

The future of electric vehicle industry 2030-2040 An EU Perspective

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Questions

1. Who will be the leaders in 2030 - 2040 ?
2. How they will be leaders, technologically and strategically ?
3. How they are doing now to be leaders ?

The actual playing field

Electric Cars sold in 2015

<http://ev-sales.blogspot.de>

PI	WORLD	Dec.	YTD	%
1	Tesla Model S	8.082	50.366	9
2	Nissan Leaf	3.637	43.870	8
3	Mitsubishi Outlander PHEV	7.058	43.259	8
4	BYD Qin	1.512	31.898	6
5	BMW i3	3.409	24.083	4
6	Kandi K11 Panda EV	4.701	20.390	4
7	Renault Zoe	3.158	18.846	3
8	BYD Tang	5.503	18.375	3
9	Chevrolet Volt (1)	2.398	17.508	3
10	Volkswagen Golf GTE	3.191	17.282	3
11	BAIC E-Series EV	1.696	16.488	3
12	Zotye Z100 / Cloud EV	2.582	15.467	3
13	Volkswagen e-Golf	1.286	15.356	3
14	Audi A3 e-Tron	1.578	11.962	2
15	Roewe 550 PHEV	1.611	10.711	2
16	JAC i EV	1.581	10.420	2
17	Ford Fusion Energi	1.067	9.894	2
18	Ford C-Max Energi	1.127	9.643	2
19	Kandi K10 EV e)	1.000	7.665	1
20	Kia Soul EV	1.225	7.510	1
	TOTAL	86.434	548.210	

Blue for BEV

TOP 20 EV manufacturer

PI	WORLD	Dec.	YTD	%
1	BYD	10.925	61.726	11
2	Tesla	8.275	50.574	9
3	Mitsubishi	7.498	48.204	9
4	Nissan	3.960	47.671	9
5	Volkswagen	7.024	40.148	8
6	BMW	6.029	33.412	6
7	Kandi e)	6.201	28.055	5
8	Renault	4.234	27.282	5
9	Zotye	4.297	24.516	4
10	Ford	2.294	21.326	4
11	Chevrolet	2.551	20.233	4
12	BAIC	1.747	17.040	3
13	Chery	2.792	14.162	3
14	Audi	1.596	12.123	2
15	SAIC Roewe	1.730	11.123	2
16	Mercedes	2.133	10.870	2
17	JAC	1.581	10.420	2
18	Volvo	3.902	10.161	2
19	Kia	1.341	7.626	1
20	Porsche	687	6.532	1

Actual EU leaders for BEV

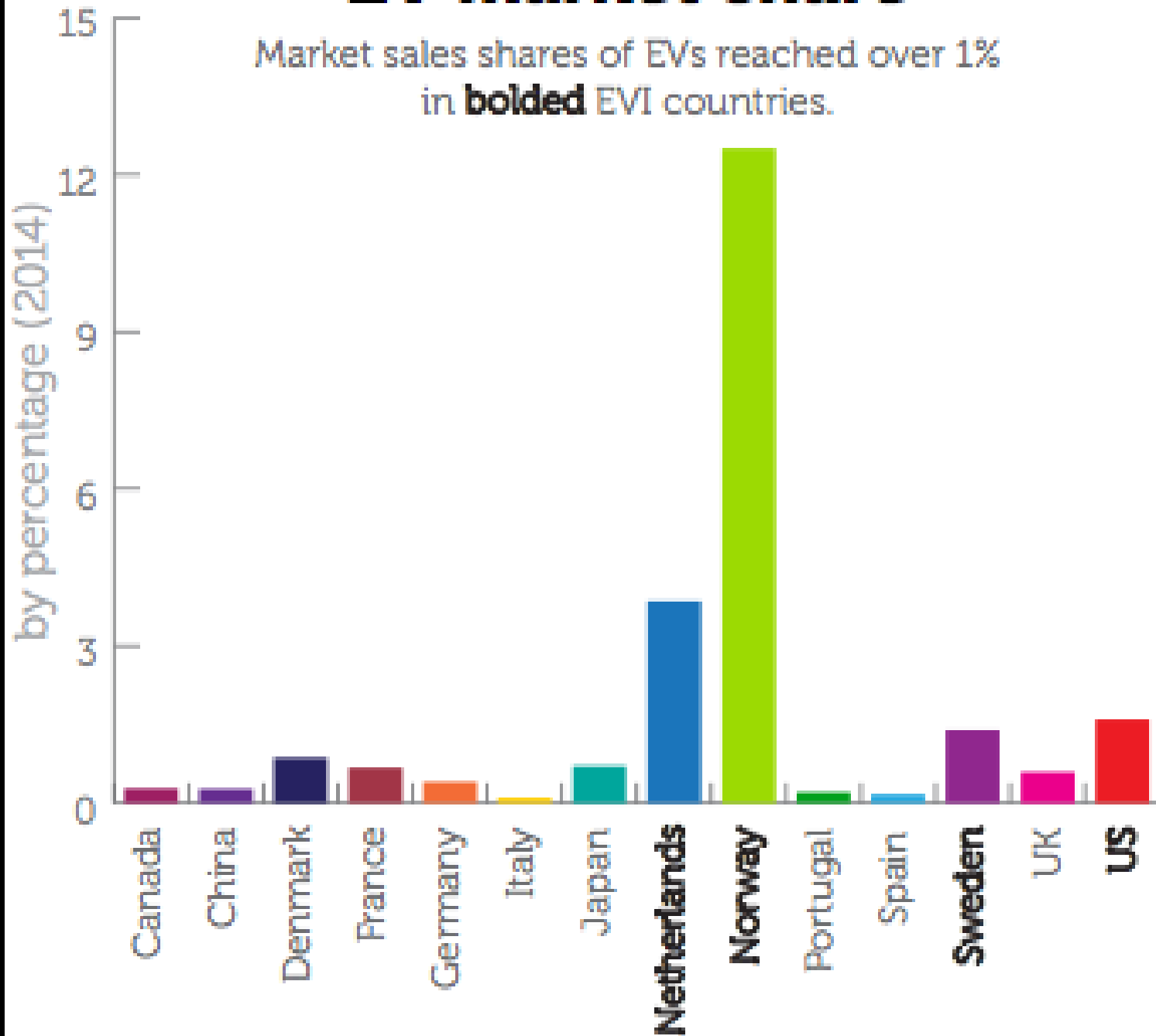
PI	Europe	Dec.	2015	%
1	Mitsubishi Outlander PHEV	6.475	31.340	16
2	Renault Zoe	3.114	18.670	10
3	Volkswagen Golf GTE	3.191	17.282	9
4	Tesla Model S	3.124	16.455	9
5	Nissan Leaf	839	15.515	8
6	BMW i3	1.718	11.820	6
7	Audi A3 e-Tron	1.514	11.711	6
8	Volkswagen e-Golf	677	11.124	6
9	Volvo V60 Plug-In	1.906	6.952	4
10	Kia Soul EV	975	5.800	3
11	Mercedes C350e	1.624	5.069	3
12	Volkswagen Passat GTE	2.357	4.686	2
13	Renault Kangoo ZE	742	4.328	2
14	Porsche Cayenne Plug-In	381	3.350	2
15	Nissan e-NV200 / Evalia	270	3.049	2
16	Volkswagen e-Up!	182	2.769	1
17	Mercedes B-Class ED	182	2.760	1
18	Volvo XC90 T8 PHEV	1.633	2.653	1
19	Renault Twizy	118	1.917	1
20	BMW i8	115	2.027	1
21	Smart Fortwo ED	56	2.013	1
22	BMW X5 40e PHEV	838	1.649	1
23	Peugeot iOn	189	1.566	1
24	Ford C-Max Energi	538	1.230	1
25	Bolloré Blue Car	83	1.166	1
26	Citroën C-Zero	41	1.118	1
27	Mercedes S500e	108	807	0
28	Mitsubishi i-Miev	23	708	0
29	Toyota Prius Plug-In	39	704	0
30	Porsche Panamera Plug-In	46	606	0
	TOTAL	33.717	193.439	100

Blue for BEV

Per country

EV market share

Market sales shares of EVs reached over 1%
in **bolded** EVI countries.



The main problem with EVs sales

The chicken and egg issue for BEVs

What is the BEV « Chicken and Egg » problem ?



- Average BEV can not run for more than 150-200 km
- So little sales
- So no need to build a charging network for Evs
- So EVs can not be largely sold...

3 models for BEV developpement in Europe

NISSAN – RENAULT

VS

TESLA

VS

BOLLORE

The NISSAN RENAULT strategy

How NISSAN deal with C&E?

- Small batteries to sell or to rent
- Looking for cooperation with Energy providers to build efficient charging stations (ENDESA)
- Looking for joint investments to develop a fast charging station safety network around big cities (Paris Exemple) => intense public lobbying

BP-NISSAN and city of Paris: 1st fast charging station 10 dec 2013



boulevard Victor
5€ per charge



The TESLA strategy

How TESLA deal with C&E?

- Large batteries for more autonomy
- Massive investments in the development of very fast charging stations
- No cooperation with local electricity actors but Vertical Integration



Superchargers today (120kW) for 30 m charging for 170 miles for free (+ wifi)



The EV Carsharing strategy

How EV Carsharing deal with C&E?

- A public private partnership with municipalities : Risk is shared
- Renting solution for EVs => intensive use on small distances... with IT management
- Using an EV not possessing it.
- The Autolib example



The parisian exemple

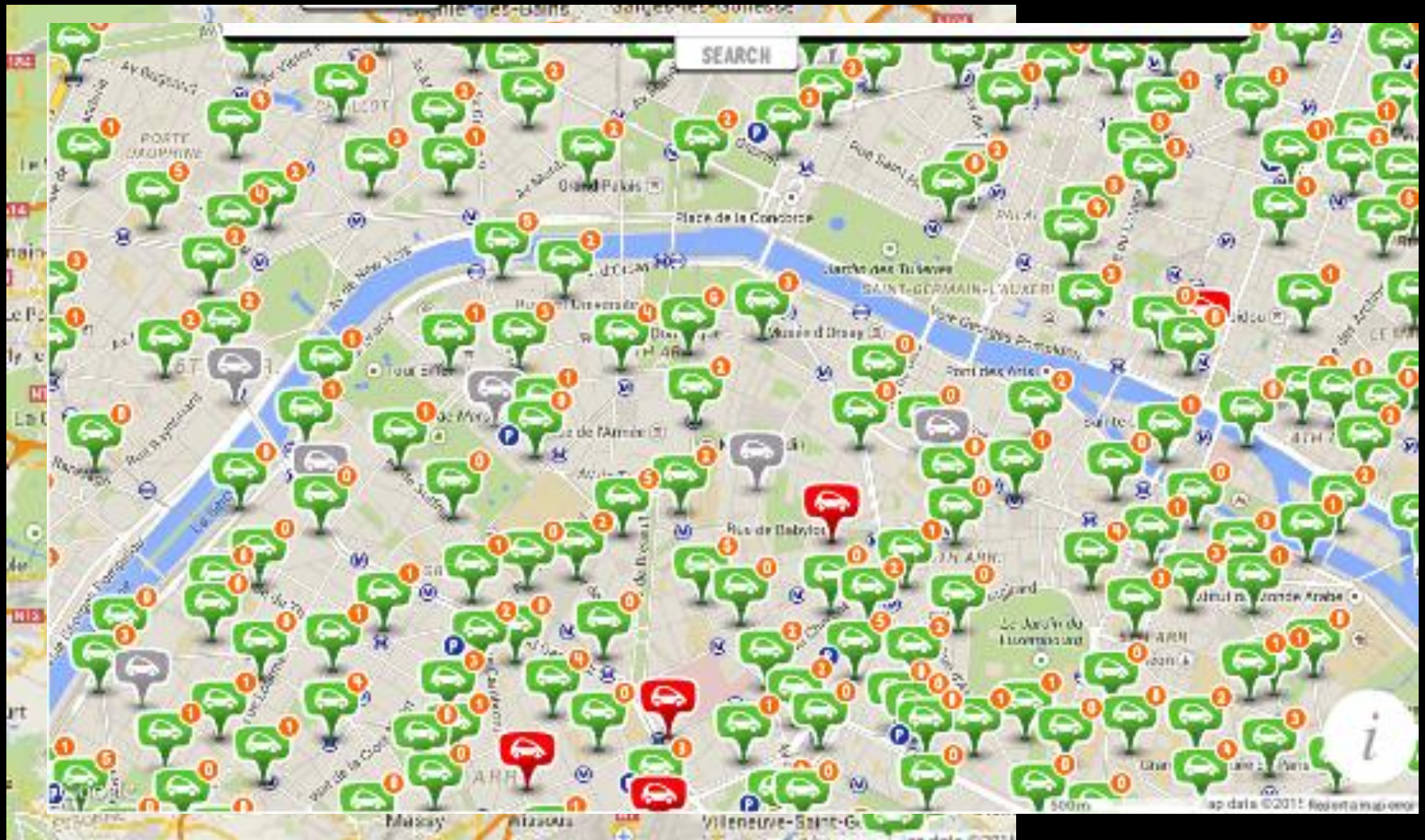
Economic organisation

- Public private partnership 2011 for 180 M€:
 - Bolloré invest in the all integrated service from Battery design, car, to IT system
 - Local public authorities invest in charging stations (1 station – 4-7 plugs => 50k€)
 - Secure the investment of Bolloré in case of losses.
 - Initial goal was to be profitable in 2018 with 80 000 customers.
 - 2013: More than 100 000...
 - Show off effect in Paris for EVs.

Infrastructures

- 3 000 EV cars running
- 1 000 charging stations (more than 4 000 low intensity plugs) open 24h/365
- No parking fees / no waste of time looking for a place to park
- Smart App to find and book EV
- No need to return at the initial point
- 120 € for annual fees + 5,5€ per 30 m of use
- Each car is rented 6-7 times per day => manage problem of over use...

Smart app overview



New business model

- New cities are buying Bolloré like solutions
 - In EU
 - Paris
 - Bordeaux
 - Lyon
 - London (UK)
 - Hanzu (China)
 - Mineapolis (USA)
 - ...

2030-2050 challenges in Europe

Challenge 1

Smart cities

Pollution / Accident / Congestion

3 Local Challenges

Pollution



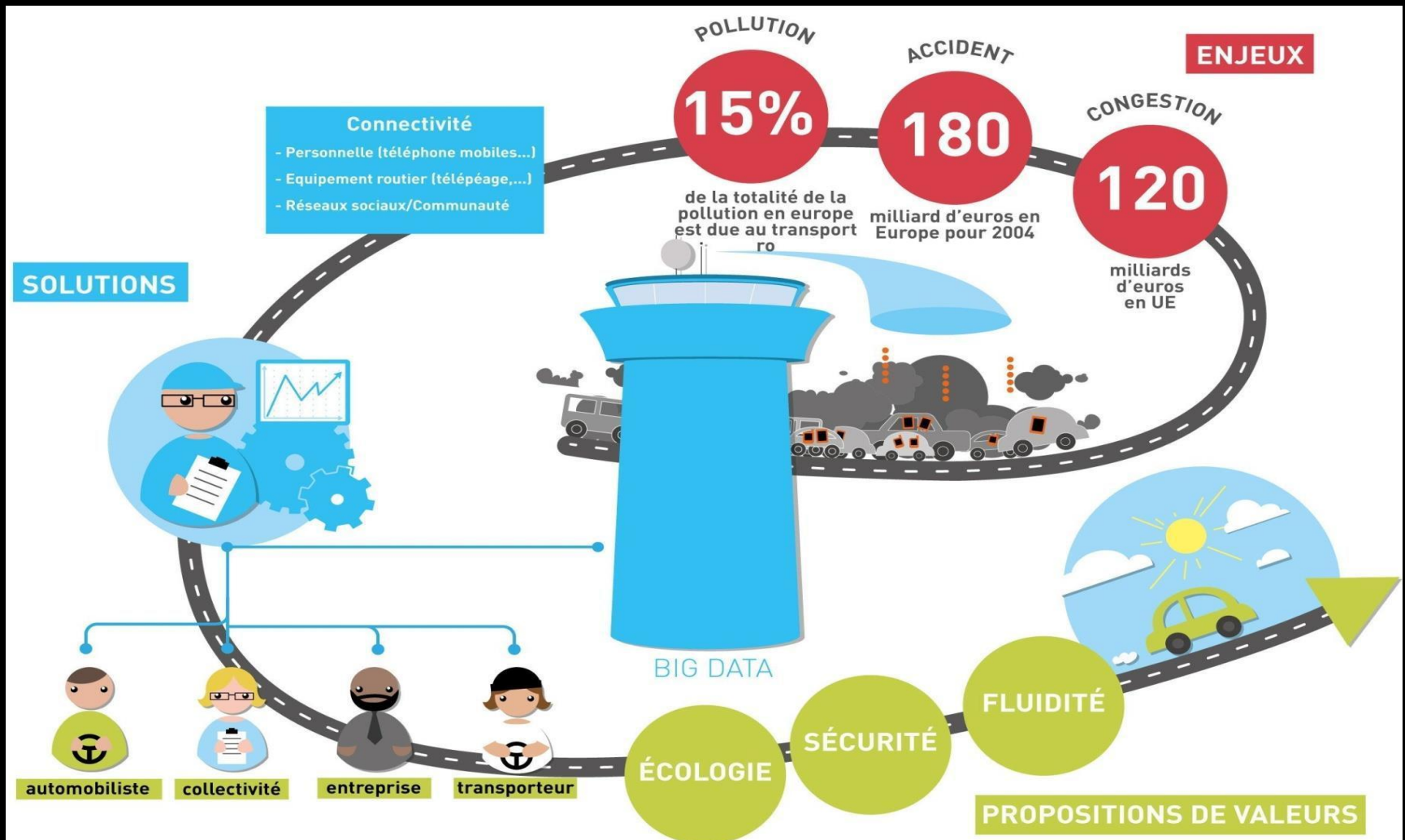
Congestion



Parking



Pollution / Accident / Congestion



Particles (PM) emissions in Paris

14th of June 2004, 10h, atmo index « Bon 3 »



9th of juin 2004, 10h, atmo index « Mauvais 7 »



European big cities are congested



Coût pour l'Europe

- **Global warming + Noise**
1,1% GDP
- **Air pollution + Traffic Congestion** **1,1% GDP**

Congestions cost in France are evaluated for 2013 and 2014 at 6 billion Euros per year

- Carbone emission
- Lost of time



European big cities are congested

Space occupied in a city street to transport 60 persons

CPF
cycling promotion fund



Carsharing or different car designs?

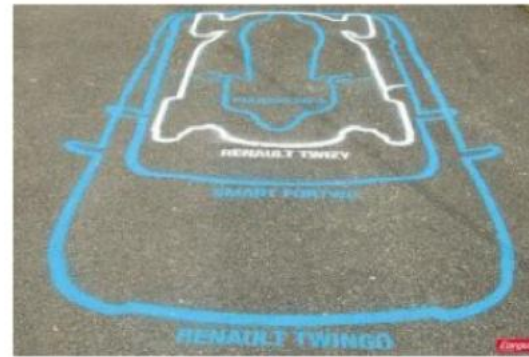
How can we address our saturated yet underutilised road infrastructure issue? Clip

More roads, smaller vehicles, more people per car or less cars

More Roads



Smaller Vehicles



More People per Car



Less Cars



Challenge 2

EVs and Smart grids

EVs are risks

And potential resources for
electricity Grids

Risks : Uncoordinate charging

Consommation d'électricité

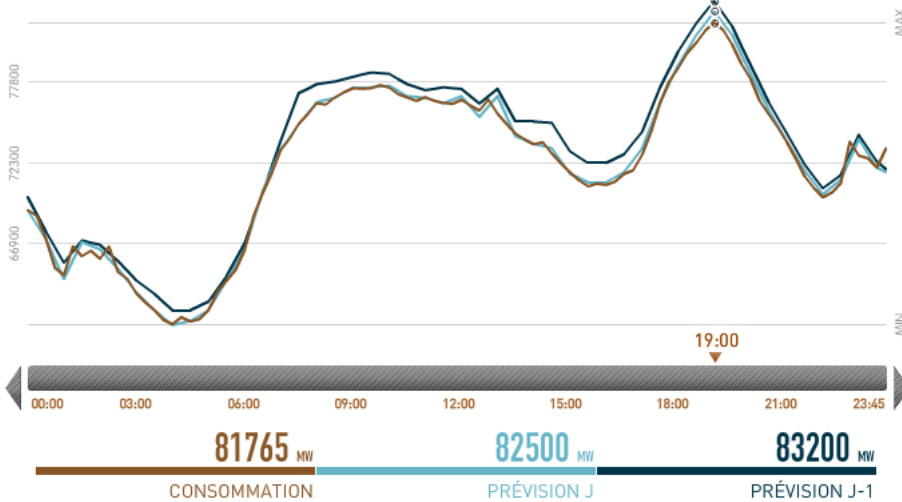
Suivez ici la consommation française d'électricité en continu, visualisez les différentes prévisions effectuées la veille et le jour même. Vous pouvez afficher les données sur 1 jour ou plusieurs jours jusqu'à 8 semaines simultanément.

Consommation d'électricité pour la journée du :

Mercredi 27 Novembre 2013

DONNÉES TEMPS RÉEL

MINIMUM MAXIMUM



Détail par filière de la production d'électricité française pour la journée du :

Mercredi 27 Novembre 2013

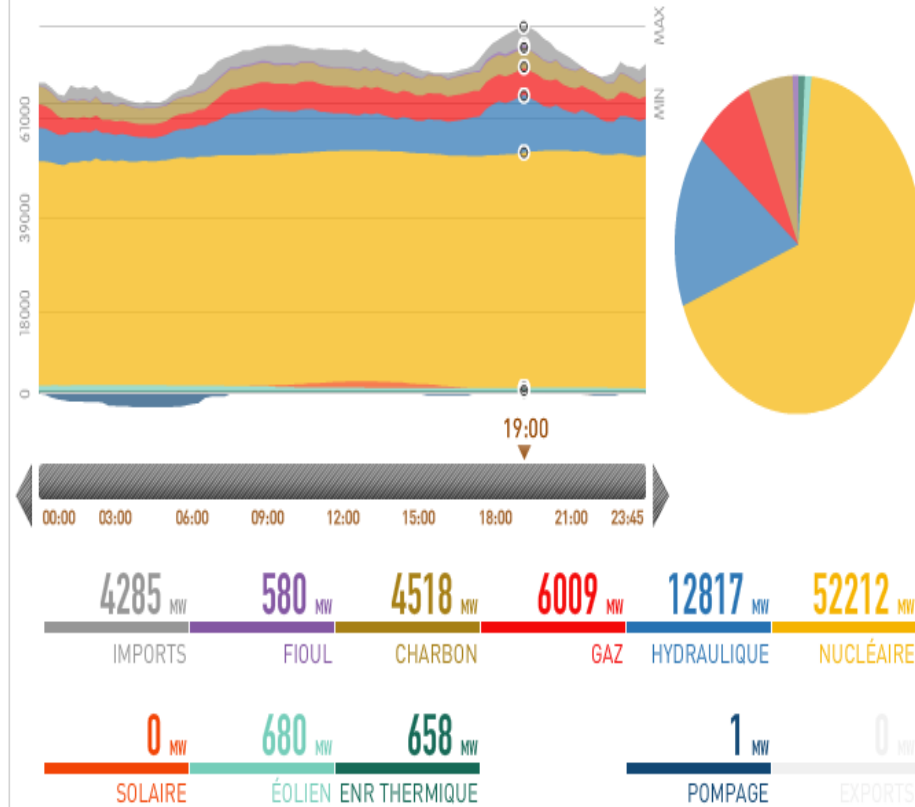
DONNÉES TEMPS RÉEL

MINIMUM

MAXIMUM

VOIR TOUTES LES FILIÈRES

RÉPARTITION PAR FILIÈRE



Uncoordinate charging a capacity question

Consommation d'électricité

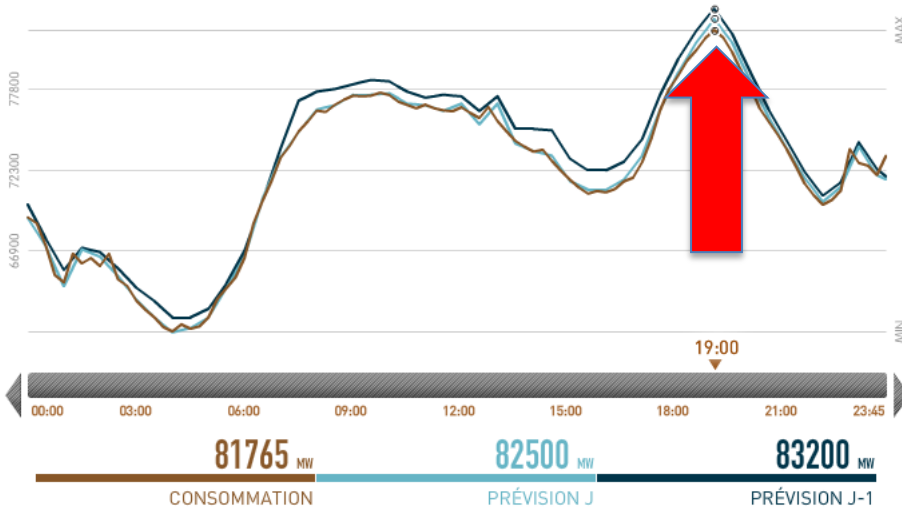
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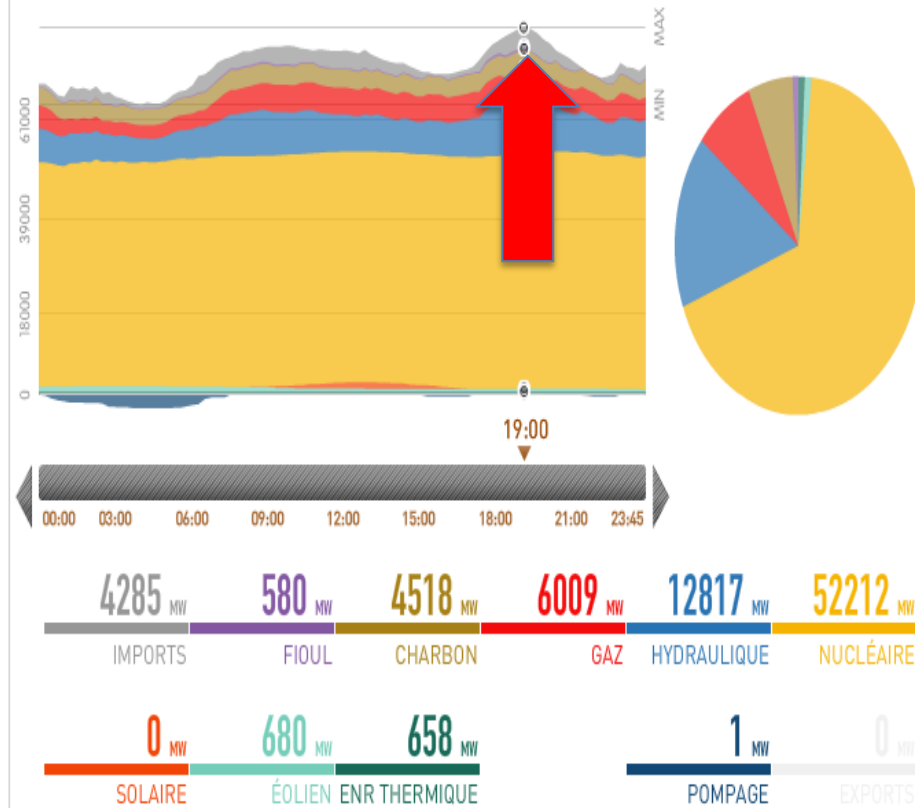
DONNÉES TEMPS RÉEL

MINIMUM

MAXIMUM

VOIR TOUTES LES FILIÈRES

RÉPARTITION PAR FILIÈRE



With coordinate charging : some solution

Consommation d'électricité

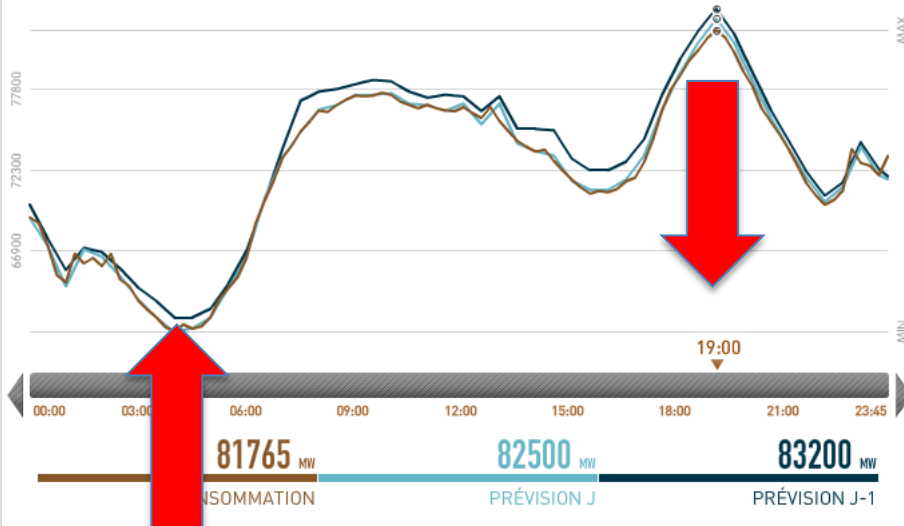
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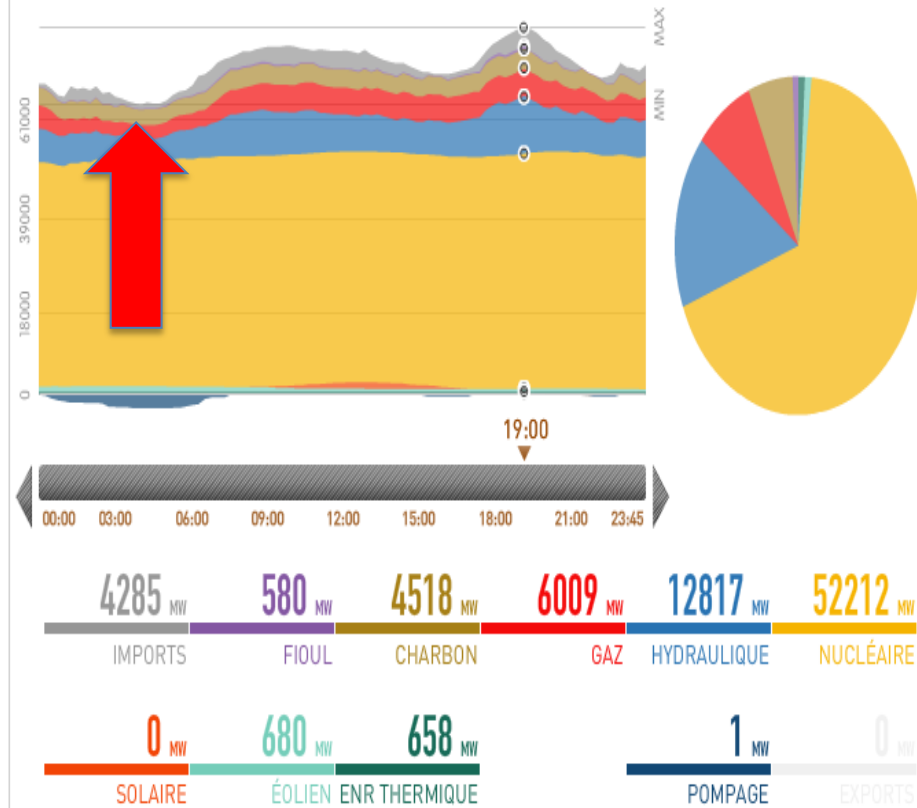
DONNÉES TEMPS RÉEL

MINIMUM

MAXIMUM

VOIR TOUTES LES FILIÈRES

RÉPARTITION PAR FILIÈRE

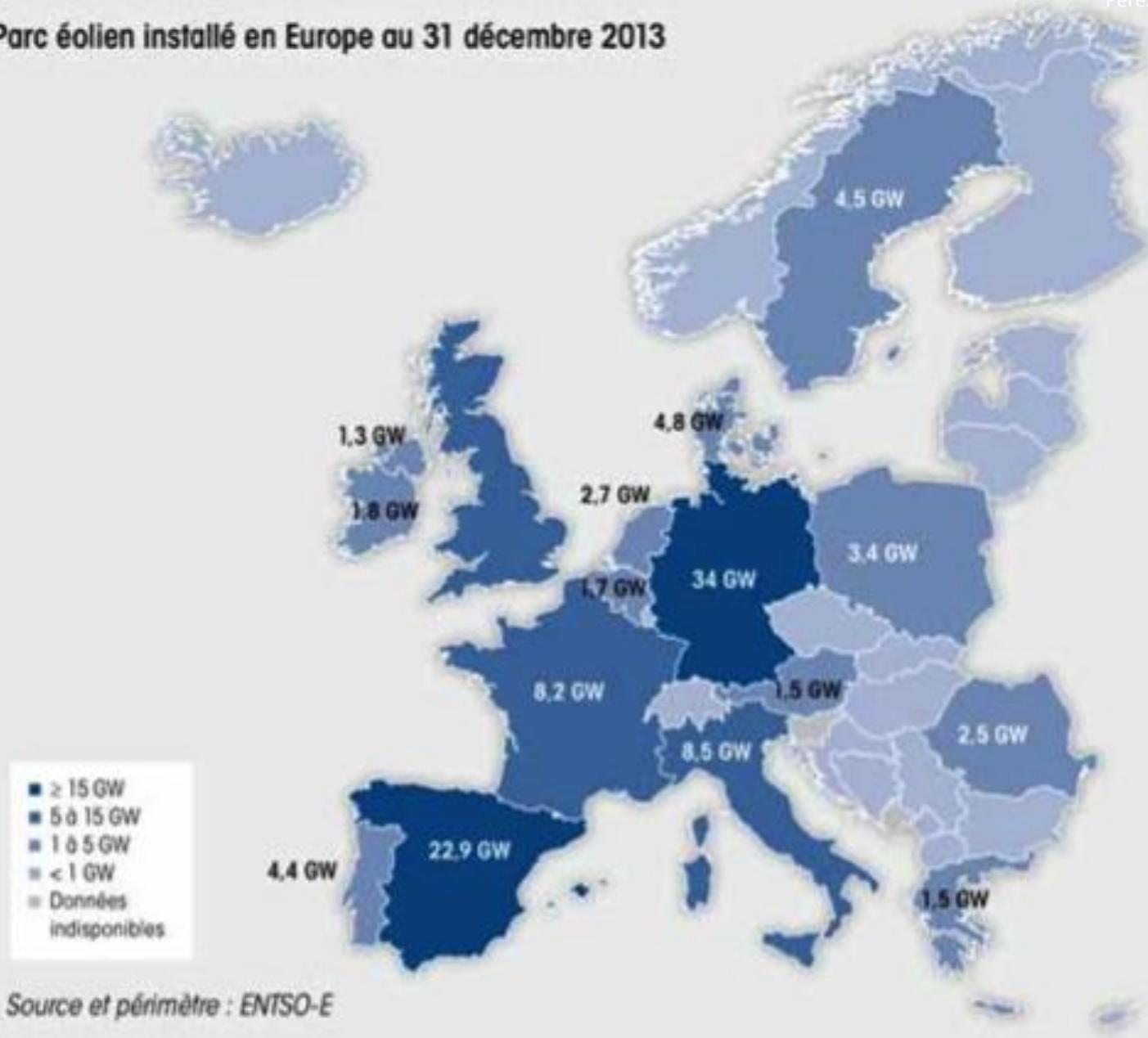


Renewables energies challenge

The EU rules for « energy »

- ✓ The Energy Directive (2009) sets an EU target of a :
 - ✓ 20% share of renewable energy in 2020, compared to the share of 8.5% today
 - ✓ 20% increase of energy efficiency and
 - ✓ 20% reduction of CO2 emission
- ✓ 2030 climate & energy framework
 - ✓ 27% share of renewable energy in 2020
 - ✓ 27% increase of energy efficiency and
 - ✓ 40% reduction of CO2 emission

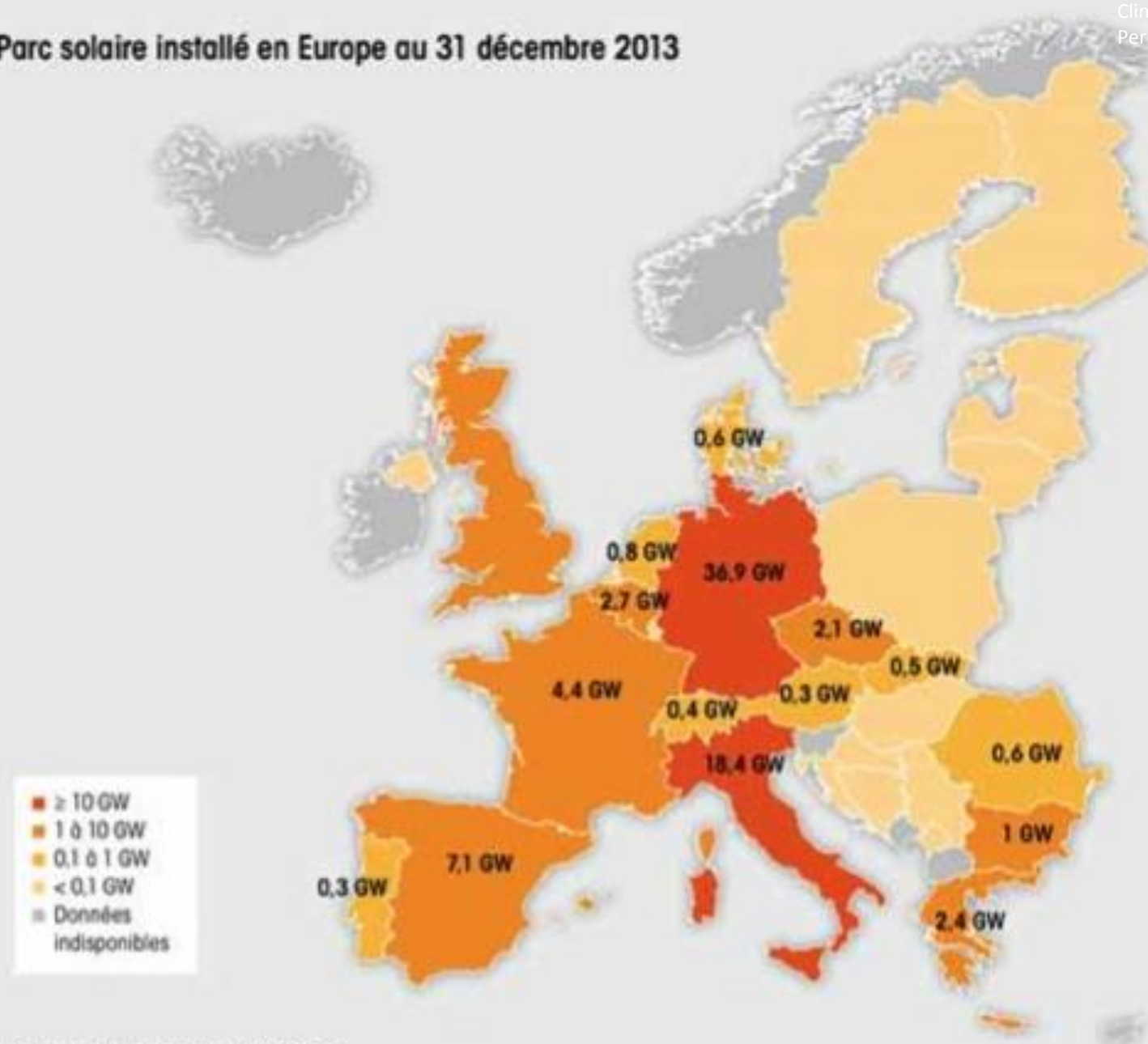
Parc éolien installé en Europe au 31 décembre 2013



- ≥ 15 GW
- 5 à 15 GW
- 1 à 5 GW
- < 1 GW
- Données indisponibles

Source et périmètre : ENTSO-E

Parc solaire installé en Europe au 31 décembre 2013

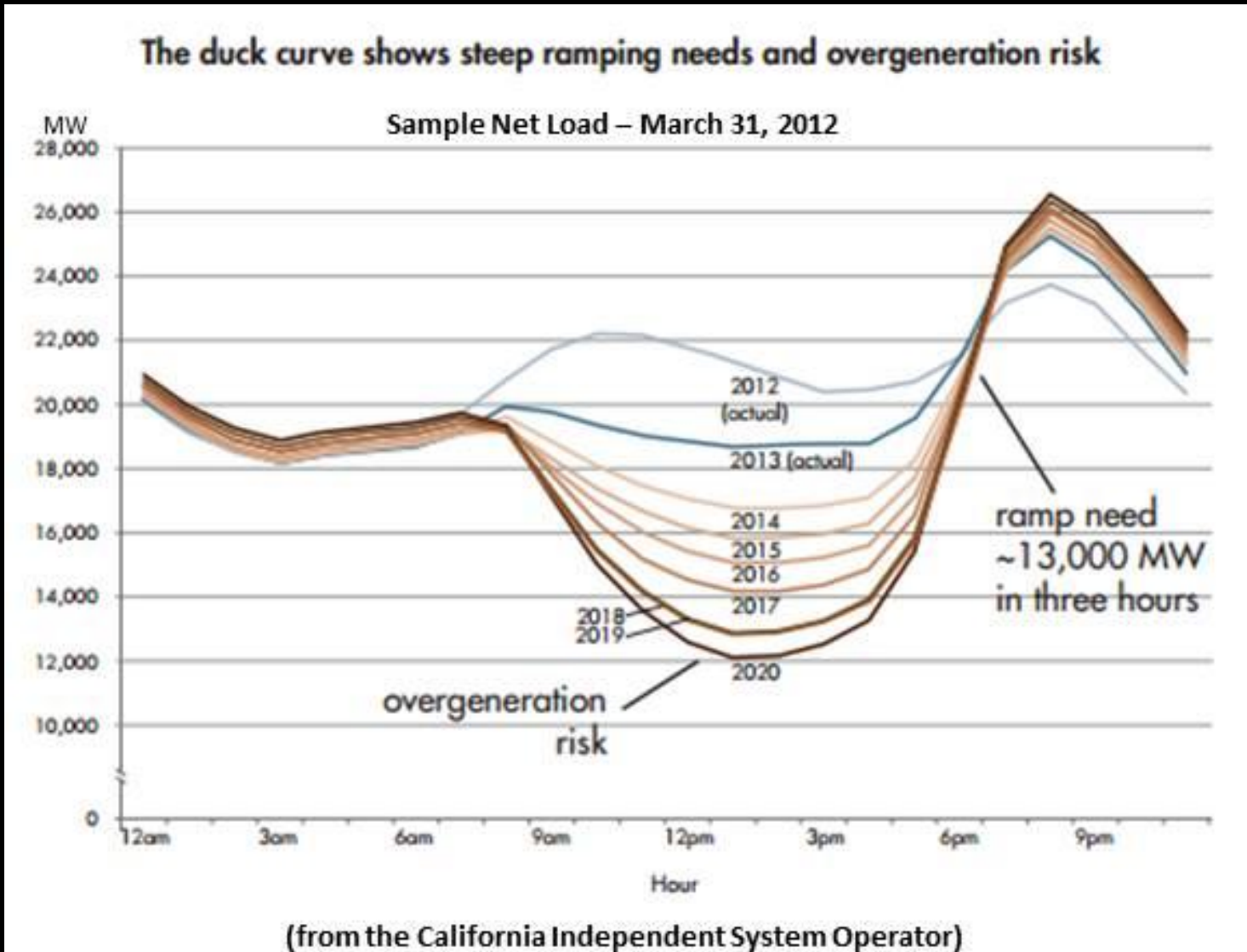


Source et périmètre : ENTSO-E

A la date de publication du Panorama, les données relatives à la Grande-Bretagne ne couvrent pas 100 % du territoire.

Issues with renewables

More PV => more Duck issues



More wind => more flexibility
required

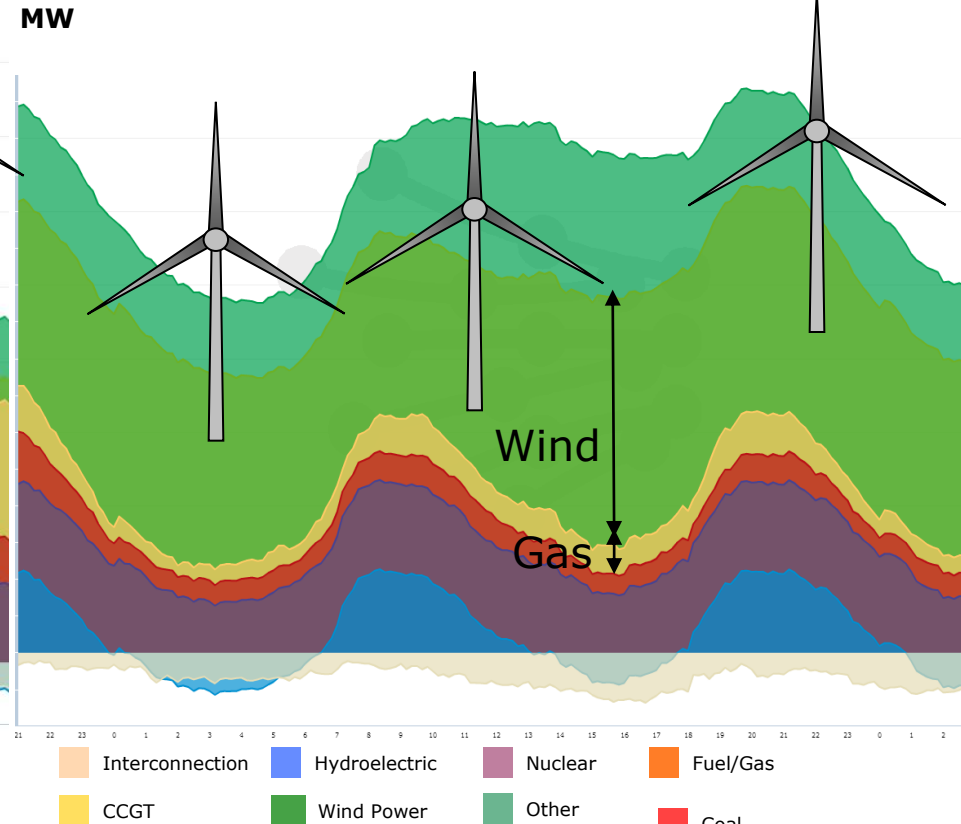
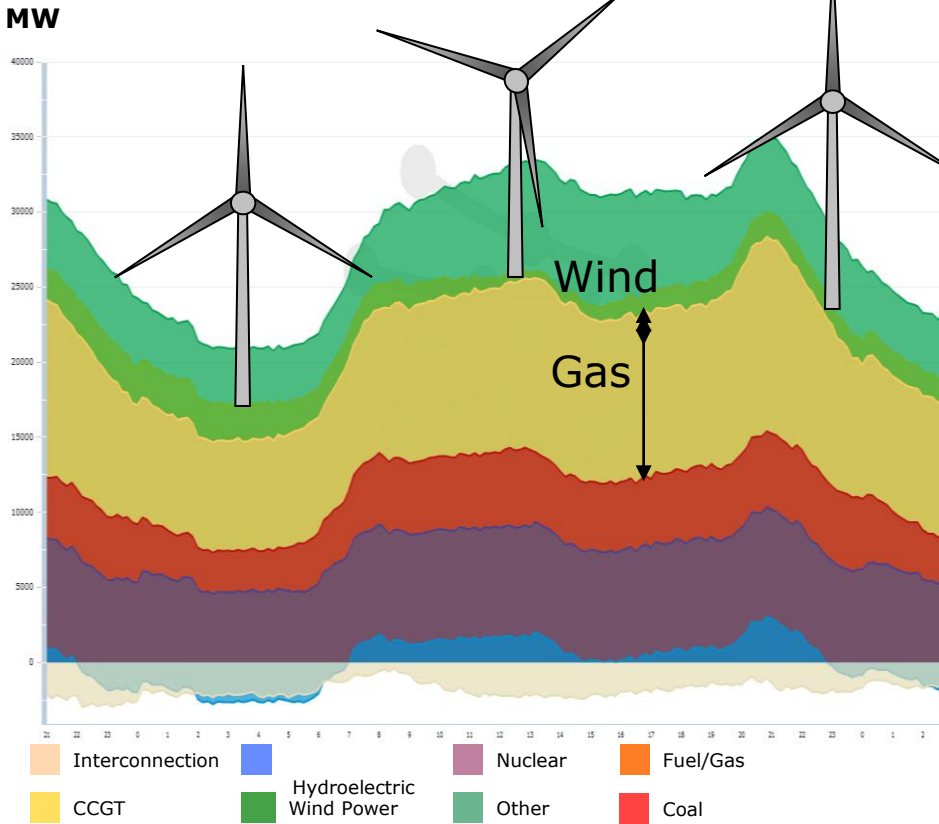
The Spanish exemple

30-september-2010

Wind 1%
17:45h

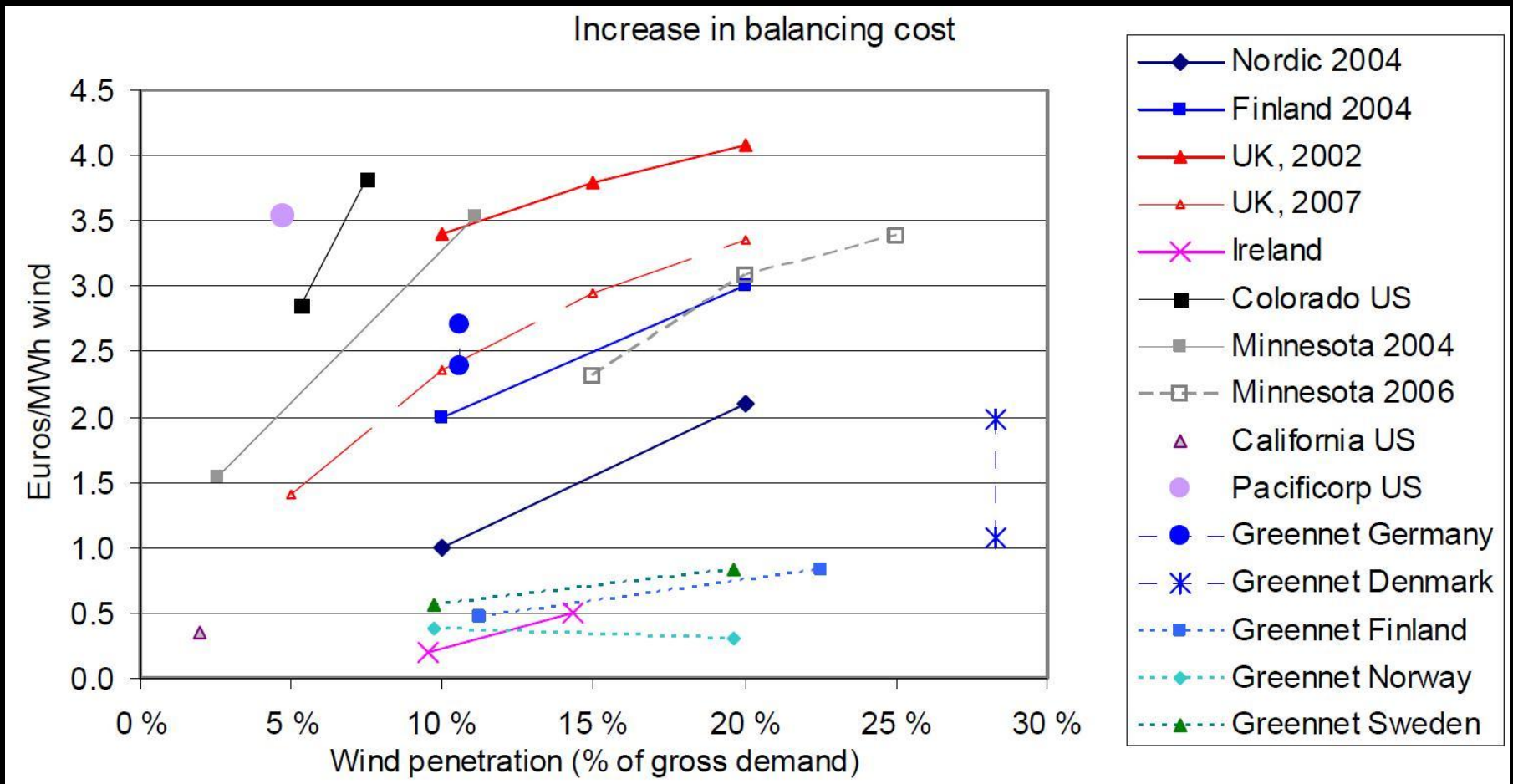
6-Februray-2013

Wind 66.5%
15:50h



Source REE, ENAGAS

More wind => more costly flexibility required



« Electric Vehicle to grid » can
provide flexibility solutions

How to manage an EV fleet?

- Not perfectly done yet...
 - VtoG experiment around the world (US / Denmark...)
 - Majors success with regulation power : mainly frequency control.
- Expected benefits from coordination :
 - Capacity reduction need (Less peak demand investment)
 - CO2 gains (& other polluting)
 - RES coupling: less grid stress
 - Demand response resources
 - Network services provision by market...

How to coordinate disperse storage unit as valuable resources?

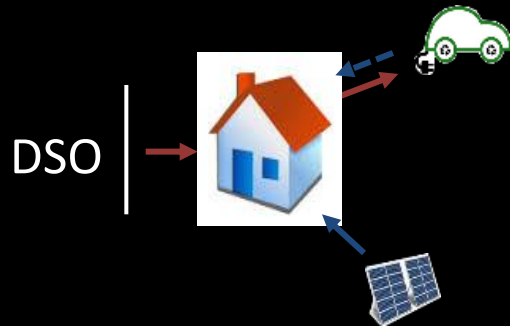
Combination of data

Into new algorithms (to be tested)

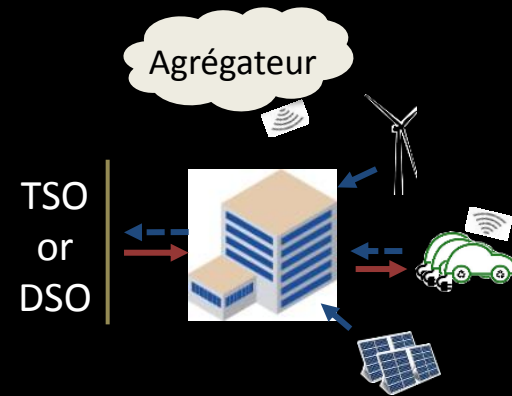
to deliver « market like products to be traded on energy markets »

Input 1: Different Possible level of bundling resources and usages

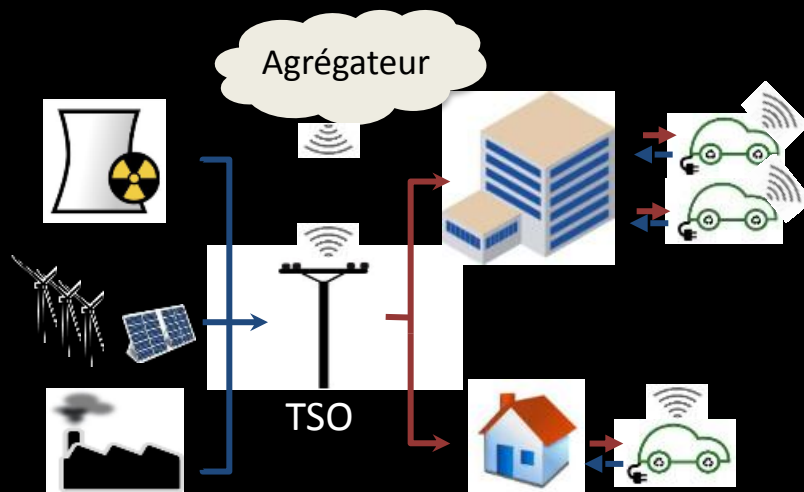
Vehicle-to-home



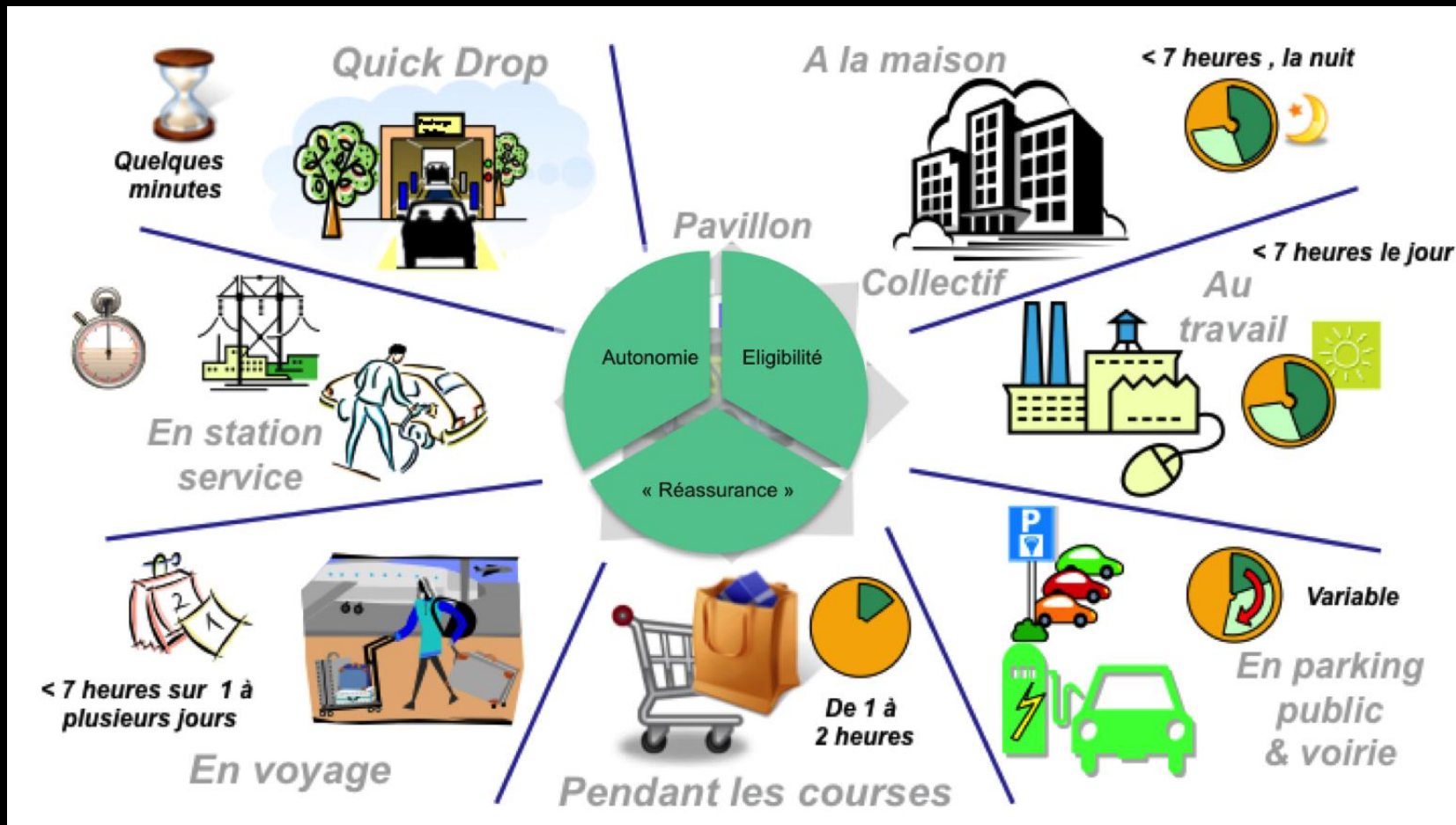
Vehicle-to-building



Vehicle-to-grid



Input 2: design of Charging infrastructure



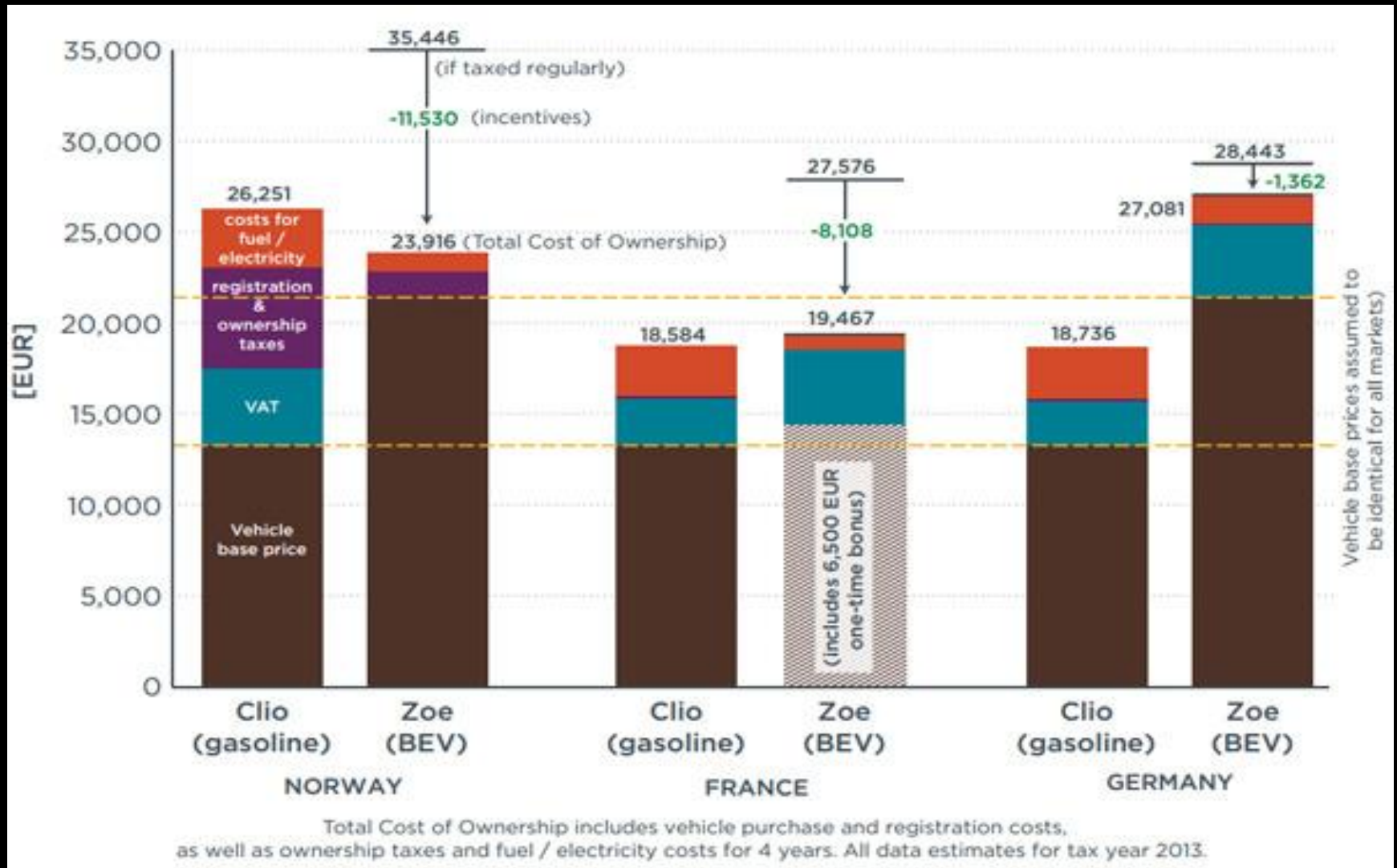
Combination of inputs to create “bundle of valuable resources” for the energy markets

Times	MW or MWh	Services on market base if exist
Second	MW	<ul style="list-style-type: none"> - Frequency regulation - Voltage regulation - Quality of delivery
Hour	MW Or MWh	<ul style="list-style-type: none"> - Tertiary reserve market - Demand respons - Balancing services - Congestion management - Intraday-market - Coupling With RES - ...
Block orders	MWh	<ul style="list-style-type: none"> - Day head market - Effacement - Time of Use - Couplage avec les EnR - ...

Values are function of market design-fleet characteristics-charging points capacities

Sources	Analyzed region	Participated market	Net Profit €/Month/Vehicle	Regulation power	Battery/ Vehicle constraints
Kempton and Tomic 2005	USA	Regulation up and down	112-165	10-15 kW	Electric drive vehicles
Tomic and Kempton 2007	USA, Four different control areas	Regulation down (Th!nk City) Regulation down and up (Toyota RAV4)	4.3 – 43 (Th!nk City) 6 – 64 (Toyota RAV4)	6.6 kW	100 Th!nk City vehicles (Nid) ,252 Toyota RAV4 (NiMH)
Larsen et.al. 2008	Denmark	Secondary and Tertiary control	6 – 160	power: 2 kW, 20 kW, 20 kW	EDV: Capacity: 5 kWh, 5 kWh, 20 kWh,
Camus et.al. 2009	Portugal	Secondary and Tertiary control	18	3.5 kW	Plug-in Hybrid and electric vehicles
Andresson et.al. 2010	Sweden/ Germany	Control energy market	30 – 80 (Germany, coal fired power plants) 19 ; 7 (Sweden, Hydro power plants)	3.5 kW	Plug-in hybrid EV (10 kWh , Maximum depth of discharge 20 %) Charging and discharging efficiency are 94 %.
V2G-Strategies 2011	Austria	Secondary and Tertiary control	7.32 – 63.94	10.5	Electric Vehicles (16 kWh, 24 kWh, 48 kWh)

Effectively reducing the TCO



Conclusions for Europe

Answer to Questions

1. Who will be the leaders in 2030-2040 ?

- ✓ Companies answering the “Congestion / pollution / Renewable challenge” with new business models

2. How they will be leaders, technologically and strategically ?

- ✓ Leaders will set business models allowing : managing IT revolution + electrical Grid revolution with renewables + batteries' technology

3. How they are doing now to be leaders ?

- ✓ They are testing and trying.

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?





Some literature about VtoG

- Donada Carole and Perez Yannick 2016, *Electromobility at the crossroads*. **International Journal of Automotive Technology and Management**, Forthcoming 2016.
- Codani Paul, Le Portz Pierre-Louis, Claverie Pierre, Petit Marc & Perez Yannick 2016, *Coupling local renewable energy production with electric vehicle charging: a survey of the French case*, **International Journal of Automotive Technology and Management**, Forthcoming 2016.
- Ramírez Alfredo, Ramos-Real Francisco, Marrero Gustavo & Perez Yannick, 2015, *Impact of Electric Vehicles as Distributed Energy Storage in Isolated Systems: The Case of Canary Islands*, **Sustainability**, 7(11):15152-15178 November 2015.
- 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.
- Donada Carole et Perez Yannick 2015, *Electromobility : Challenging issues an Overview*. **International Journal of Automotive Technology and Management**. Vol. 15, No. 2, pp 97-102.
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- Perez Yannick et Staropoli Carine, 2014, *Quelle politique industrielle pour la transition énergétique ?*, **Revue d'Economie Industrielle**, N° 148, pp 19-31 2014.
- 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, 2014

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An EU Perspective**

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Additional

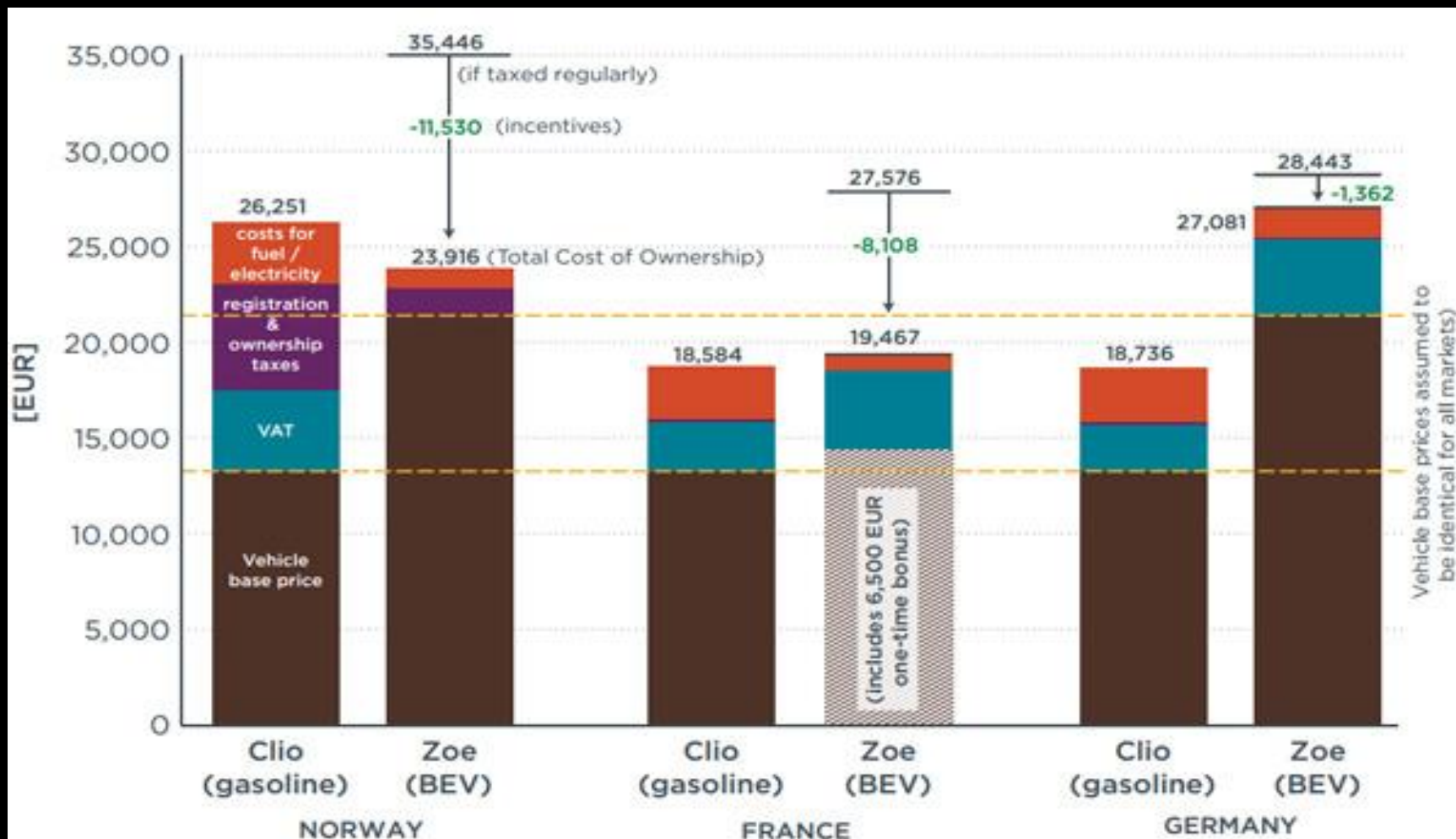
Norway

Package of Policies in Norway

1. Action toward demand stimulation
 - VAT tax exemption
 - Highway fees exemption
 - Local tax exemption
 - Access to buses lane in cities
2. Building a safety network of Fast charging at the entry of main cities to secure last miles stress + on highways critical points
3. No action toward offer: no Norwegian EV manufacturers.

Limits of the Norwegian Model

- Cost of the public support
 - Implicit valuation of pollution reduction, infrastructure building, health value, social innovation... are very high.
- The design of the demand side policy is biased in favour of expensive cars because the help is in % of the car price.



Total Cost of Ownership includes vehicle purchase and registration costs, as well as ownership taxes and fuel / electricity costs for 4 years. All data estimates for tax year 2013.

Dutch Rule

Every 50 km a fast charging station with a newly created operator in charge of it

