

VtoX: Taking Stocks, Looking Ahead

Yannick Perez

RITM - University Paris-Sud, LGI CentraleSupélec

&

Armand Peugeot Chair

(CentraleSupélec & Essec Business School)

Yannick.perez@supelec.fr

Electric vehicles are challenging for Grid operators

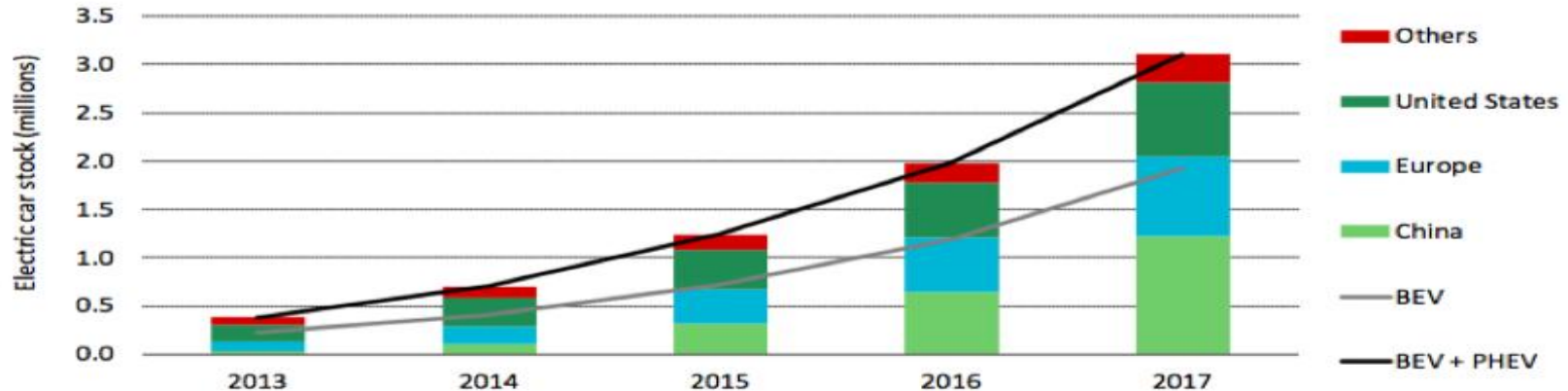
1. Vehicle to Transmission grid = Vto TG
 2. Vehicle to Distribution grid = Vto DG
 3. Vehicle to buildings = VtoB
 4. Vehicle to Home = VtoH
 5. Vehicle to Load = VtoL
- => VtoX

Outline

1. **The electromobility challenge in energy markets**
2. Solution by market coordination
3. Solution by contracts
4. Conclusion

Sales are booming

Figure ES 1 • Evolution of the global electric car stock, 2013-17



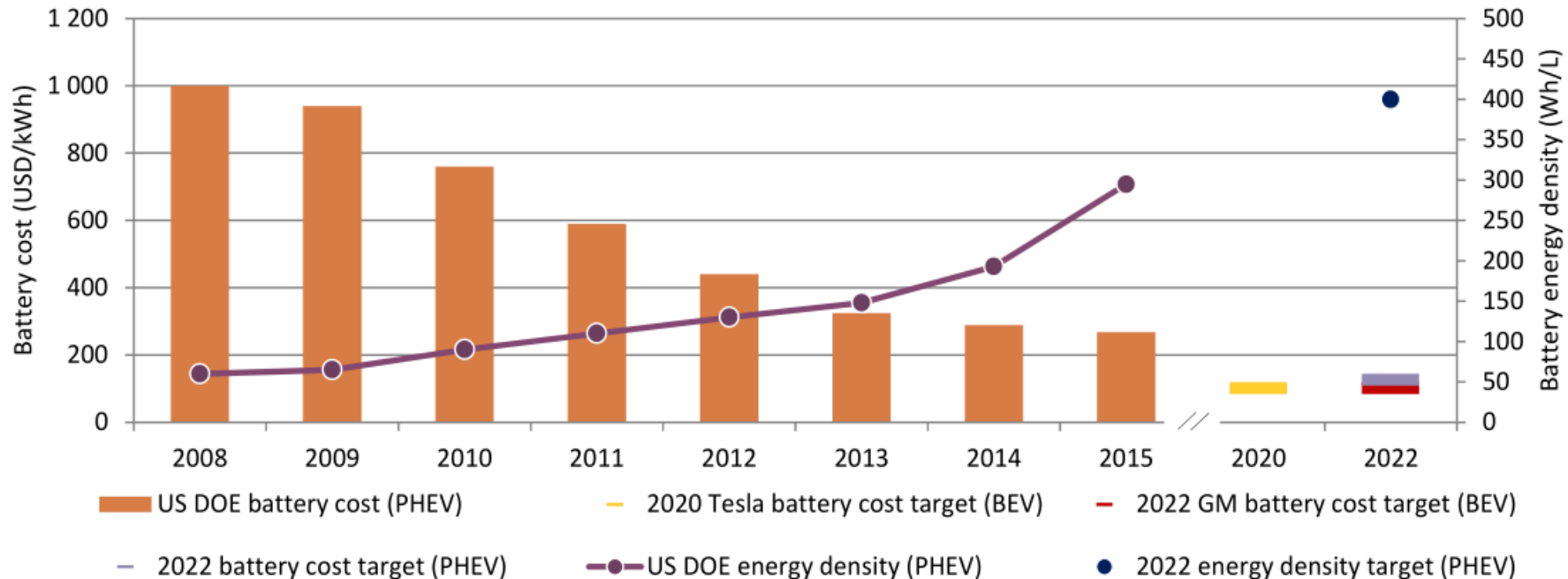
Notes: The electric car stock shown is primarily estimated on the basis of cumulative sales since 2005. Where available, stock numbers from official national statistics have been used (provided that the data can be shown to be consistent with sales evolutions).

Sources: IEA analysis based on country submissions, complemented by ACEA (2018); EAFO (2018a).

Key point: Global electric car stock is expanding rapidly, crossing the 3 million vehicle threshold in 2017.

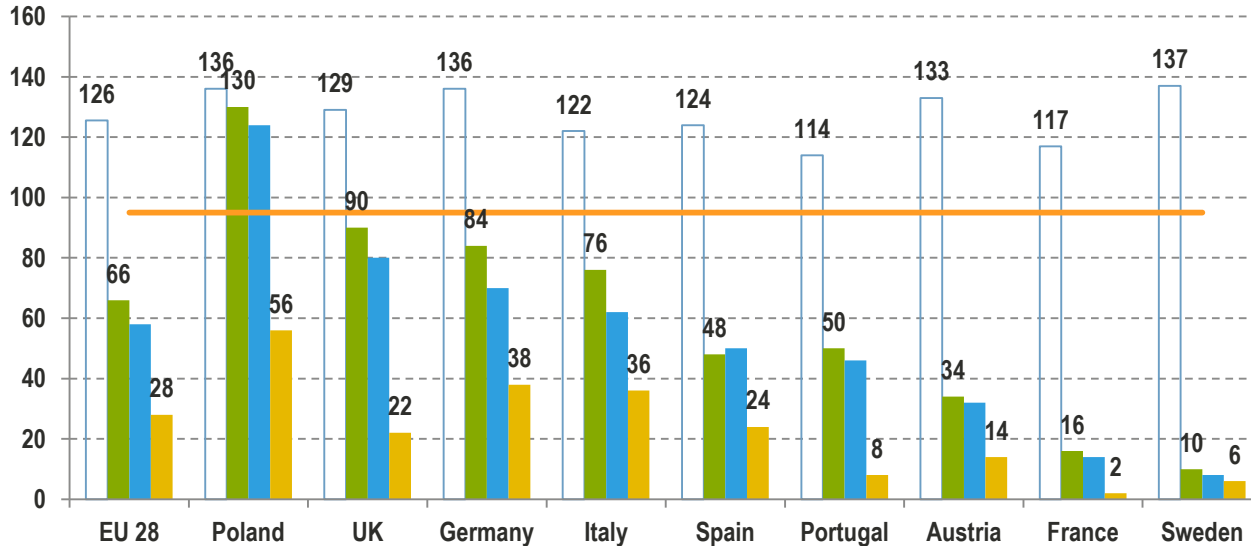
Source: IEA Global EV Outlook 2018

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



Source: IEA Global EV Outlook 2016

EVs emit less CO₂ than conventional cars



□ Average of CO2 of new cars
■ Average of CO2 EVs (2010)
■ Average of CO2 EVs (2015)
■ Average of CO2 EVs (2035)Ref Scenario 2013
— 2021 Goal 95 gr

- With the 2010 carbon intensity, a typical EV emits about 66g CO₂/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)

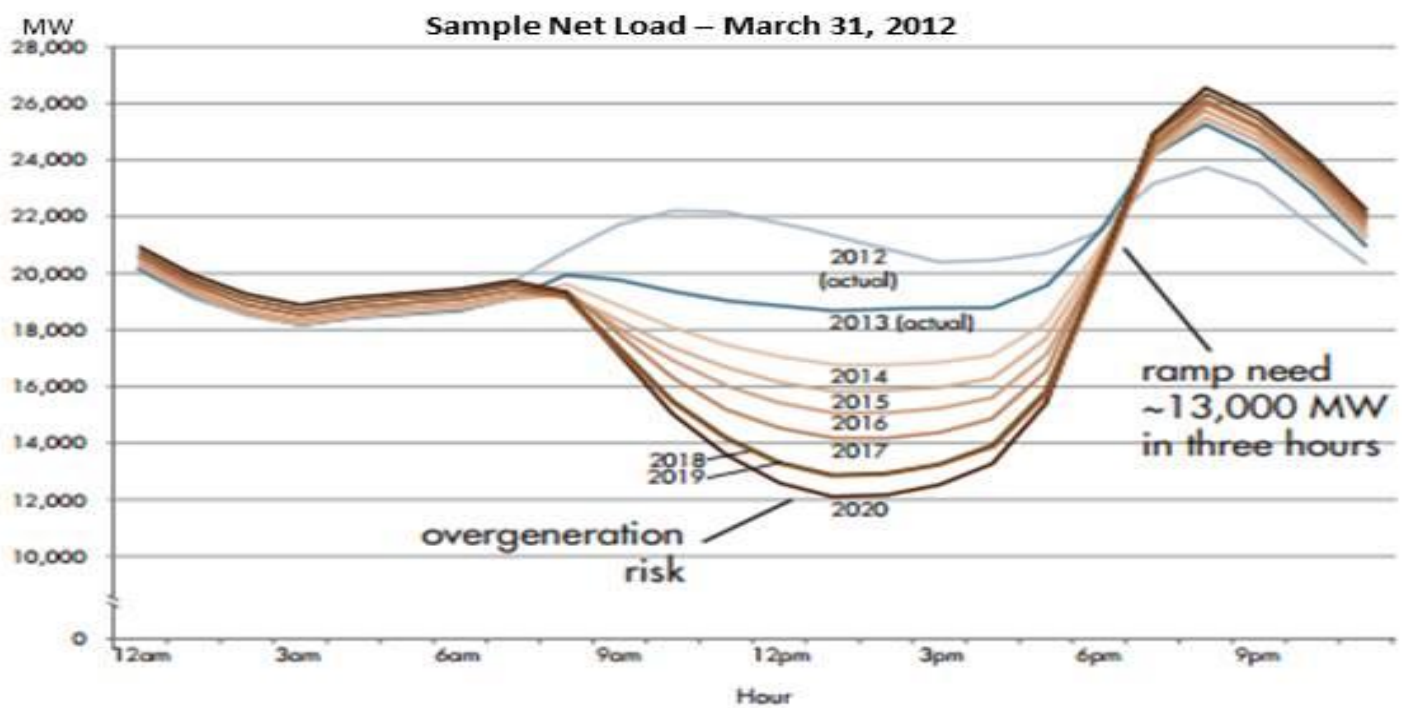
- In France
- 2020 : 525 000 VE – VHR
 - = 1,3 TWh (source : RTE)
 - 0,2% of the total
 - => no energy problem

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

More PV => more Duck issues => more flexibility

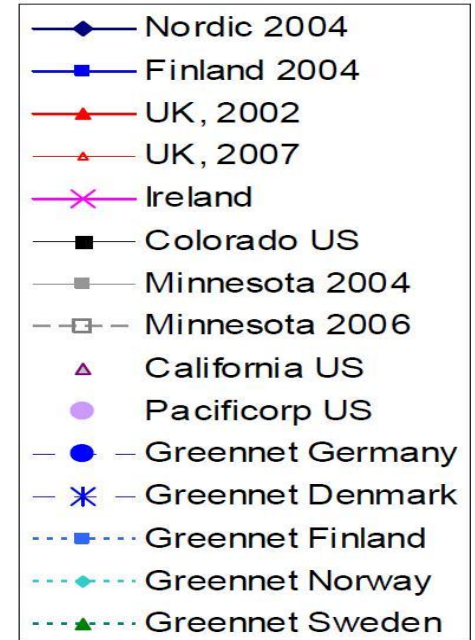
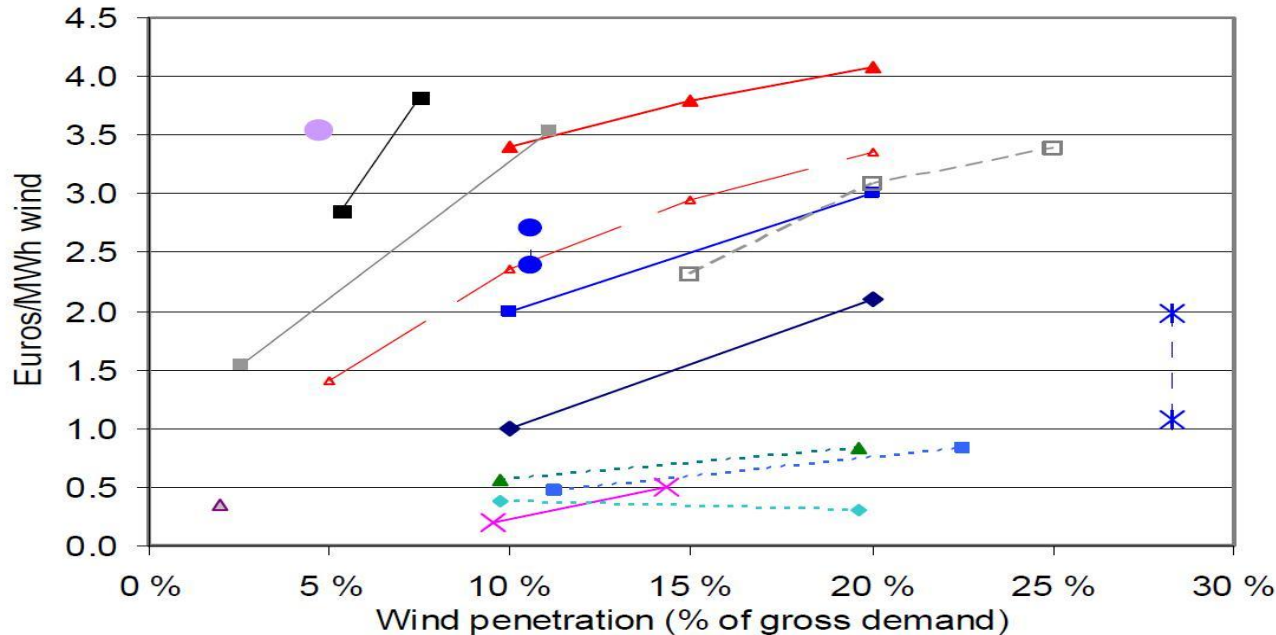
The duck curve shows steep ramping needs and overgeneration risk



(from the California Independent System Operator)

More wind => more flexibility required

Increase in balancing cost



The electricity sector needs more flexibility

Connected EV Fleets are potentially very flexible
ressources...

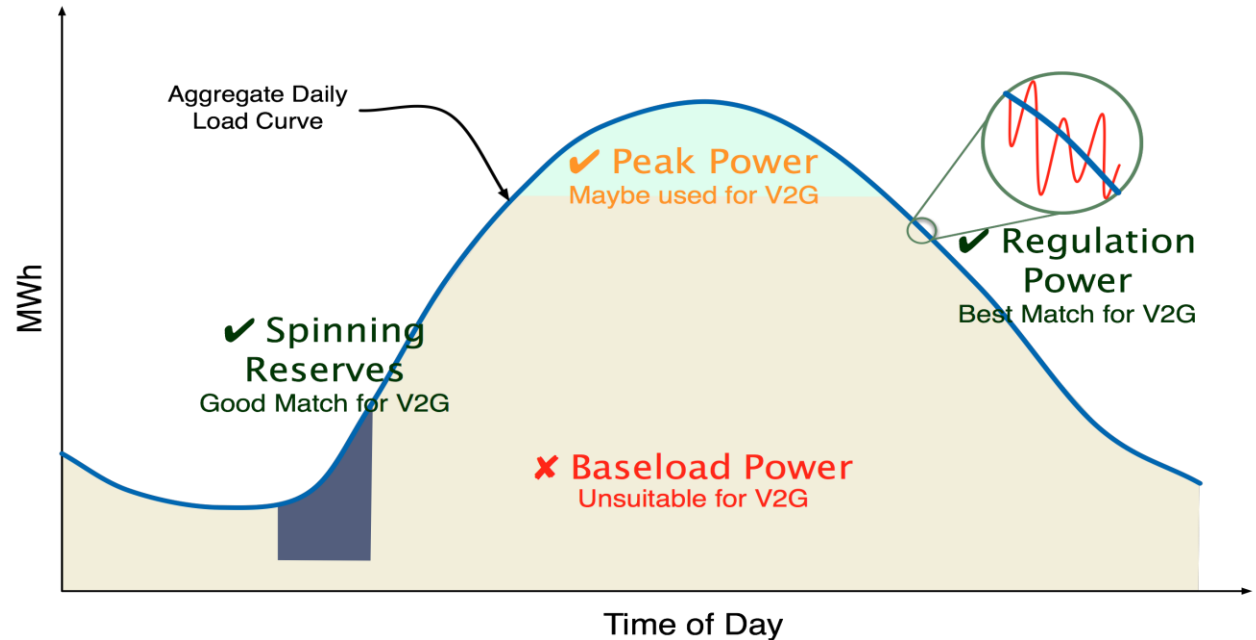
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EV fleet for one Market or for Markets?

Profitable markets for EVs:

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



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

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

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 €

But

Rules of the game are created for previous technologies

Size of the bids / Time granularity...

and

they act as barrier to entry for new tech

See Borne et al. (2018 a and b)

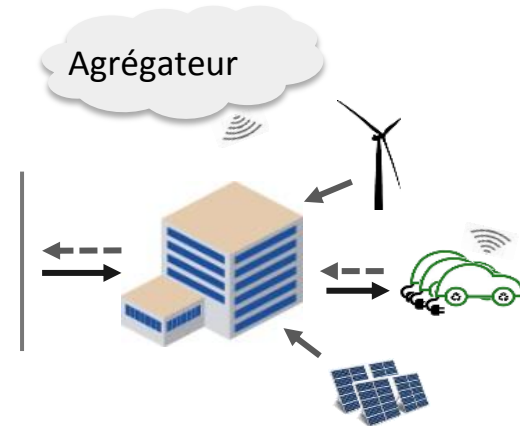
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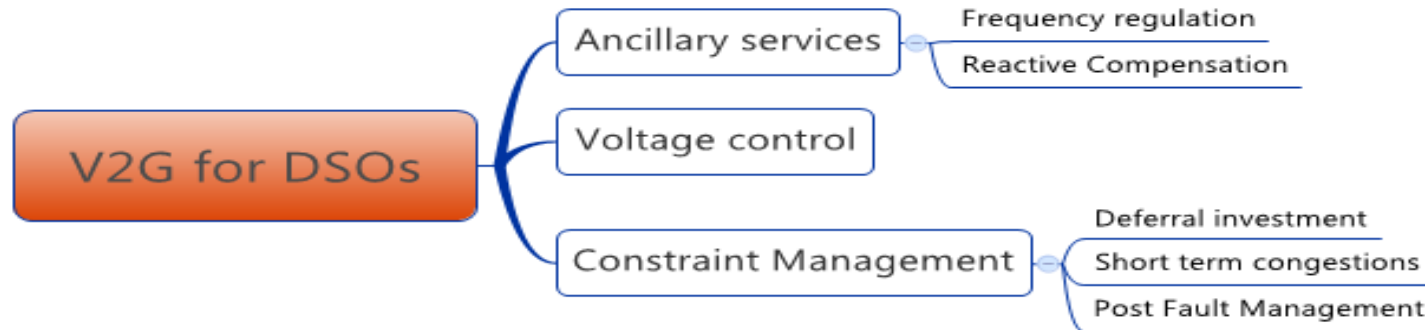
Contractual solutions for VtoB

- Objectives of the site manager
 - Minimizing energy cost over time
 - Maximizing self consumption of local renewable energies
 - Minimizing the peak demand toward networks
 - Limiting the investments in networks reinforcements
- 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 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
 - Distribution grid services provision (optional)

Vehicle-to-home



And the off-grid « solution » VtoL

- “Tesla-Solar City” proposes implicitly “off grid - green” solution



Conclusions

Electric vehicles are challenging for Grid operators

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If cooperation

If no cooperation

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?



18 & 19 juin 2018
Cité des Congrès de Nantes

Selected Literature

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