ENERGY STORAGE

Integrating Renewables thanks to Consumers Flexibility

Introduction to Energy Pool

The leading European Demand Response Operator

YOUNG, FAST DEVELOPING COMPANY

- **2009** – Company set up in France
- **2010** – Strategic partnership with Schneider Electric
- **2013** – First operations in Belgium & UK
- **2014** – First operations in Cameroon, Japan & Norway
- **2015** – 70 employees; Deployment in 4 countries; 1st DRMS sales

RECOGNISED FIELDS OF EXPERTISE

- Regulatory & DR Product design
- DR Operations
- Customer Enrollment
- IT

OPERATING CENTERS
1,500 MW managed 24/7

- Chambéry
- Douala
- Tokyo
- London

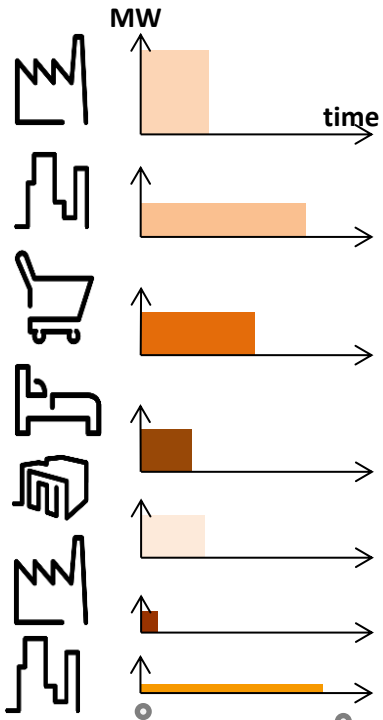
R&D programs

- Renewable integration through DR
- Electric vehicle and DR
- Electrical storage and DR
- Microgrid & complex sites

What is Demand Response?

Aggregate flexibilities ... to deliver a reliable service to the electricity grid

Individual flexible capabilities

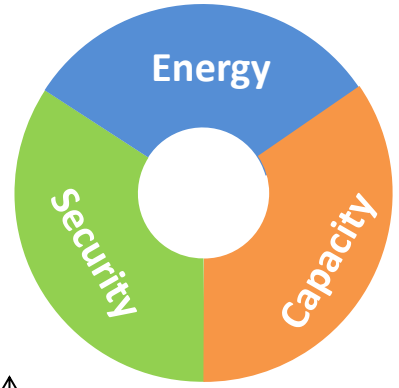


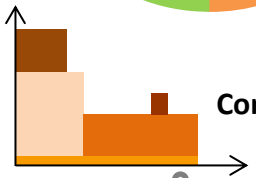
Extract capacity & aggregate

Operate & optimise value

DR operator

System needs





Identify and value flexibilities

Limit operational and financial risks

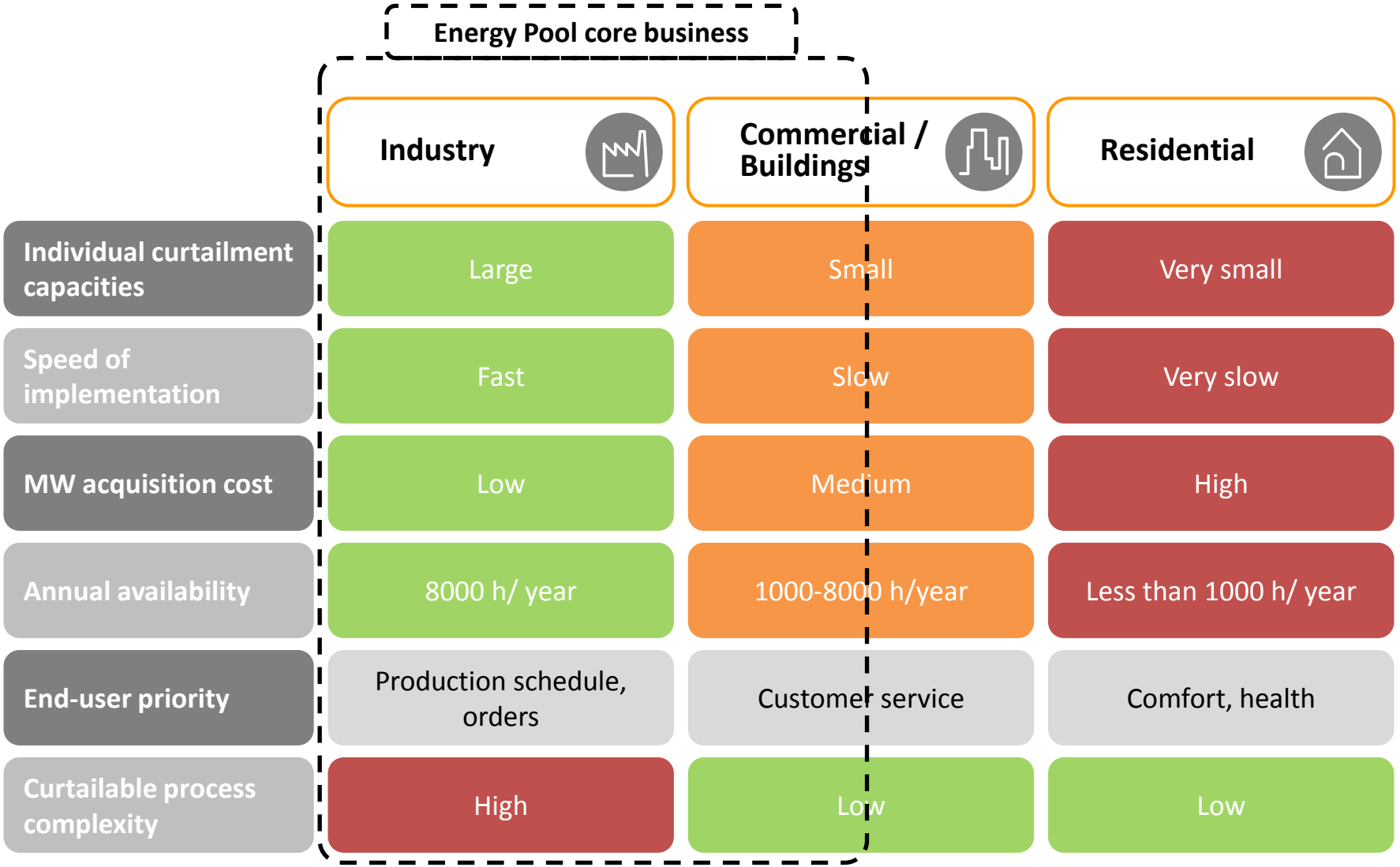
Handle DR products complexity

Enhance reliability through pooling effect

Increase DR participation in the markets

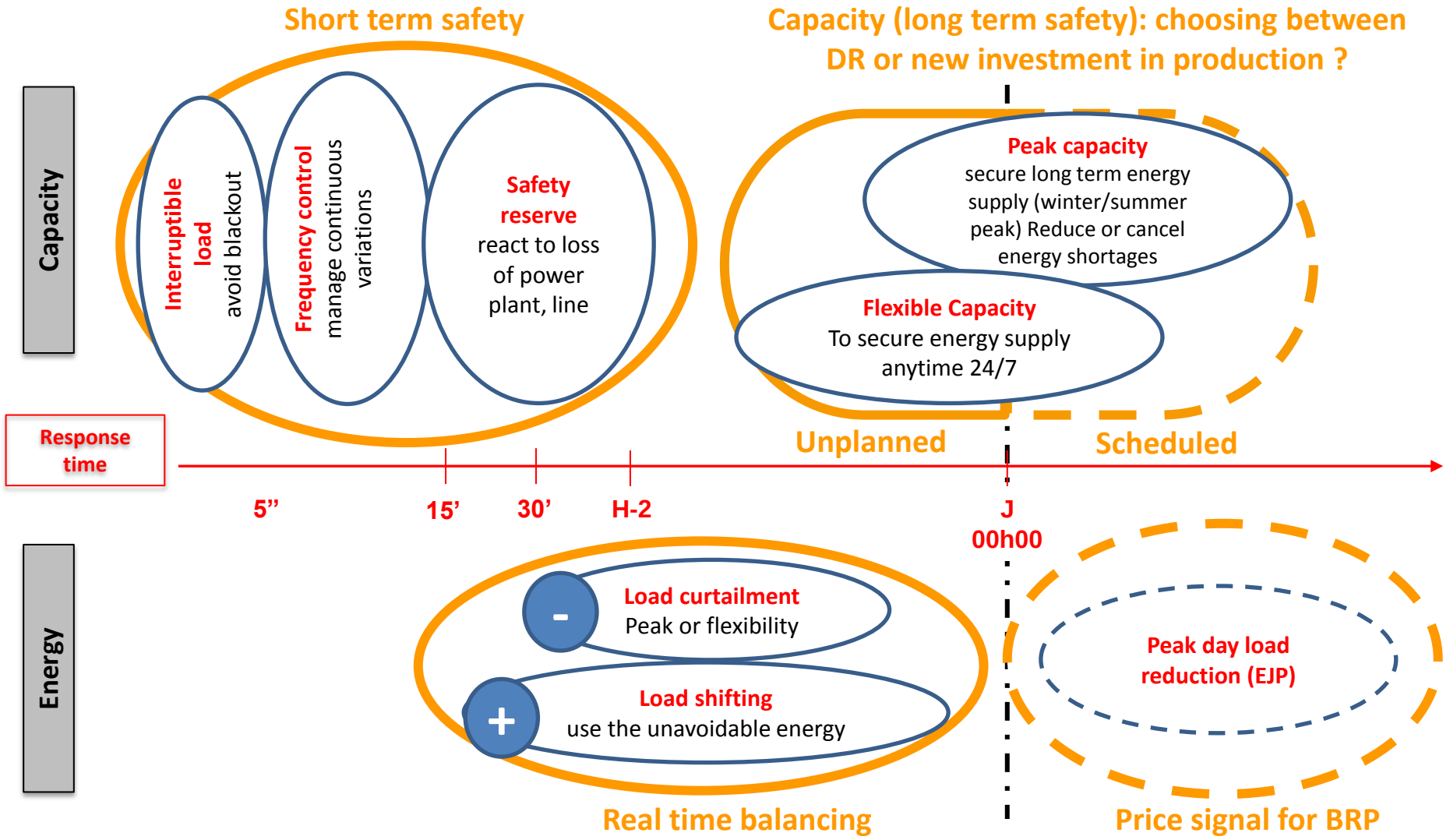
What is Demand Response?

What is Commmercial & Industrial Demand Response?



Different DR products to address different system needs

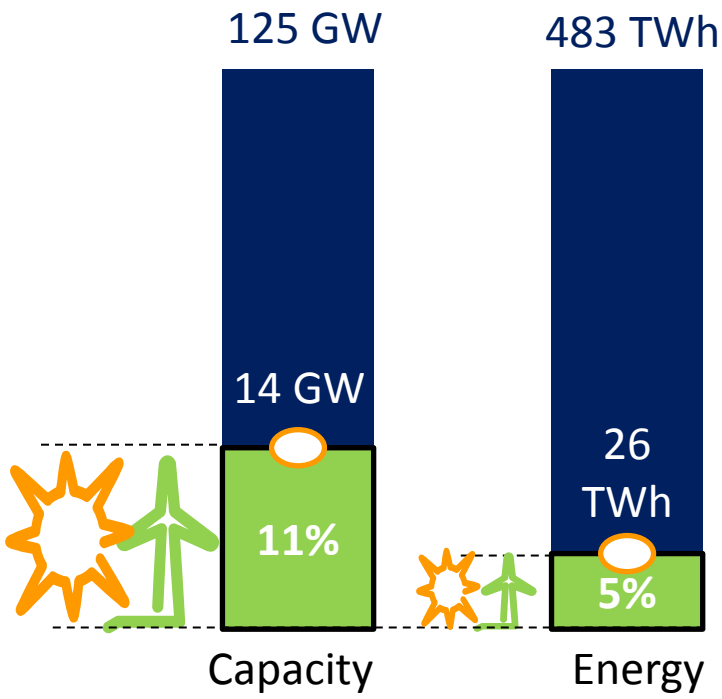
DR offers a wide range of services covering all system needs



Current generation share in France:

Installed Capacity in 2015:
125 GW with 14 GW of RE* (11%)

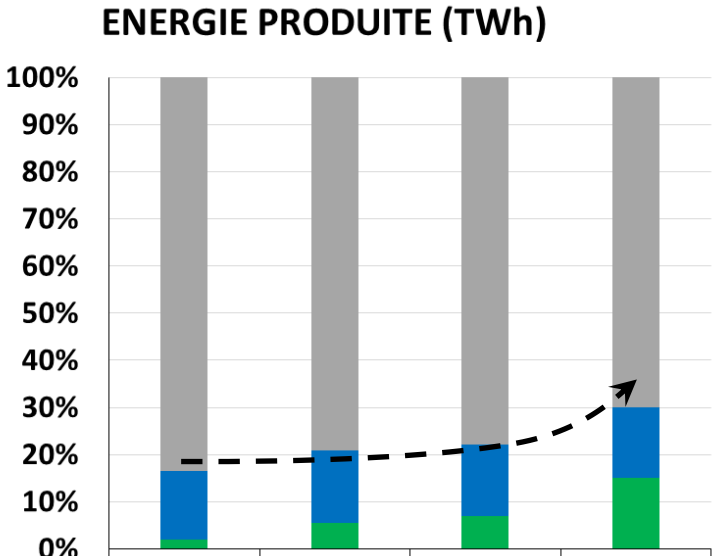
Estimated Energy Generation in 2015:
483 TWh with 26 TWh of RE* (5%)



CO_2 Emission: France produces 11 times less CO_2 than Germany

**RE = Solar + Wind (ex. hydro)*

Evolution of French Generation Mix



	2010	2015	2018	2030
Somme de Energie hors EnR	426	382	385	350
Somme de Hydro	75	75	75	75
Somme de EnRV	10	26	34	75

2030 Obj:

RE accounts for 30% of total energy generation

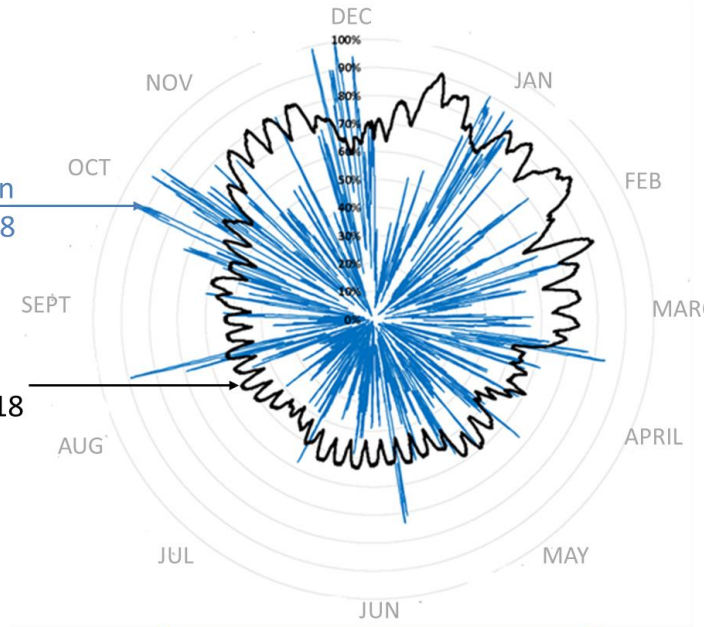
(including 15% of hydro)

=> In 15 years, RE will generate 3 times more energy than today

Macro View: RE Generation vs Consumption

Wind generation forecast for 2018

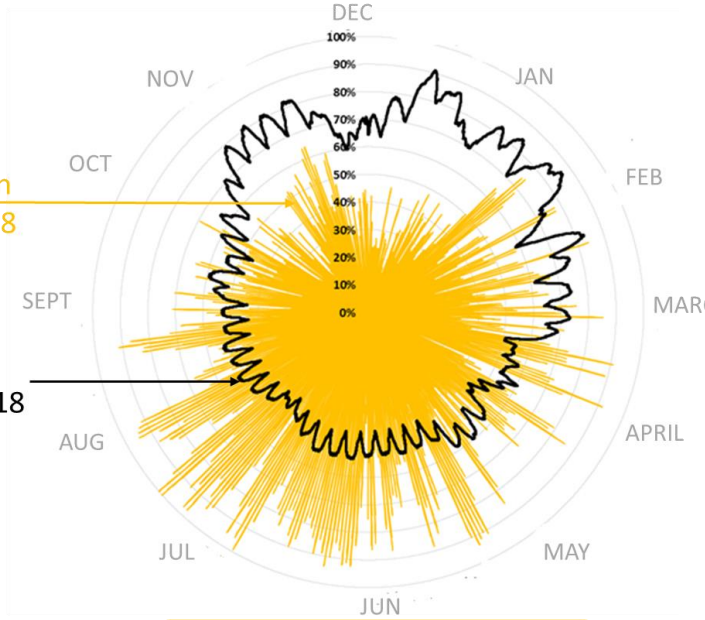
Consumption forecast for 2018



=> Wind generation partially in phase with consumption

Solar generation forecast for 2018

Consumption forecast for 2018

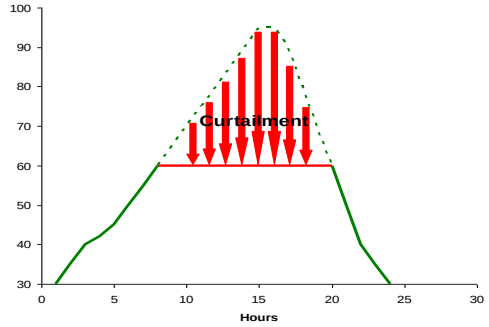


=> High solar generation when low consumption

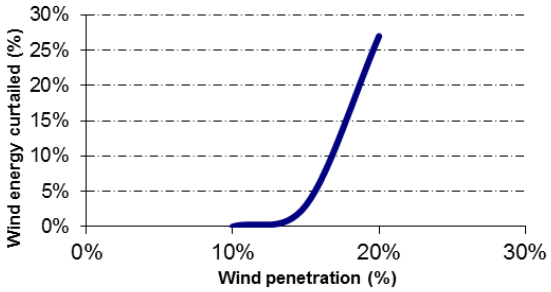
=> RE Generation not in phase with Consumption!

So what? A Typical Issue…

- 2.2% of the total wind energy were curtailed in Ireland in 2011
- The curtailment occured during the night because of low consumption and high wind power penetration



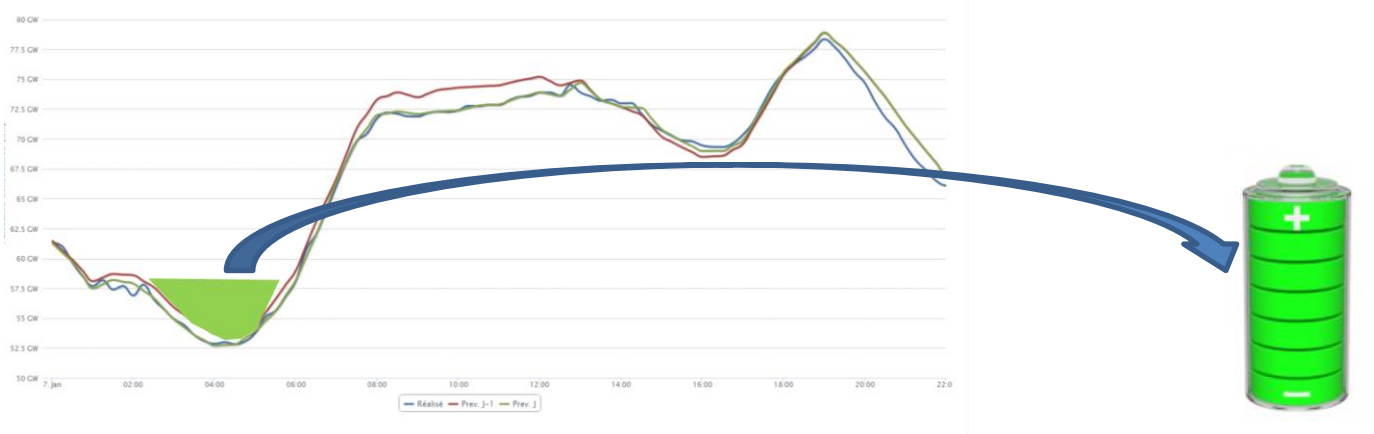
- Why do we curtail wind farms?
  - Main reasons:
    - Low electricity consumption during high power generation
    - System Stability (wind is unpredictable and contributes to make the grid weaker)
    - Operating Reserve (wind cannot generate reserve: « take energy or leave it »)
    - …
- In Ireland, the share of wind power is 15%
- What will happen if the share is 20%?
  - More curtailment (~25%)



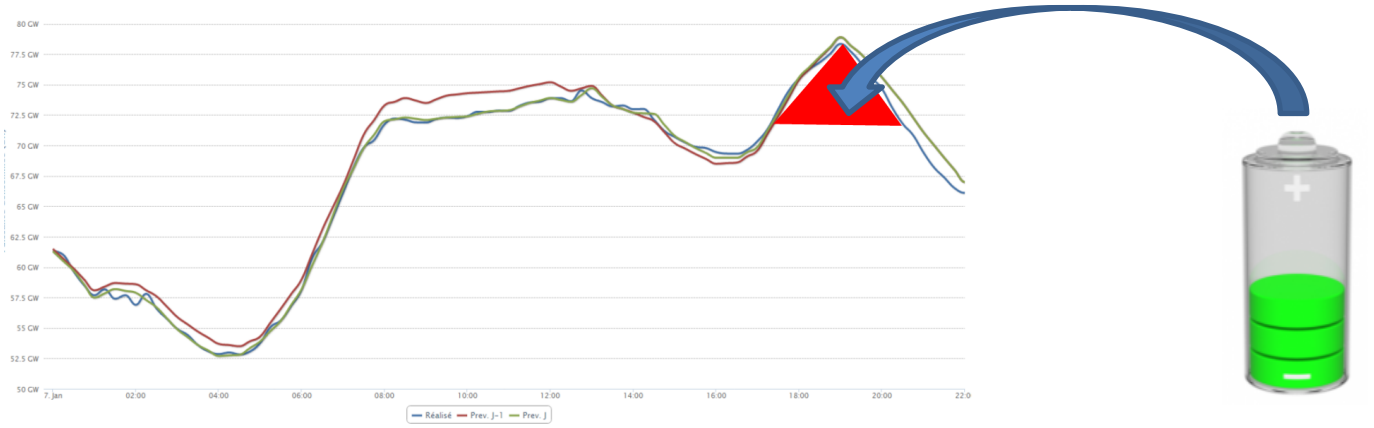
=> RE energy will be curtailed more than 25% of the time if we do nothing!

What could be the solution?

- Store electricity in a battery at low demand and high RE generation

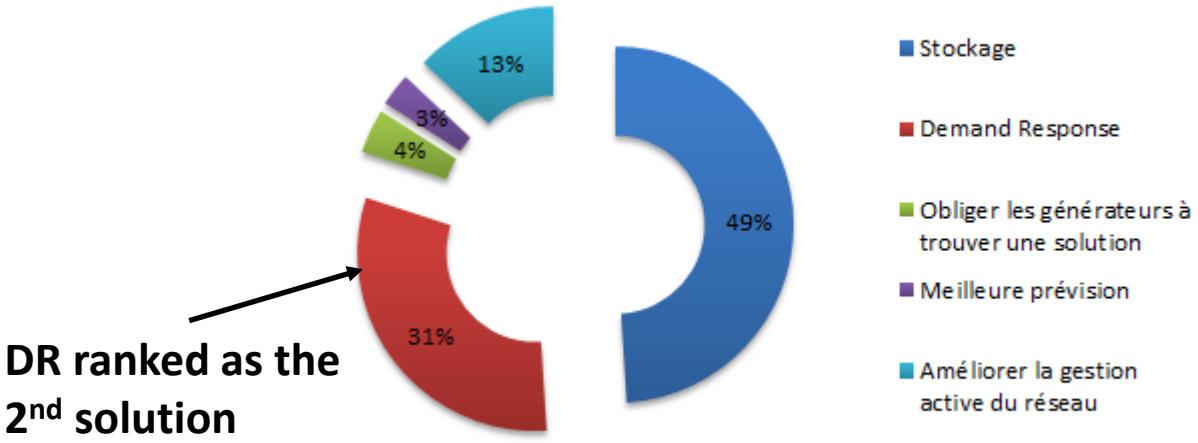


- Restore electricity from the battery for high demand & low RE generation



…but several other solutions may co-exist…

- Such as « Demand Response » or « Demand Flexibility Management »…
- What is the best solution for introducing large amounts of renewable energy in the European networks?
  - Results of a survey among North American utilities and suppliers of Smart Grid technologies:



DR ranked as the 2nd solution

Demand Flexibility as Storage Facility

The « Storage » Solution by Energy Pool

- **A Storage Facility can be:**
  - A electrochemical battery (Li-Ion or so on) at minimum 350$/kWh (Tesla)
  - « A existing consumer able to store energy with a low cost instrumentation »
  - …
- **What kind of consumers could store energy?**

Cold Storage Plant

Building

Data-center

Ice Rink

Chemistry

Water

Thermal Energy Stored

Potential Energy Stored

More than 5GW of consumers able to store energy is already existing in France!!

Demand Flexibility as Storage Facility

Comparison Battery/ Consumers

Battery

Water Supply Distribution System

Some Economics

Comparison Battery/ Consumers

Battery

Battery Cost: 3500$/10kWh (Tesla annoucement)

Cost for a 1MW/1MWh Battery:

350k$

Water Supply Distribution System

Instrumentation cost for a 1MW Flexibility at the consumer side:

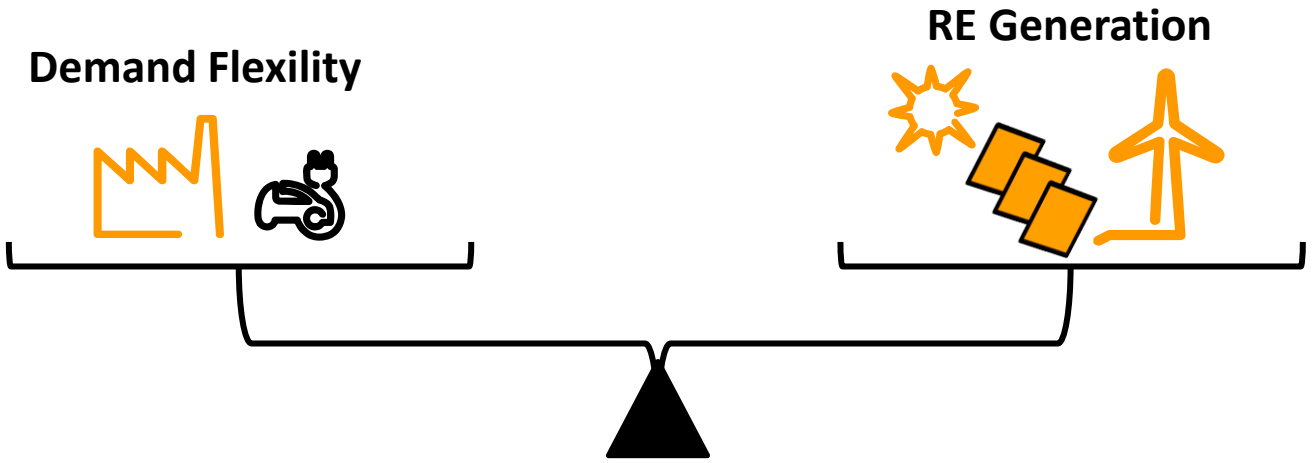
35k$

Store Energy in existing consumers is 10 times cheaper than the cheapest battery!!

Conclusion

Demand Flexibility as the Low Cost Solution to RE

- High Penetration of Renewables will require Demand Flexibility or integration of new assets like battery
- Existing consumers could behave like batteries from a grid point of view
- Flexible consumers able to store energy could be an alternative to expensive electrochemical battery
- Subsidies should be shared between flexible consumers willing to instrument their process and participate to RE balancing, and battery industry

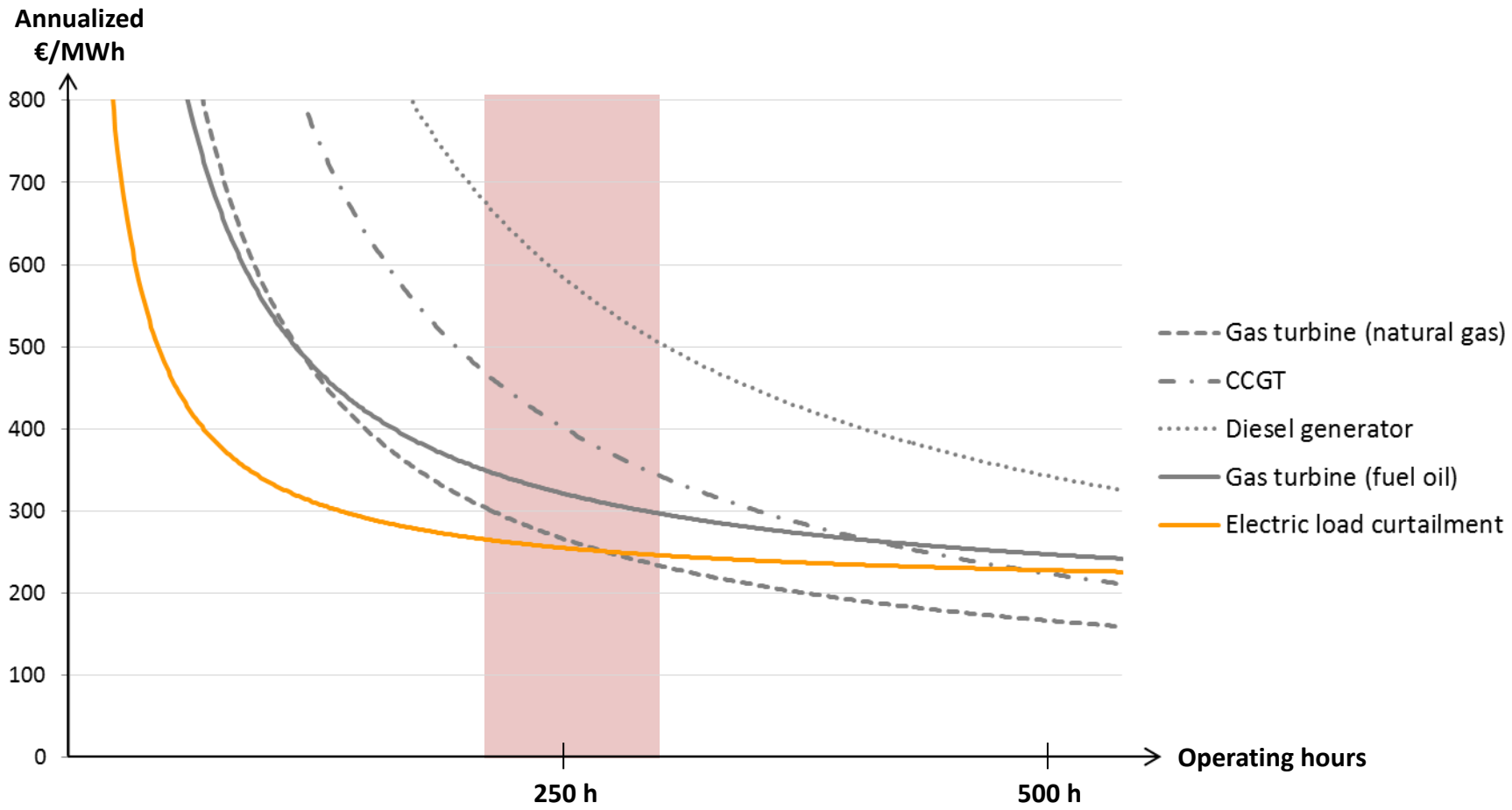


ANNEXE

What is Demand Response?

Industrial DR is the most cost-effective option to meet peak demand

Example of a cost structure of a traditional peaking plant vs. electric load curtailment

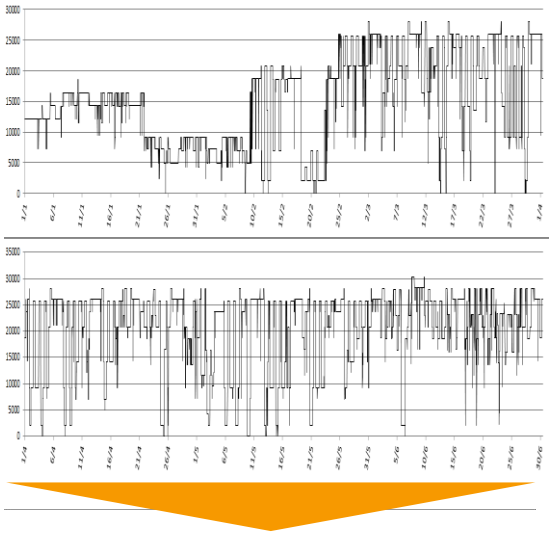


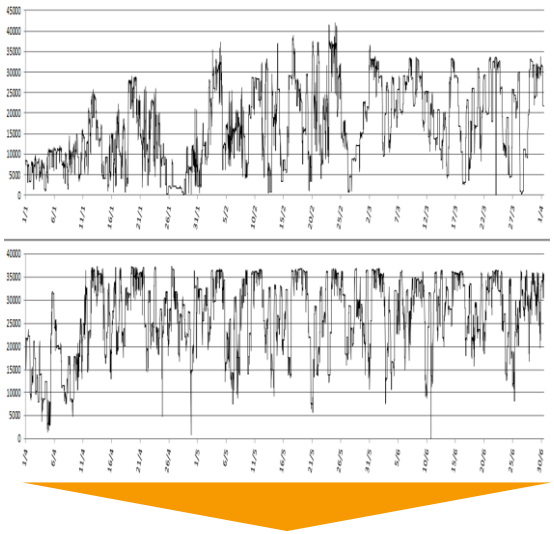
Aggregation benefits

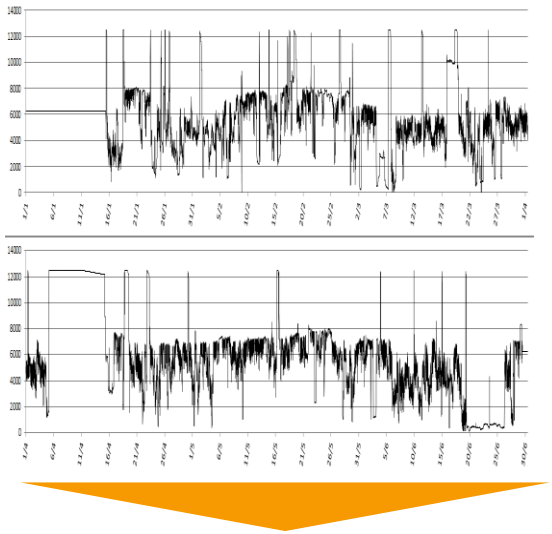
Portfolio effect increases DR potential and reliability [1/2]

Data set #1 – 1 cement plant | **Data set #2 – 4 other cement plants** | **Data set #3 – 1 phosphate producer**

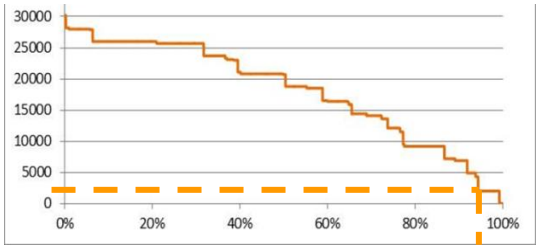
DR assets curtailable load profile over 6 months

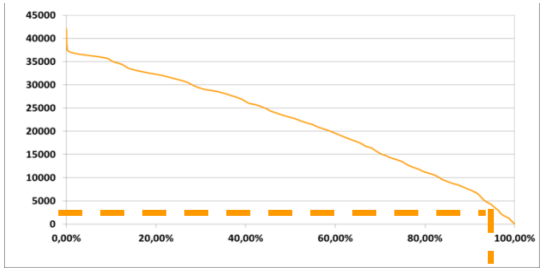


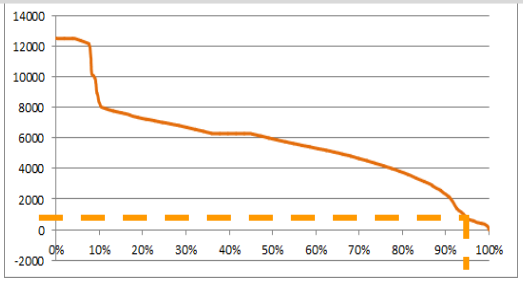




DR assets corresponding curtailable load duration curve







DR assets reliable @ 95%

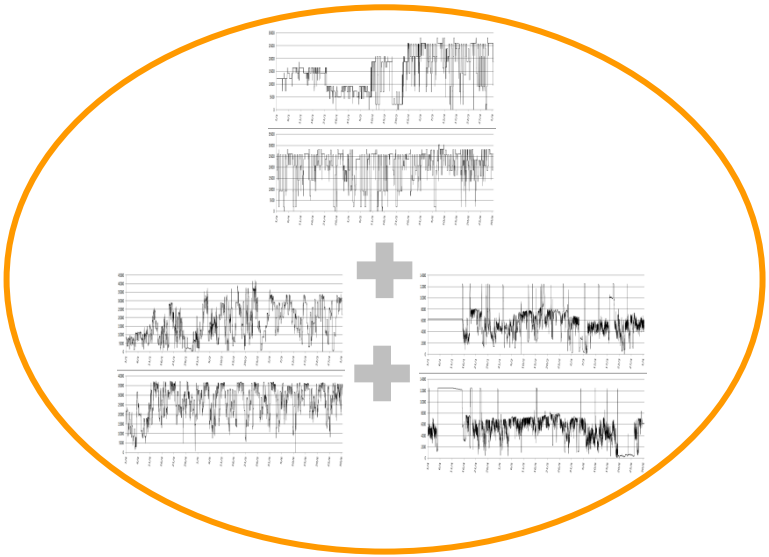
2MW

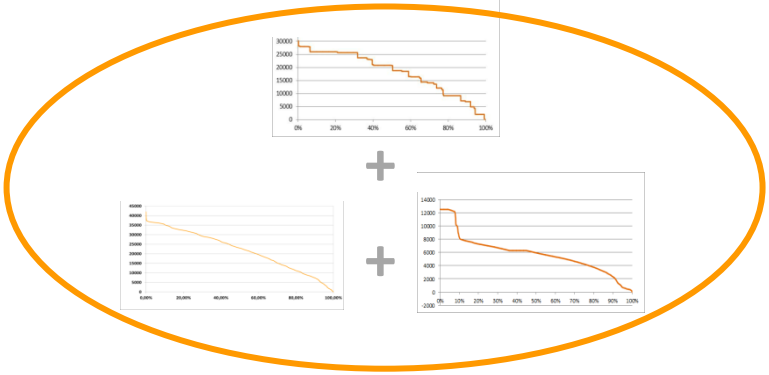
2MW

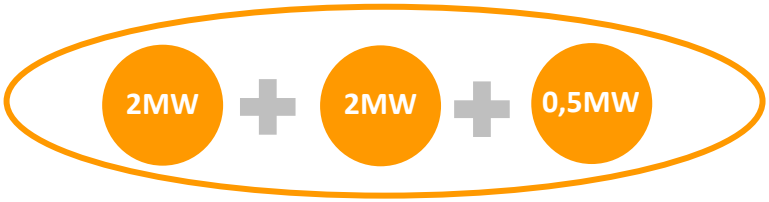
0,5MW

Aggregation benefits

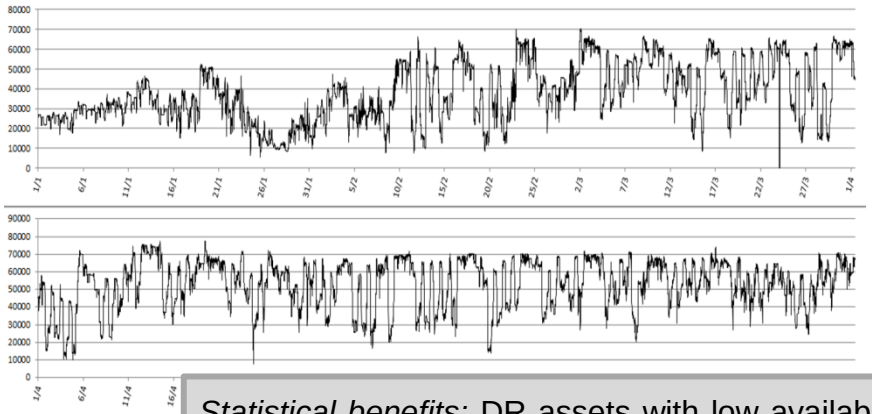
Portfolio effect increases DR potential and reliability [2/2]



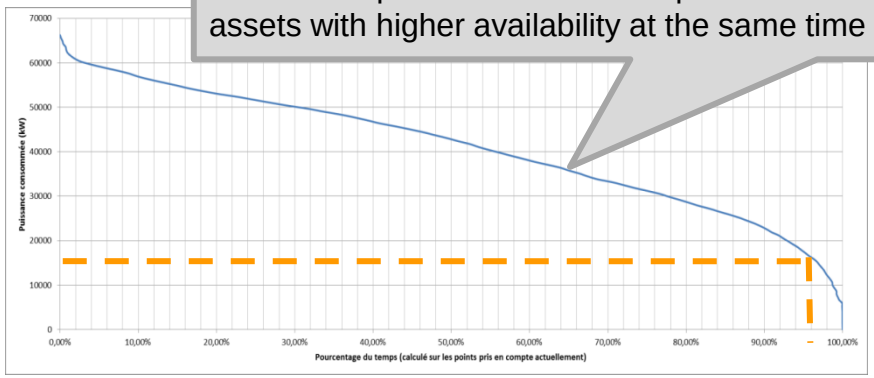




Pool effect



Statistical benefits: DR assets with low availability at a certain point of time are compensated with DR assets with higher availability at the same time



x3 = 15MW

Comparison Battery/Consumers

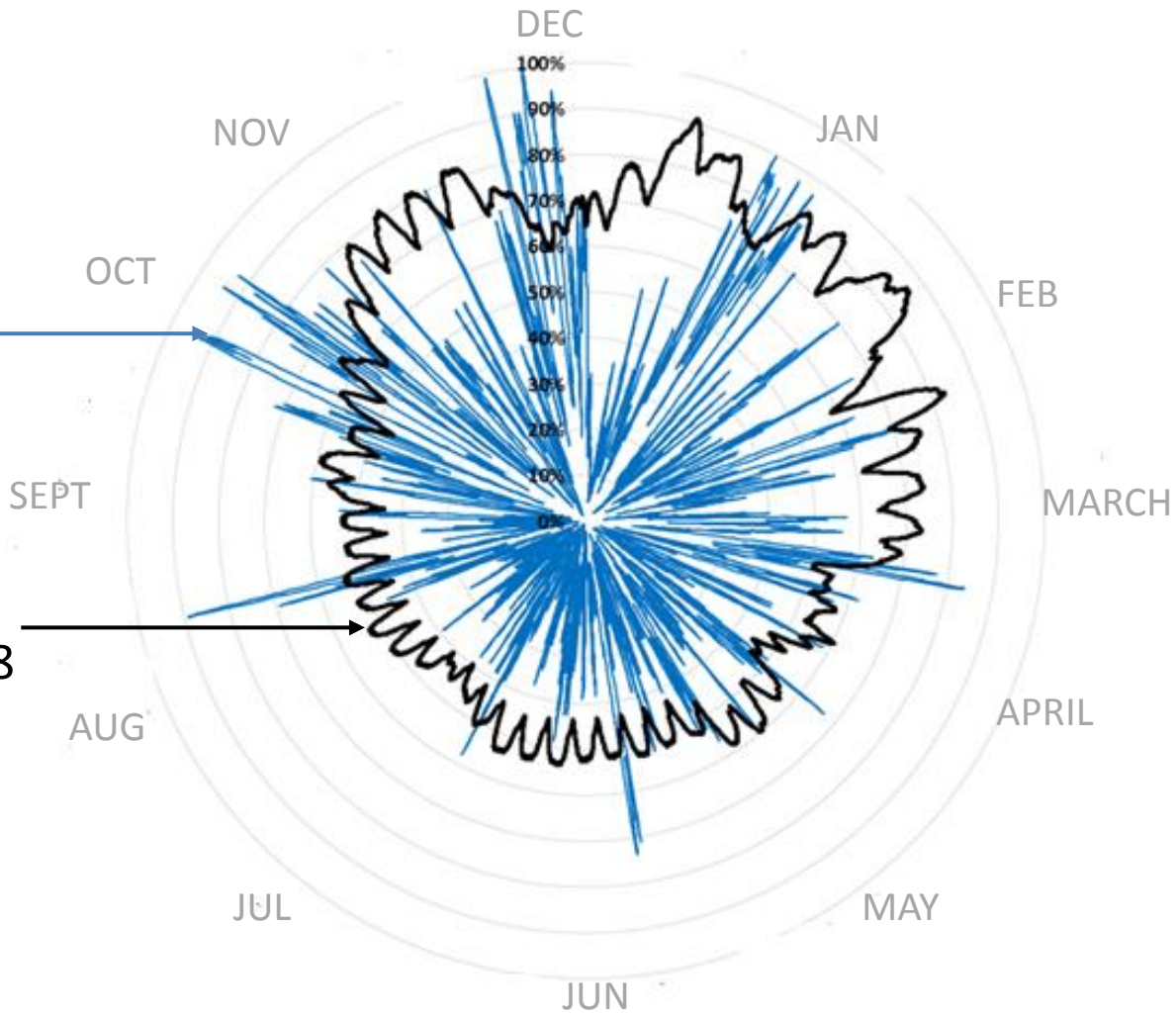
Type of Services provided

Service		Battery	Consumers
Electric supply	Electric energy time-shift	✓	✓
	Electric supply capacity	✓	✓
Anciliary service	Load following	✓	✓
	Area regulation	✓	✓
	Electric supply reserve capacity	✓	✓
	Voltage support	✓	✗
Grid system	Transmission support	✓	✓
	Transmission congestion relief	✓	✓
	Transmission & distribution (T&D) upgrade deferral	✓	✓
	Distribution support	✓	✓
End-user/utility	Time-of-use energy cost management	✓	✓
	Demand charge management	✓	✓
	Electric service reliability	✓	✗
	Electric service power quality	✓	✗
Renewable integratoion	Renewables energy time-shift	✓	✓
	Renewables capacity firming	✓	✓
	Wind generation grid integration	✓	✓

Macro View: Wind Generation vs Consumption

Wind generation forecast for 2018

Consumption forecast for 2018

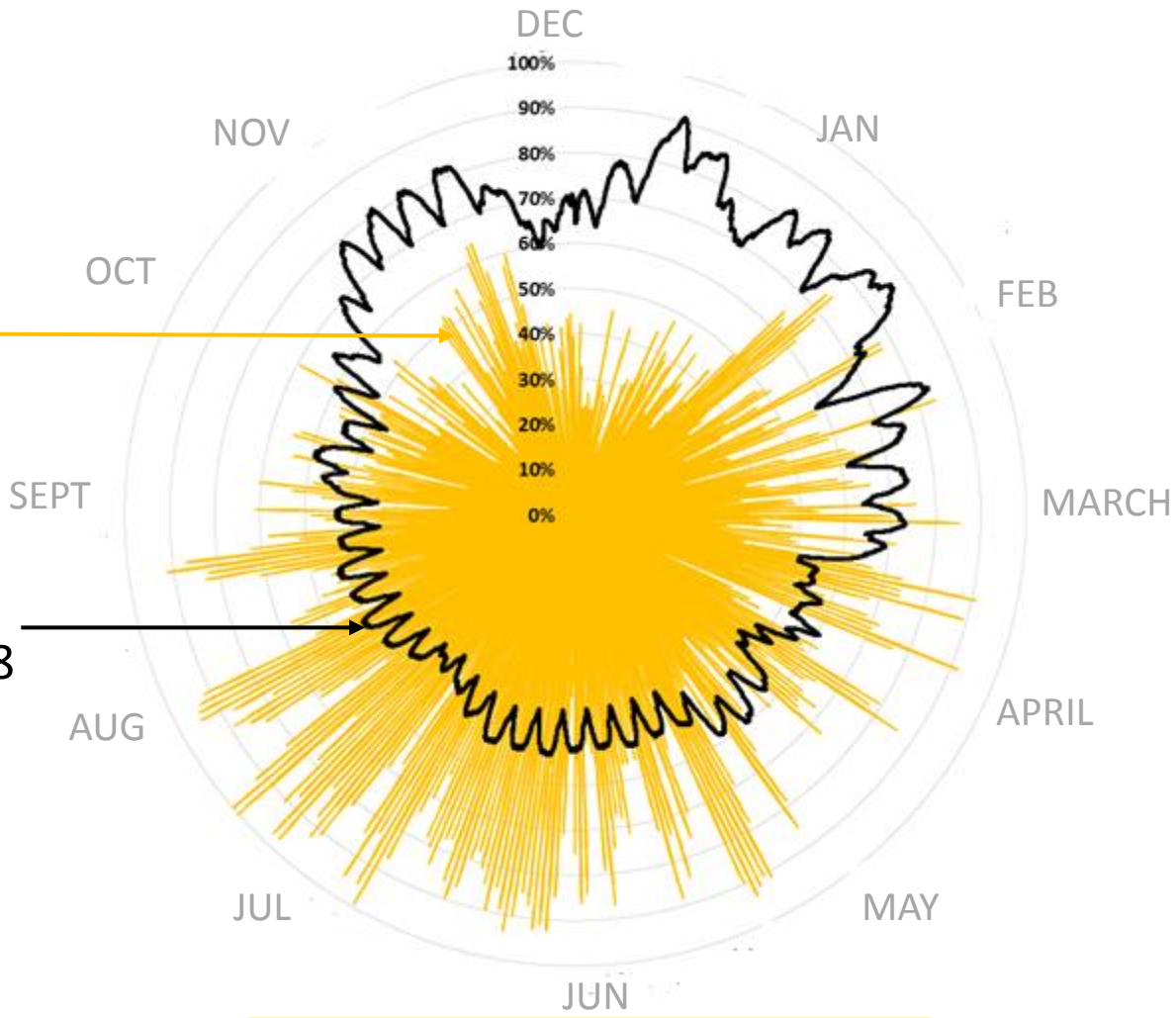


=> Wind generation partially in phase with consumption

Macro View: Solar Generation vs Consumption

Solar generation forecast for 2018

Consumption forecast for 2018



=> High solar generation when low consumption