

# VtoX: Taking Stocks, Looking Ahead

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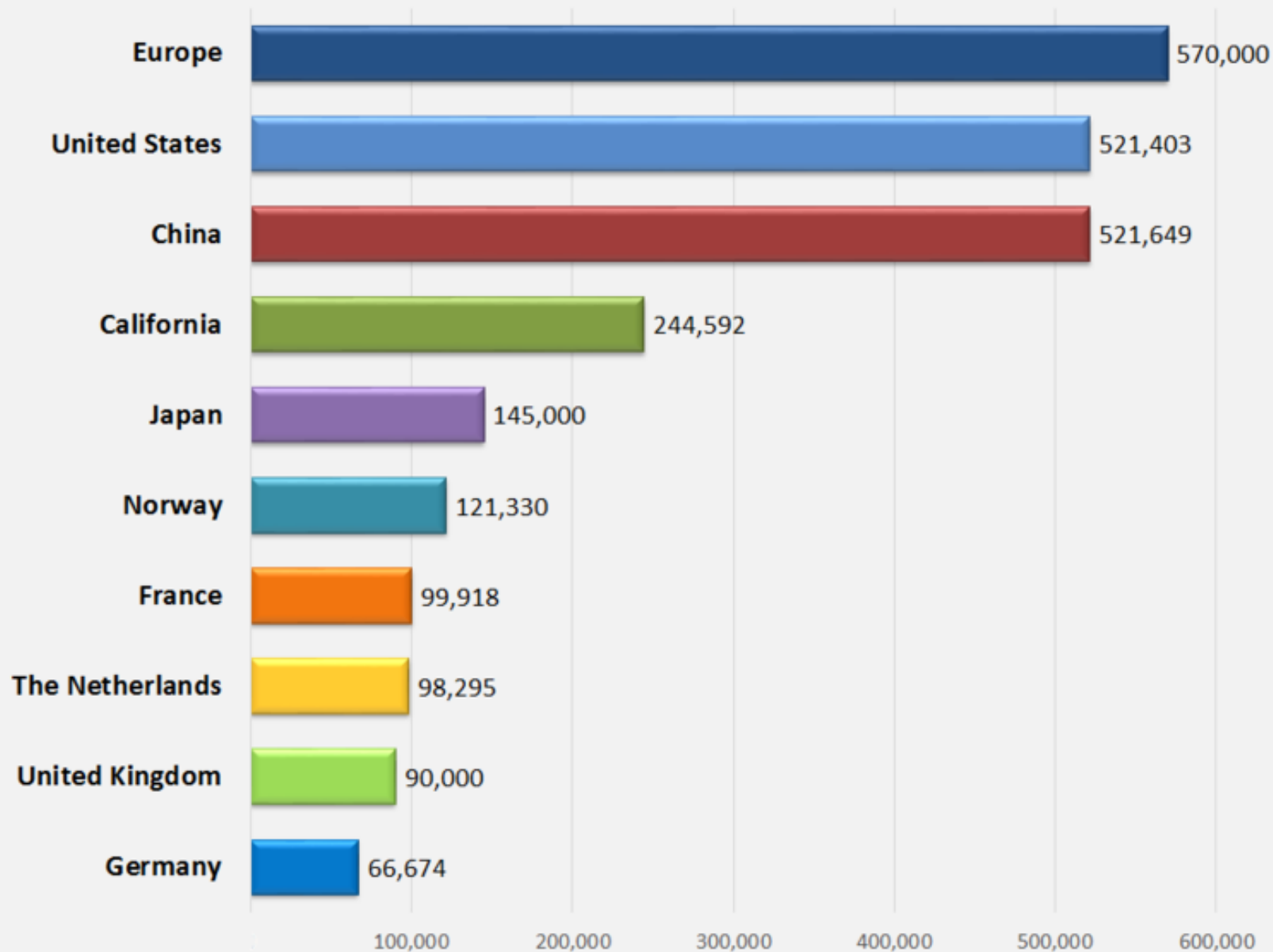
# Electric vehicles are challenging

- Vehicle to Transmission grid = VtoG
- Vehicle to Distribution grid = VtoG
- Vehicle to buildings = VtoB
- Vehicle to Home = VtoH
- Vehicle to Load = VtoL

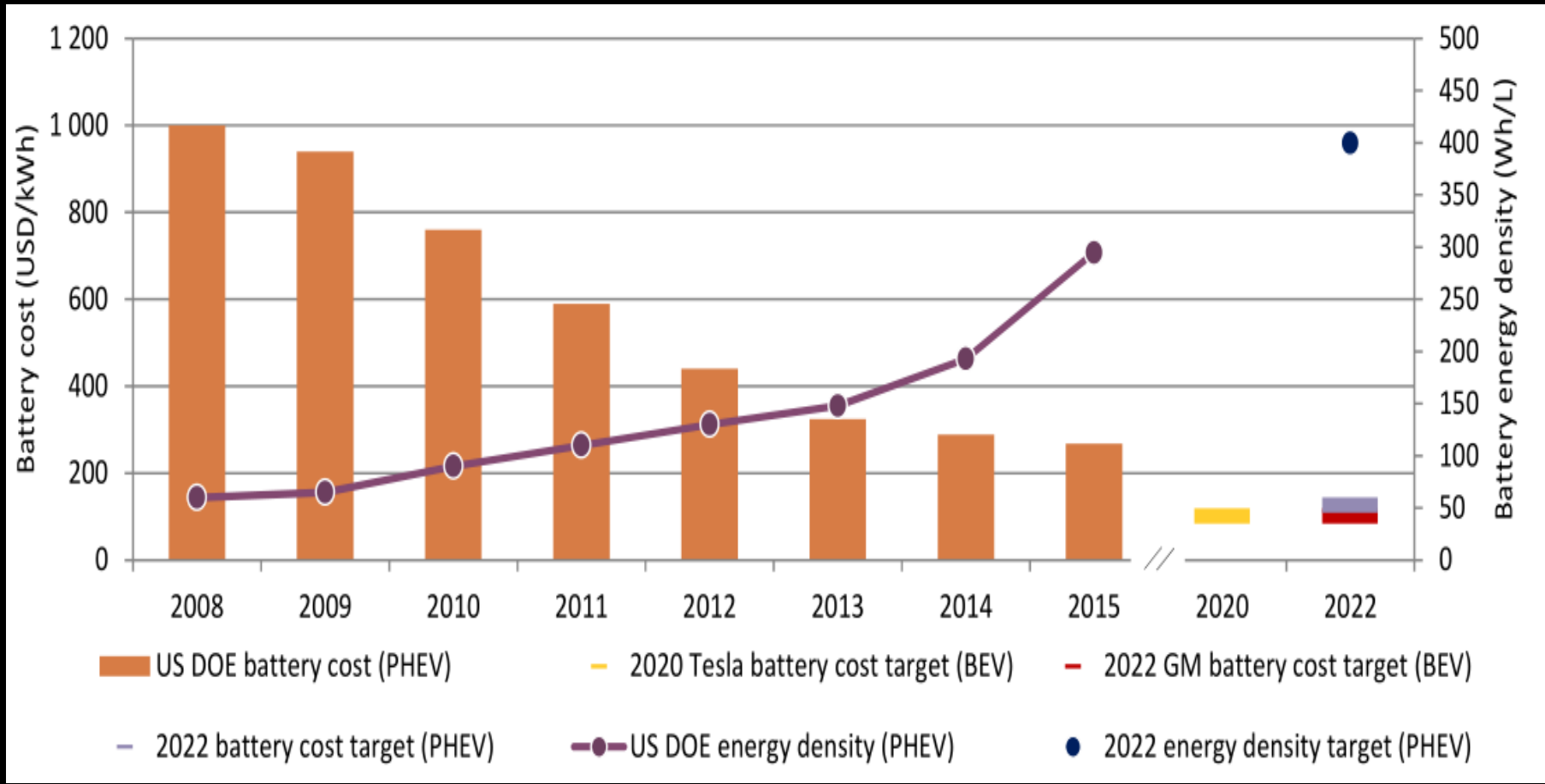
# Outline

1. The electromobility challenge for energy regulation
2. Solution by markets coordination
3. Solution by contrats
4. Conclusion

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

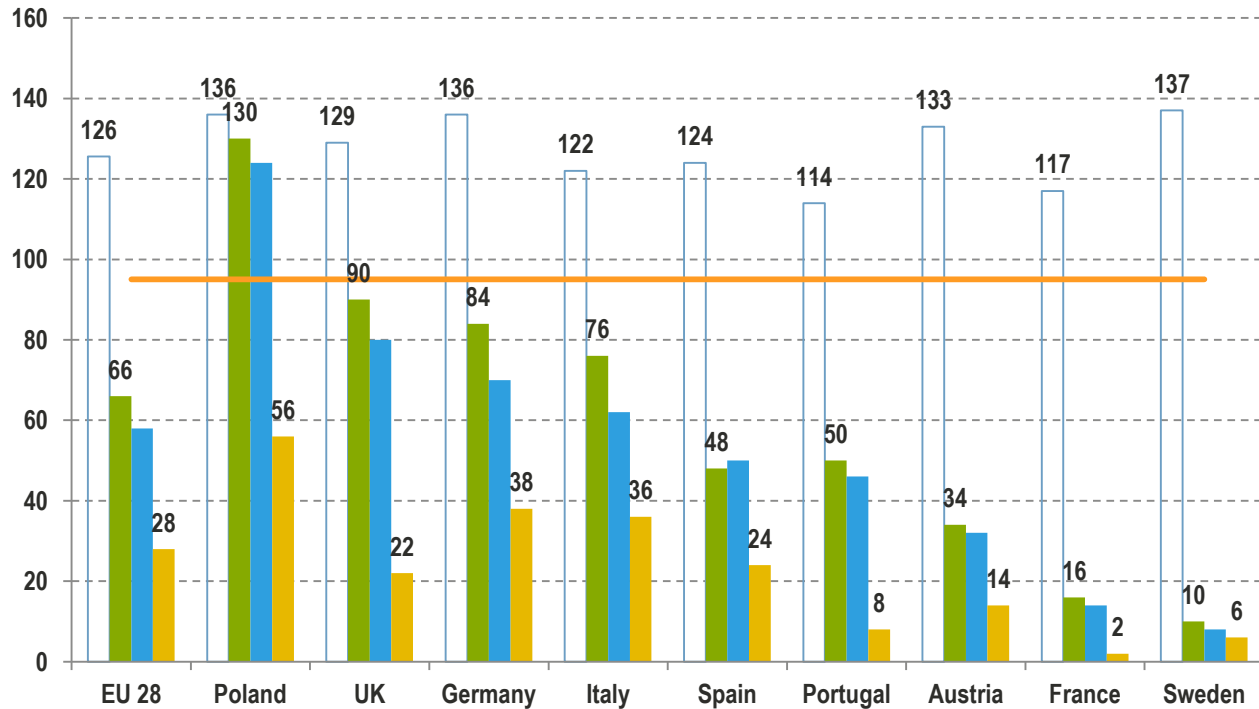


# EVs enjoy a Double dynamic: Increase in ENERGY DENSITY & decrease of COST



Source: IEA Global EV Outlook 2016

# EVs emit less CO<sub>2</sub> than conventional cars



□ Average of CO<sub>2</sub> of new cars

■ Average of CO<sub>2</sub> EVs (2015)

— 2021 Goal 95 gr

■ Average of CO<sub>2</sub> EVs (2010)

■ Average of CO<sub>2</sub> EVs (2035)Ref Scenario 2013

- With the 2010 carbon intensity, a typical EV emits about 66g CO<sub>2</sub>/km
- EVs will be even cleaner in the future as the power sector continues to decarbonise by 2050

# 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:
  - 100.5 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%
  - Today Fast charger technologies are booming : 120 kW to 400 kW
  - + local issues with distribution grid / RES

# The electricity sector needs more flexibility provision

Connected EV Fleets are potentially very flexible resources...



# Outline

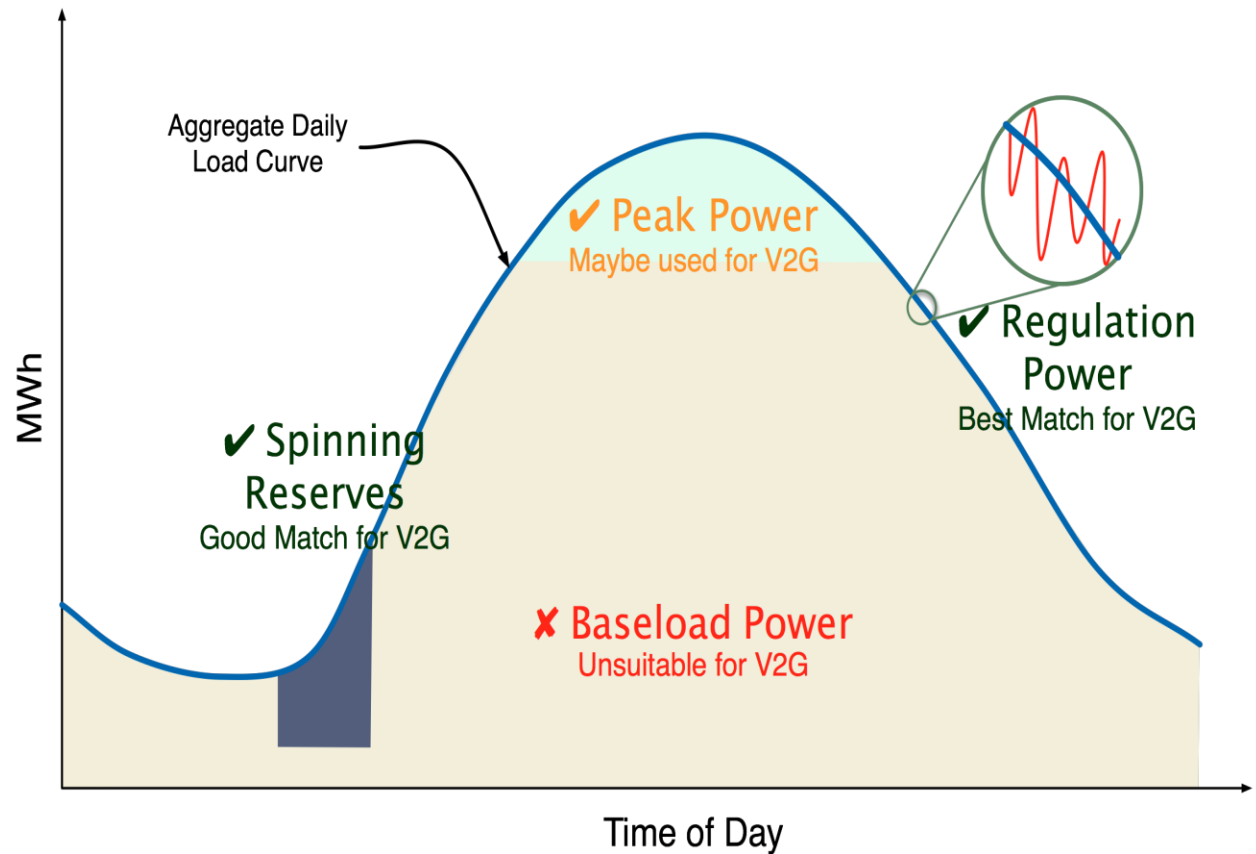
1. The electromobility challenge in energy  
Regulation
2. **Solution by market coordination**
3. Solution by contrats
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# EV fleet for one Market or for Markets?

## Which possible markets?

Profitable markets for EVs:

- little amount of energy, quick responsiveness
- remuneration based on availability and not utilization



# Bigdata combination to create “bundle of valuable flexible resources” for energy markets

Times	MW or MWh	Services on market base if exist
<b>Second</b>	MW	<ul style="list-style-type: none"> <li>- <b>Frequency regulation</b></li> <li>- Voltage regulation</li> <li>- Quality of delivery</li> </ul>
<b>Hour</b>	MW Or MWh	<ul style="list-style-type: none"> <li>- Terciary reserve market</li> <li>- Demand response</li> <li>- Balancing services</li> <li>- Congestion management</li> <li>- Intraday-market</li> <li>- Coupling With RES</li> <li>- ...</li> </ul>
<b>Block orders</b>	MWh	<ul style="list-style-type: none"> <li>- Day head market</li> <li>- Time of Use</li> <li>- Coupling with RES</li> <li>- ...</li> </ul>

# Frequency remunerations for EV : PJM real case / France exploration/ Denmark under construction

Charging point capacity (kW)		Revenus /VE/ year
Primary	Secondary	
3	0	179,4 €
3	3	310,7 €
3	7	505,7 €
3	22	1346,8 €
7	0	474,5 €
7	3	543,4 €
7	7	780 €
7	22	1448,2 €

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

Sources: Codani, Petit & Perez (2016)

# Conclusion on Frequency regulation

Rules of the game are created for  
previous generation technologies  
and  
they act as barrier to entry for new tech

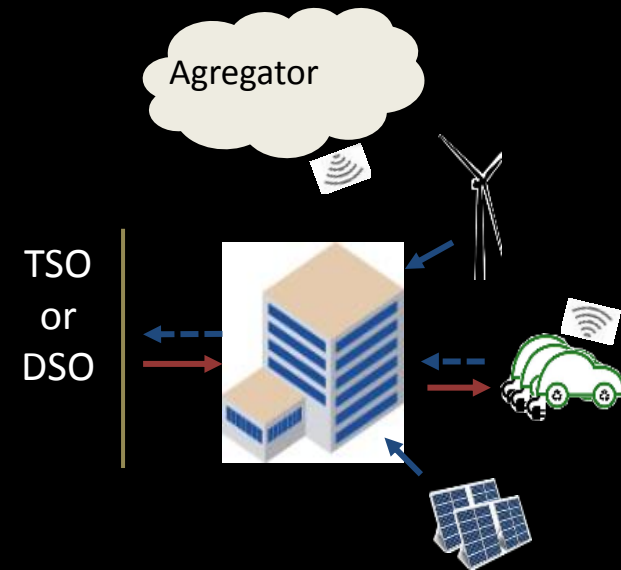
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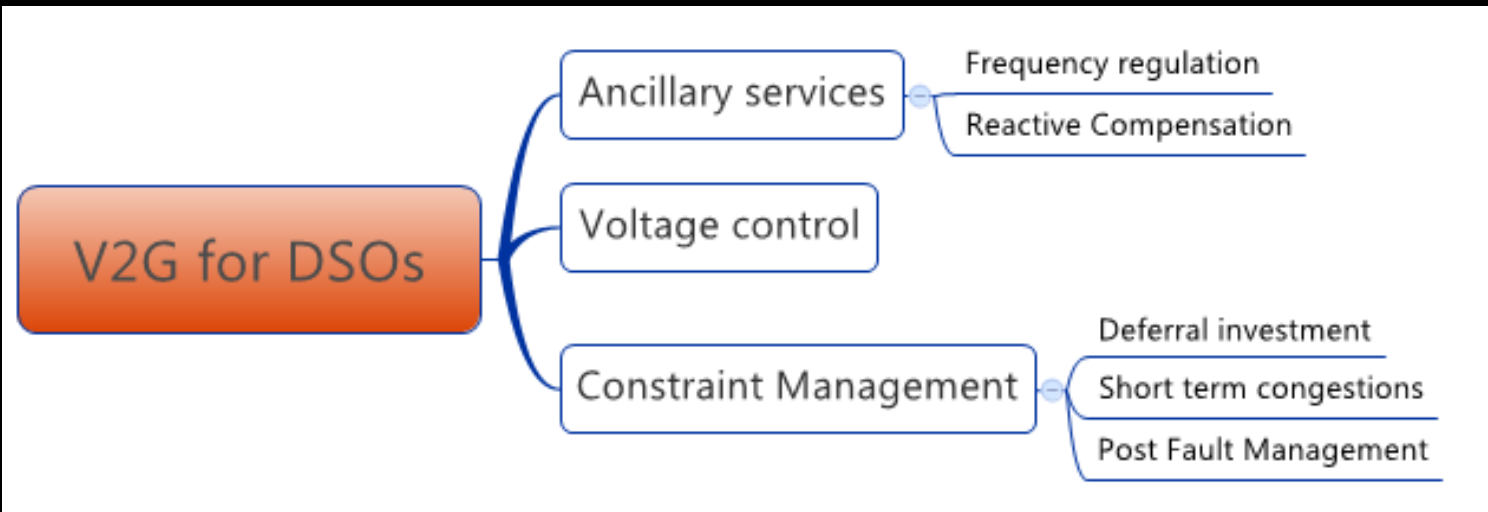
# Contractual solutions for VtoB

- 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

## Vehicle-to-building



# Contractual solution with the Distribution Service Operator (DSO)



If V2G avoids investments, at least the value of V2G has to equal 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 proposes implicitly “off grid green” solution
  - Home Storage Solution + Solar Roof + EV with 100kWh batteries...



# Conclusions

# Flexibility provision with EV fleets

- **Not perfectly done yet...**
  - VtoG experiment around the world (US / Denmark...)
  - Major success with regulation power : mainly frequency
- **3 Main problems to overcome**
  - Rules and Market regulation are barrier to entry for EV Fleets in most VtoG services or markets
  - Communication standards (15118 / CHAdeMO...) need to be clarified
  - Engaging cooperation between Electricity and automotive industries for optimal charging infrastructure deployment

# 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

- Codani Paul, Perez Yannick and Petit Marc 2016, *Financial Shortfall for Electric Vehicles: economic impacts of Transmission System Operators market designs*, **Energy**, Volume 113, pp 422-431.
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