

Trying to push for innovation between two industries: the VtoX experiment

Yannick Perez

RITM - University Paris-Sud - LGI CentraleSupélec

&

Armand Peugeot Chair

(CentraleSupélec & Essec Business School)

Yannick.perez@centralesupelec.fr

Electric vehicles are challenging for Grid operators

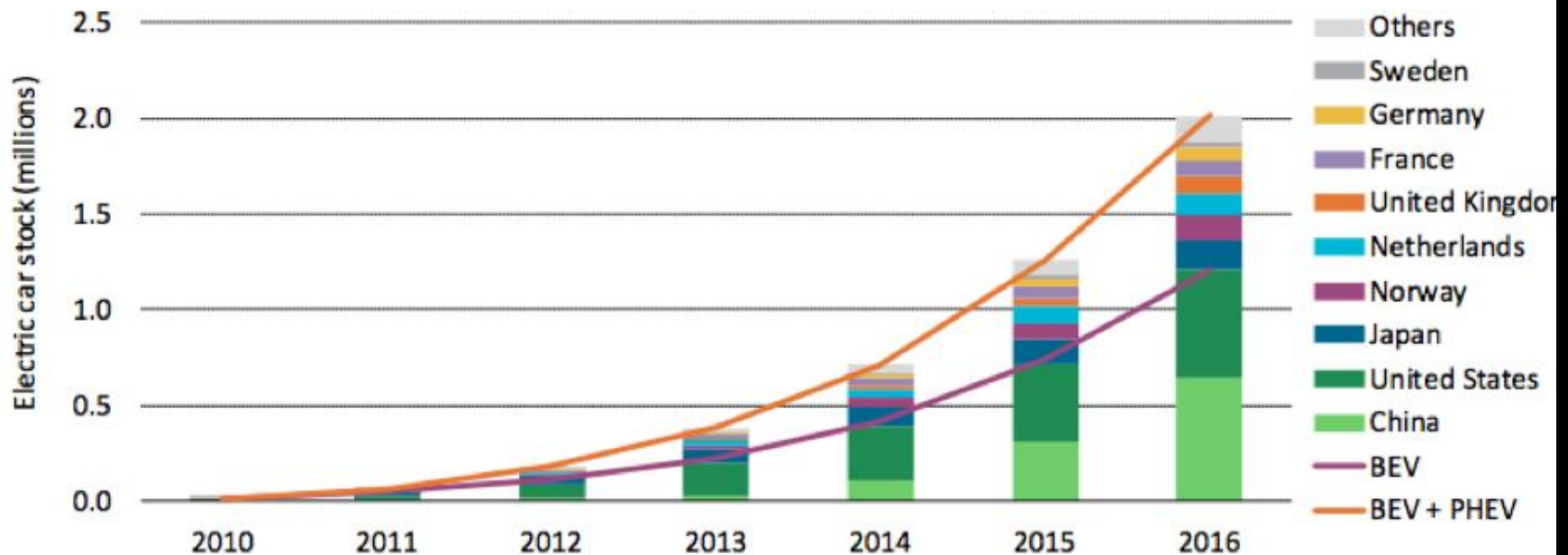
1. Vehicle to Transmission grid = VtoG
 2. Vehicle to Distribution grid = VtoG
 3. Vehicle to buildings = VtoB
 4. Vehicle to Home = VtoH
 5. Vehicle to Load = VtoL
- => VtoX

Outline

1. The electromobility challenges
2. Solution by markets coordination
3. Solution by contracts
4. Conclusion

Sales are booming

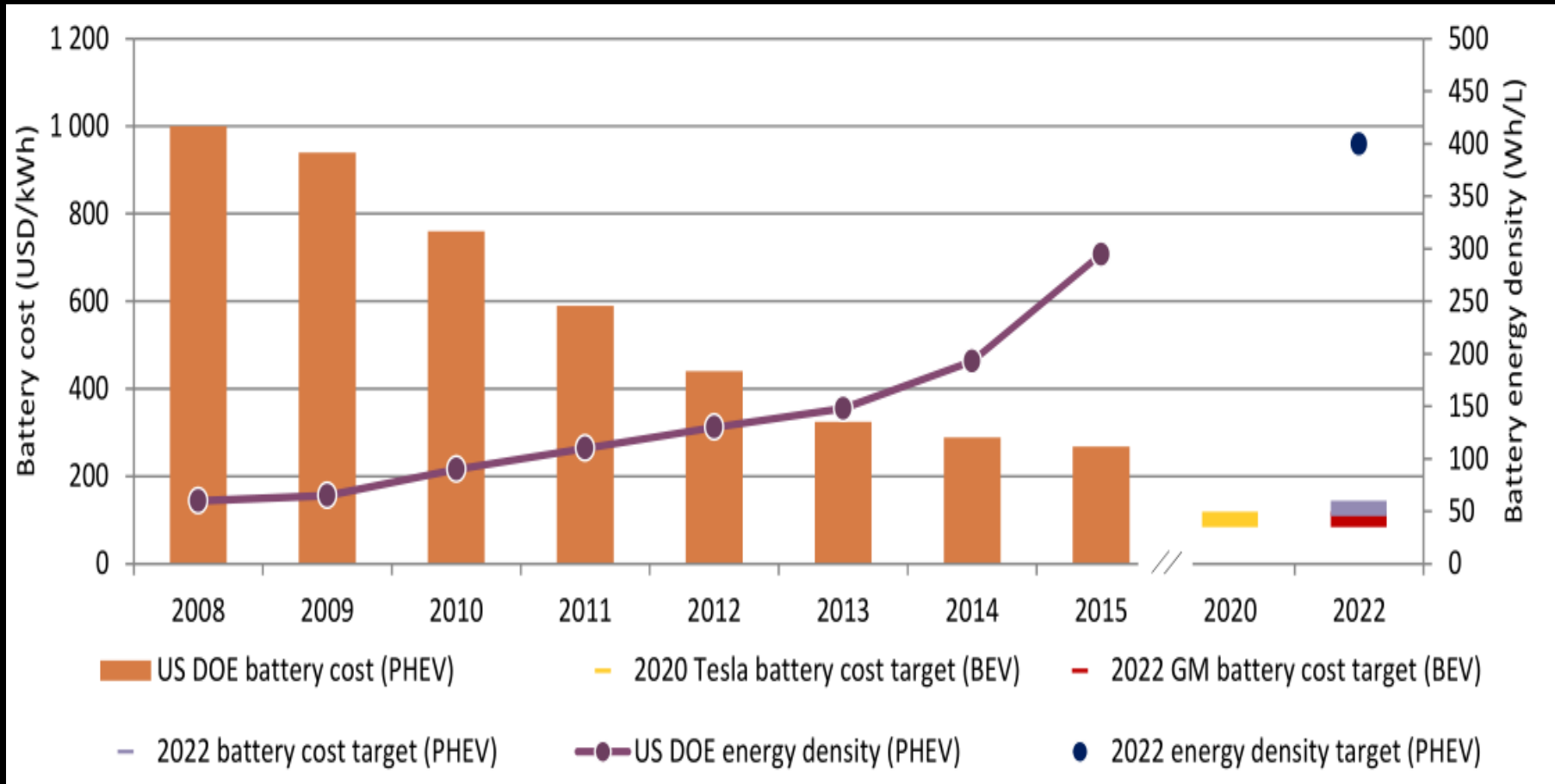
Figure 1 • Evolution of the global electric car stock, 2010-16



Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.

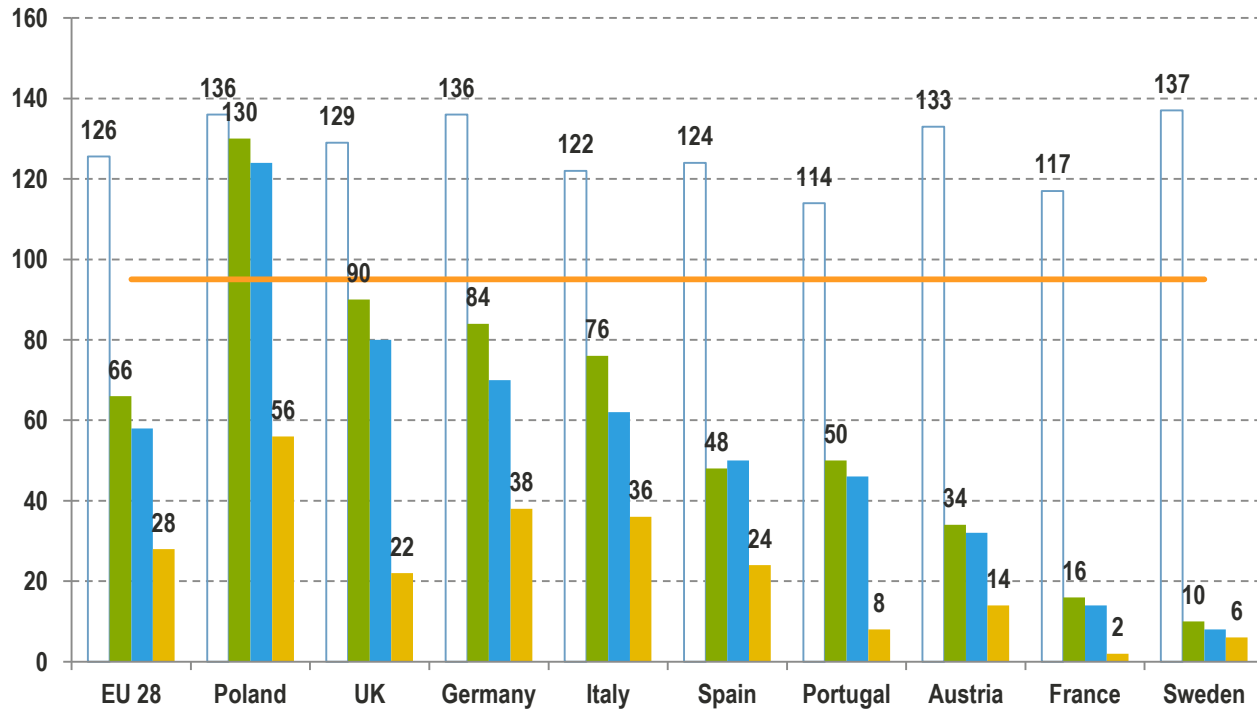
Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a), IHS Polk (2016), MarkLines (2017), ACEA (2017a, 2017b) and EEA (2017).

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 (2015)

— 2021 Goal 95 gr

■ Average of CO₂ EVs (2010)

■ Average of CO₂ EVs (2035)Ref Scenario 2013

- 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

The electricity sector needs more flexibility provisions

Connected EV Fleets are potentially very flexible resources...

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 GW
 - 3% per year
 - + 28% in 10 years
- 2020 : 525 000 VE
 - 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

Outline

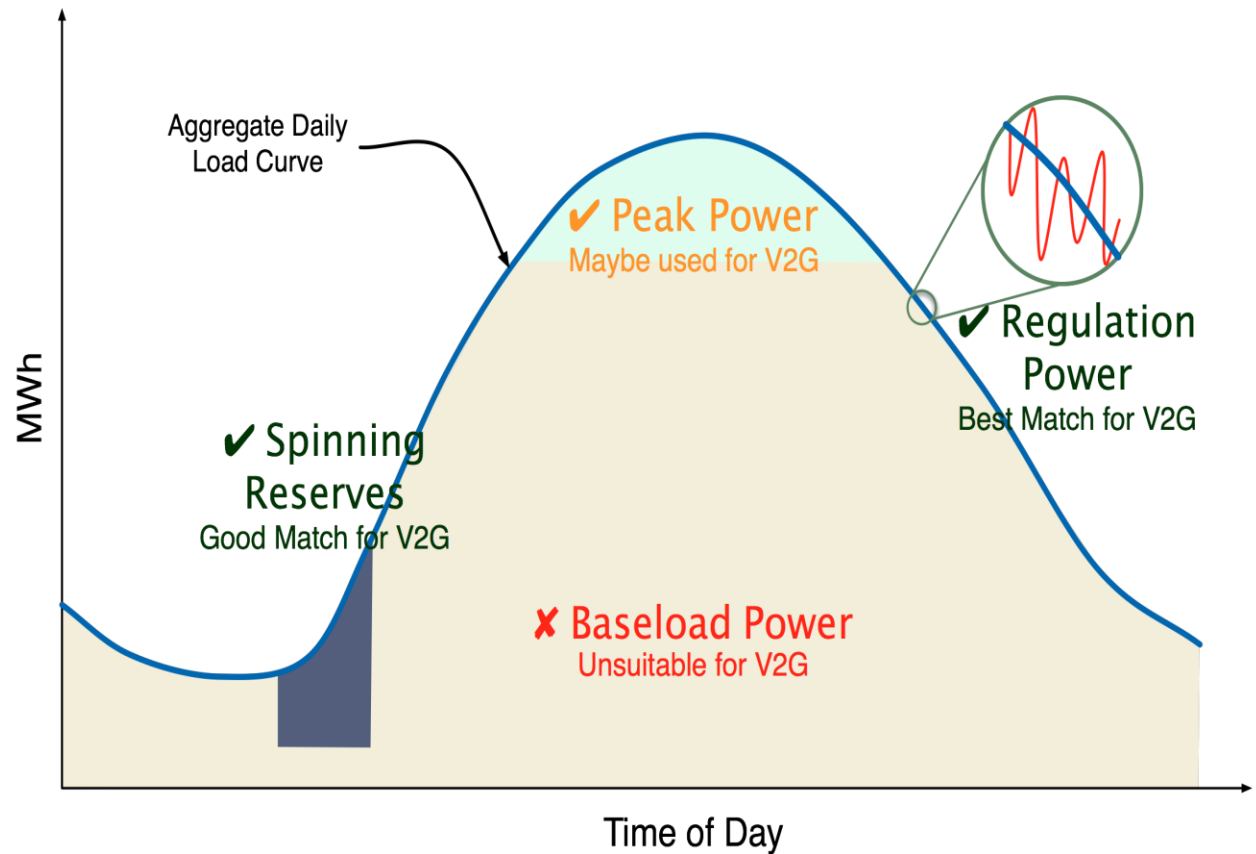
1. The electromobility challenges
2. Solution by market coordination (cooperation)
3. Solution by contracts
4. Conclusion

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 unless high number of EVs



Step 1: Proof of concept

Frequency participation with EV fleets:

PJM – Denmark – Netherlands – (France :

Launching phase for reserves + balancing market)

**1500 €/ year and per car
in PJM Zone**

**For « 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 €

Sources: Codani, Petit & Perez (2016)

But

Rules of the game are created for previous
generation technologies

Size of the bids / Time granularity...

and

they act as barrier to entry for new tech

See Borne et al. (2018)

How to push for innovation?

How to push for innovation?

Looking for technical solutions + Forum creation on Electromobility

- Since 2013, Armand Peugeot chair organises a international conference “forum type” (academics + regulators + industrial actors) for experiments sharing and identification of the new challenges to be overcome
 - Paris conferences 2013 – 2014 -2016 -2017
 - Singapore 2015
 - EU Workshop of FSR with EU regulators 2017 & 2018

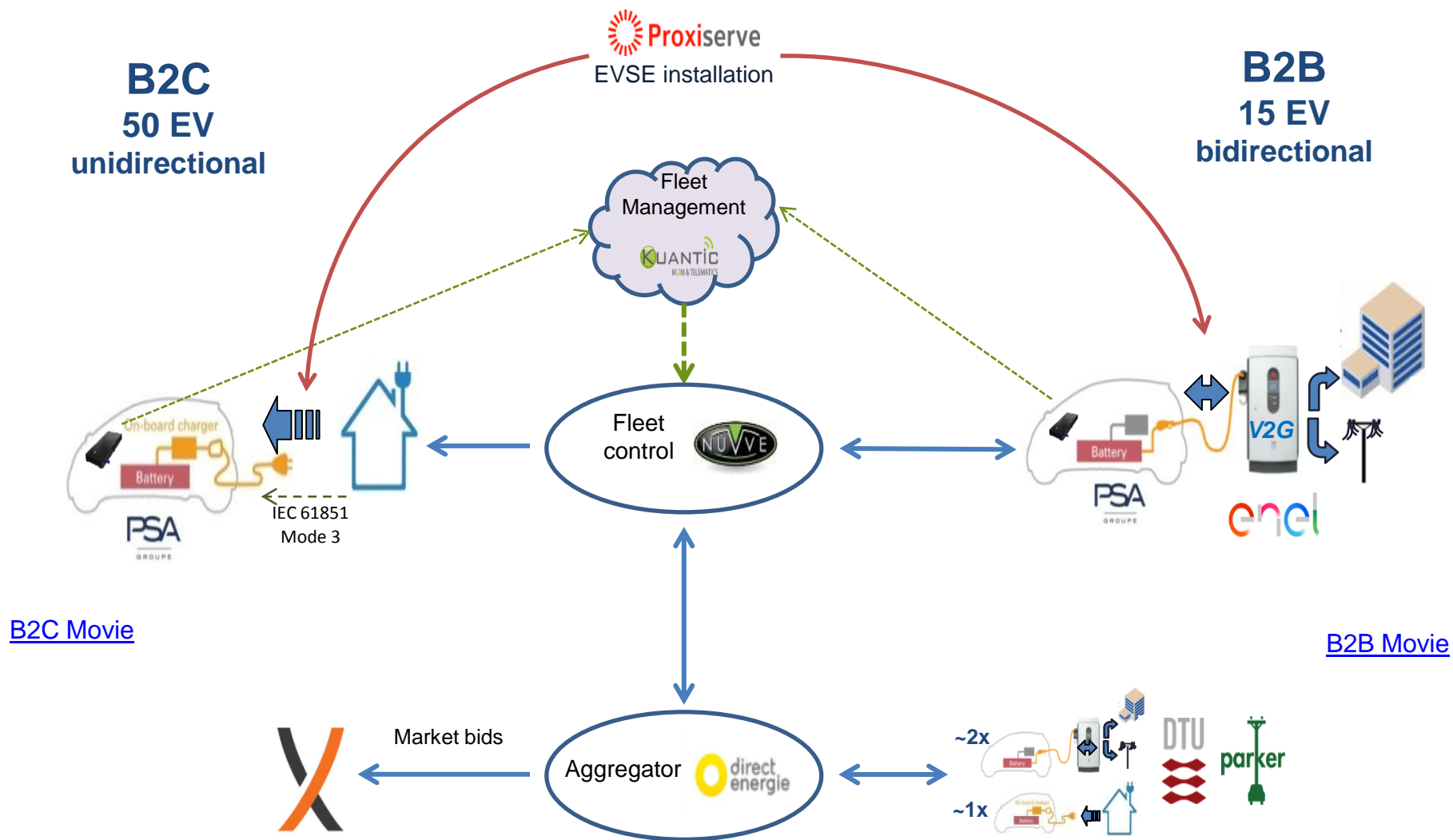
Thursday 14th December 2017
Location : Salle R. Aron - Dauphine University

08h15– 08h45	Registration
08h45– 09h00	Opening words Eric Brousseau, Chair Governance and Regulation Danièle Attias, Jan Lepoutre and Marc Petit –Armand Peugeot Chair
Session 1: International experiences	Chairman: Bernard Sahut – PSA Group
09h00 - 09h40	Perspectives on Norway’s supercharged electric vehicle policy Erik Figenbaum -Institute of Transport Economics- Norway
09h40- 10h20	<i>Japan and the Future of Automobile Industry</i> Tatsuya Suzuki - Nagoya University, Japan
10h20- 11h00	EU deployment plans for EVs Christian Thiel - JRC Petten
Coffee Break 11h00 – 11h30am	
Session 2: EV Ecosystems analysis	Chairman: Eric Brousseau, Chair Governance and Regulation
11h30- 12h10	Towards a Theory of Business Ecosystems Michael Jacobides - London School of Economics
12h10-12h50	Tesla as the creation of an EV Ecosystem Yurong Chen – CentraleSupélec and Armand Peugeot Chair
Lunch Time 12h50pm – 02h00pm	
Session 3 Field experiments	Chairman: Dominique Jamme – Commission de Regulation de l’Energie
02h00pm-02h40pm	Vehicle to Grids in the US: A review Willett Kempton- Delaware University
02h40pm-03h20pm	The Parker Project in Denmark: First results Peter Bach Andersen – DTU
03h20pm-04h00pm	GridMotion project in France Paul Codani, PSA Group
Coffee Break 04h00pm – 04h30pm	
16h30 – 17h00	EV in France in 2035 Thomas Veyrenc – RTE, France
17h00-18h15pm	Roundtable: The future(s) of electromobility Chairman: Eric Lalliard (PSA) Christophe Bonnery (Enedis); François Colet (Vedecom); Michael Jacobides (LSE); Romain Beaumes (Nexans); Willett Kempton (Delaware university), Thomas Veyrenc (RTE, France)
06h00pm end of the conference	

How to push for innovation?

Looking for technical solutions + Forum creation on Electromobility

- Since 2013, Armand Peugeot chair organises a international conference “forum type” (academics + regulators + industrial actors) for experiments sharing and identification of the new challenges to be overcome
 - Paris conferences 2013 – 2014 -2016 -2017
 - Singapore 2015
 - EU Workshop of FSR with EU regulators 2017 & 2018
- Goals are
 - to share the state of art of field experiments and projects with main actors
 - Build a network and use the other experiments
 - Build a French experiment: Gridmotion project.



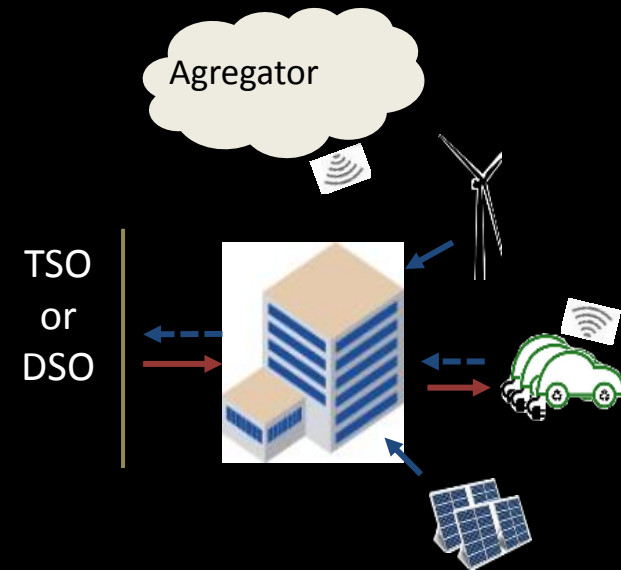
Outline

1. The electromobility challenges
2. Solution by markets coordination (cooperation)
3. Solution by contracts (no cooperation)
4. Conclusion

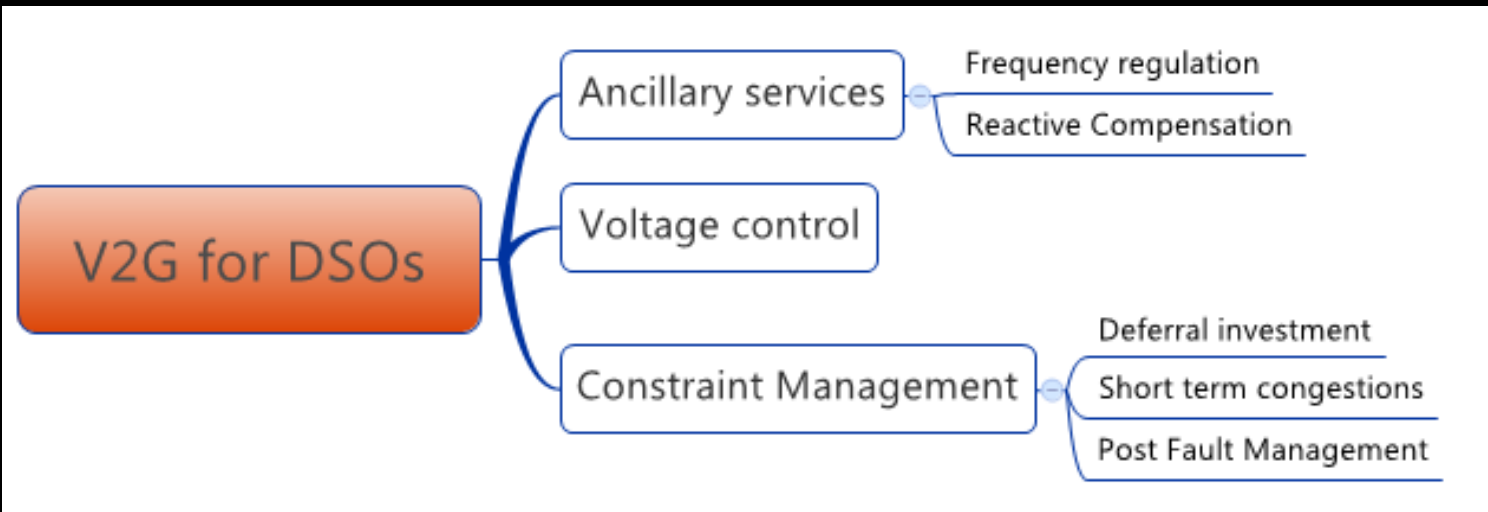
Contractual solutions for VtoB

- 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
- Actors involved : Bouygues / Renault...

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-Solar City” proposes implicitly “off grid green” solution
 - Home Storage Solution + Solar Roof + EV with 100kWh batteries...



Conclusions

Electric vehicles are challenging for Grid operators

1. Vehicle to Transmission grid = VtoG

If cooperation

2. Vehicle to Distribution grid = VtoG

3. Vehicle to buildings = VtoB

4. Vehicle to Home = VtoH

If no cooperation

5. Vehicle to Load = VtoL

3 Main problems to overcome

1. Regulations are barrier to entry for EV Fleets in most **markets**
=> To date 2 strategies are played : Test on Markets + **NC**
2. Communication Standards war (15118 / CHAdeMO...)
3. Building cooperation between Grids and automotive industries
 1. for optimal charging infrastructure deployment
 2. For Grid service provision
 3. With few habits to do it...

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

- Borne Olivier, Korte Klaas, Perez Yannick, Petit Marc and Purkus Alexandra 2018, *Barriers to entry in Frequency-Regulation Services Markets: Review of the status quo and options for improvements*, **Renewable and Sustainable Energy Review**. Volume 81, Part 1, January 2018, Pages 605–614
- 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.
- Eid Cherrelle, Codani Paul, Perez Yannick, Reneses Javier, Hakvoort Rudi, 2016, *Managing electric flexibility from Distributed Energy Resources: A review of incentives for market design*, **Renewable and Sustainable Energy Reviews**, 64 (2016) pp 237–247.
- Donada Carole and Perez Yannick 2016, *Introduction to the special issue about « Electromobility at the crossroads »*. **International Journal of Automotive Technology and Management**, Vol 16, N°1, pp 1-15, 2016.
- Donada Carole et Perez Yannick (eds) 2015, *Electromobility : Challenging Issues*. **International Journal of Automotive Technology and Management**. Vol. 15, No. 2.
- Codani Paul, Petit Marc and Perez Yannick, 2015, *Participation of an Electric Vehicle fleet to primary frequency control in France*, **International Journal of Electric and Hybrid Vehicles**, Vol 7, N°3, pp 233-249.
- Kempton Willett, Perez Yannick, and Petit Marc, 2014, *Public Policy Strategies for Electric Vehicles and for Vehicle to Grid Power*. **Revue d'Economie Industrielle**. N° 148, pp 263-291.