The Value of Electricity Storage and Flexibility

Main Consideration for Market Creation

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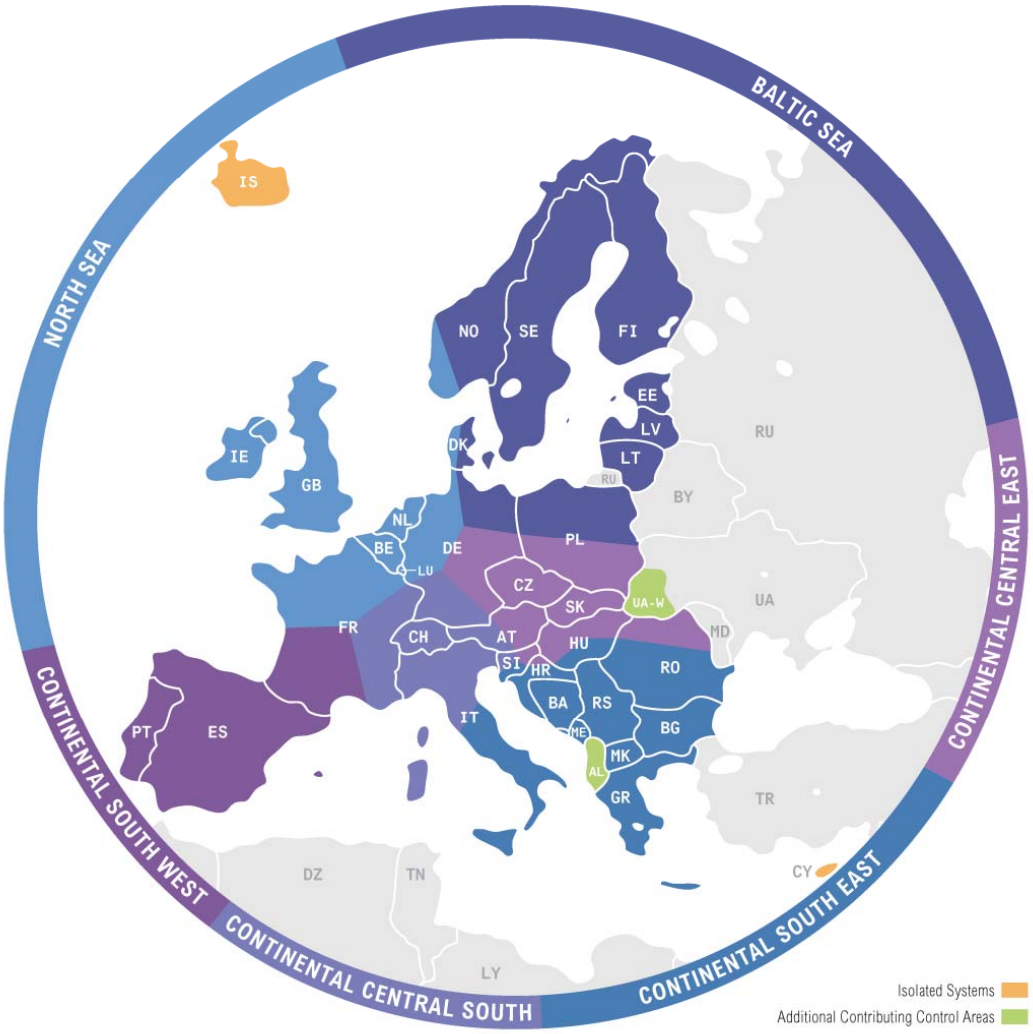
Agenda

- The Changing Context
- The Tools of the System Operator
- Flexibility
- The Case for Energy Storage
- Technical Challenges and Possible Solutions
- Non Technical Challenges and Possible Solutions
- Food for Thought

European Electric System



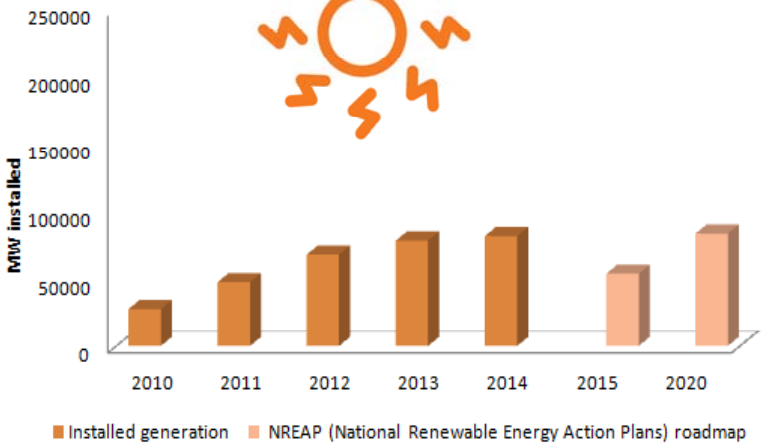
Europe in numbers (*)

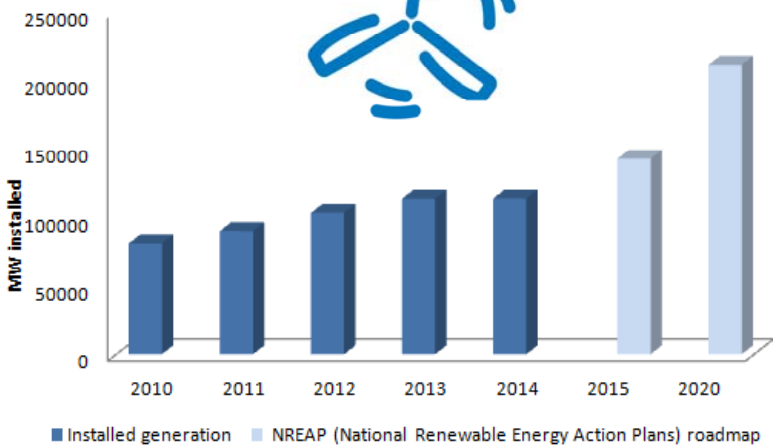
- 34 Countries
- 41 TSO
- 307.503 km of lines
- 3.307,9 TWh electricity consumption
- 1.004.062 MW net generation capacity

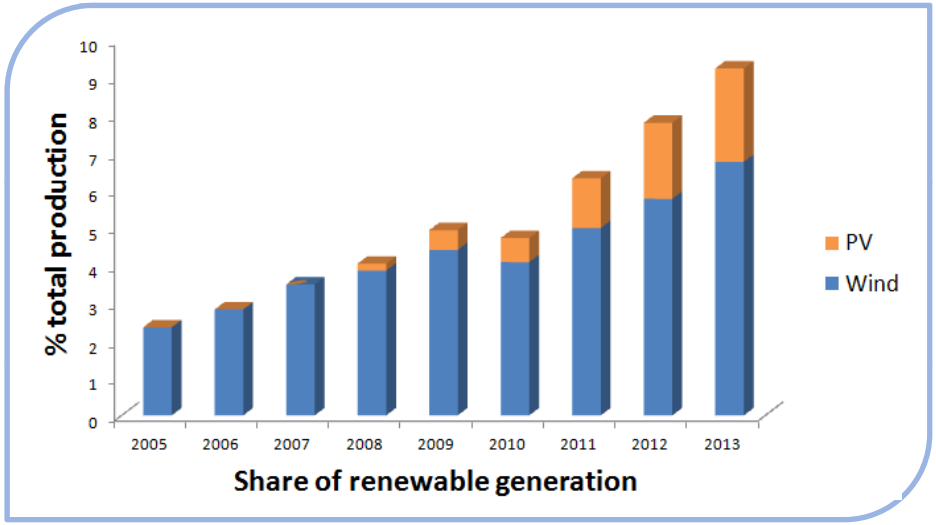
(*) Data from Entso-e (2013)

The Situation So Far

RES Generation in Europe







Following the NREAP, each European country has done its best to successfully achieve the targets set by European Directive 2009/28/EC.

PV generation in 2014 has already exceeded the forecasted value for 2020

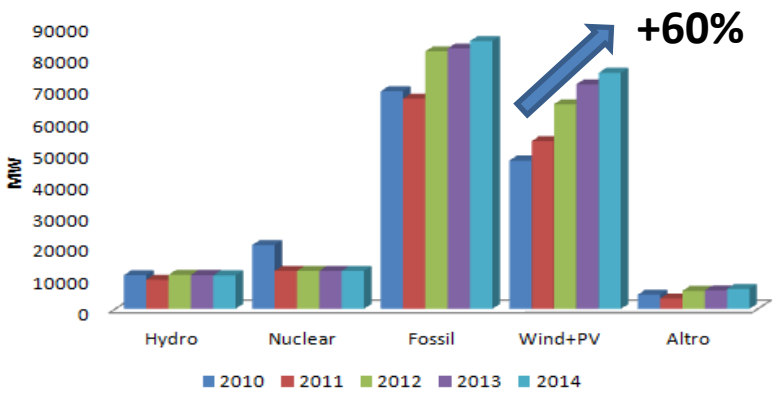
Trends and Challenges

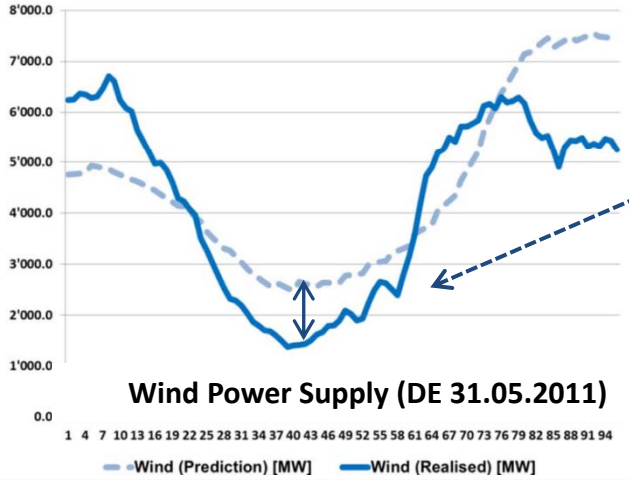
The huge increase in RES generation has brought new challenges to the system

Challenges

- Still mostly uncontrolled and non-programmable power supply
- Difficult estimation of grid availability
- Challenges in dealing with congestions on critical lines
- Very fast fluctuation in power supply
- Reduction of the market share for traditional generation = reduction in regulating reserves

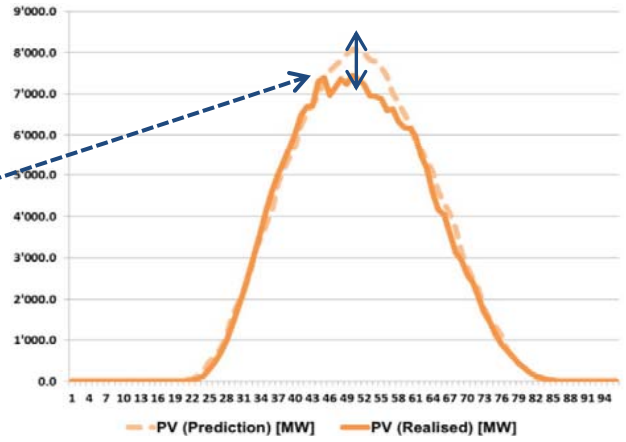
Case Study - Germany





Wind Power Supply (DE 31.05.2011)

Error ~1000 MW!



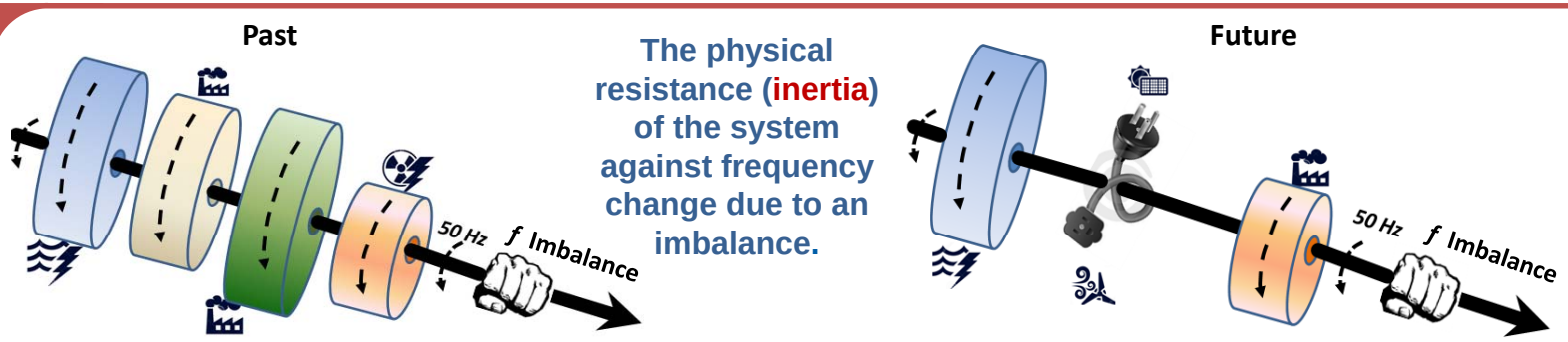
PV Power Supply (DE 31.05.2011)

The solution is **Operational Flexibility in Power Systems!**

Sources: https://www.entsoe.eu
http://www.esc.ethz.ch

The Defense of the Grid

Instantaneous/ Spinning Reserve



Time

Primary Regulation

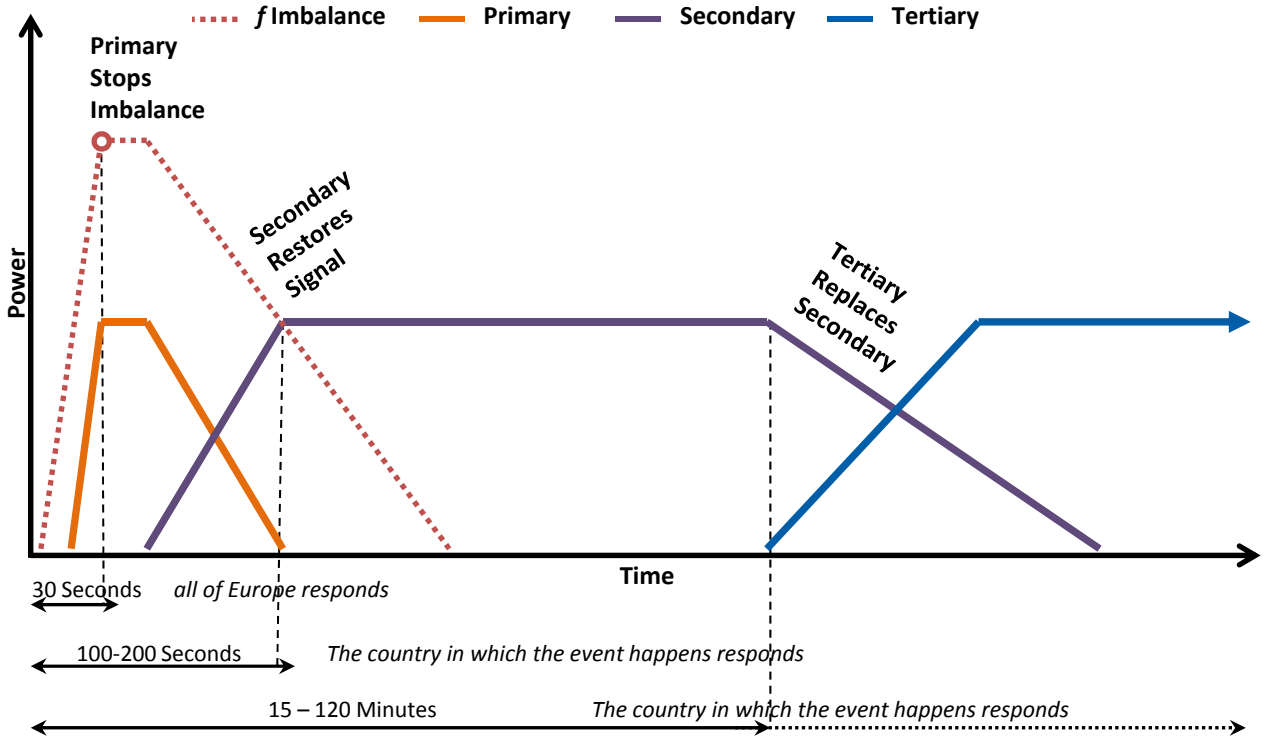
Ensures that power frequency (in Europe) is *always kept* at 50 Hz

Secondary Regulation

Ensures that power frequency (in Europe) is *brought back* to 50 Hz

Tertiary Regulation

Partially complements and finally replaces Secondary Reserve by re-scheduling generation.



Why We Need More Flexibility on the Grid

Definition

Flexibility is Defined as the Capacity of an Asset to react to Different Scenarios

The Changing Energy Mix

Means that all planned assets must be adequate to today's as well as tomorrow's Grid

The adequacy of the Grid

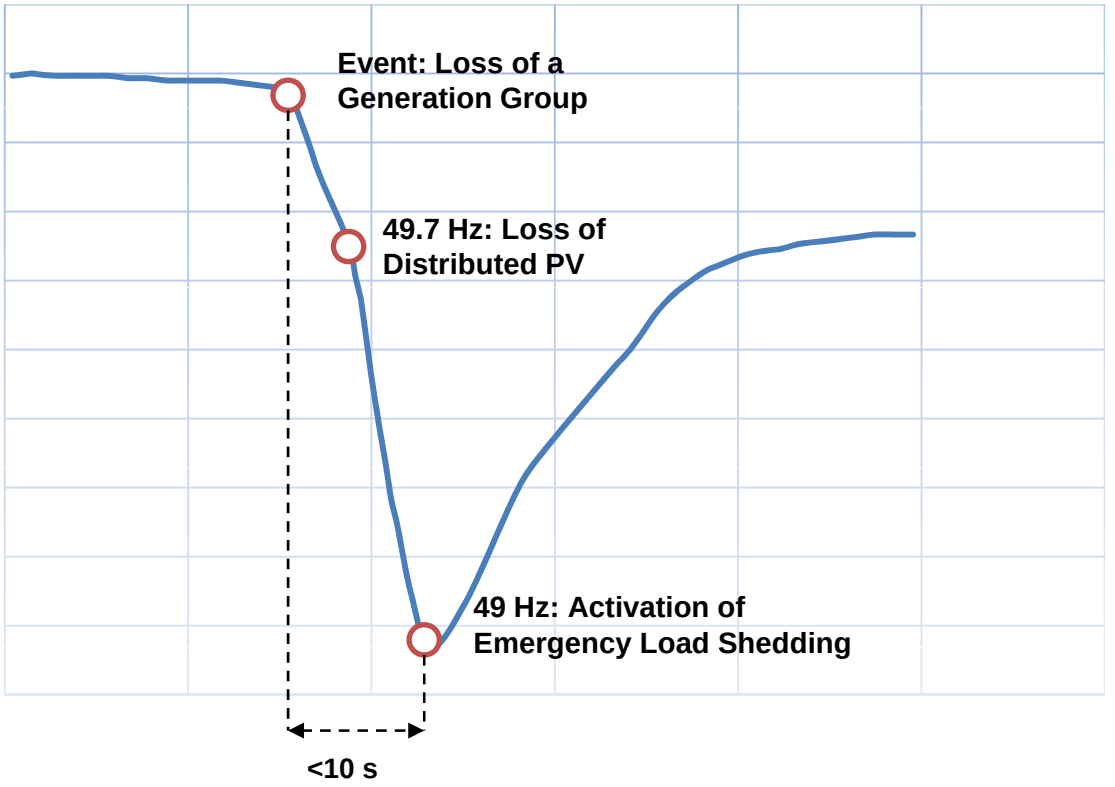
Has been traditionally evaluated by assessing the point of highest demand

Distributed Generation

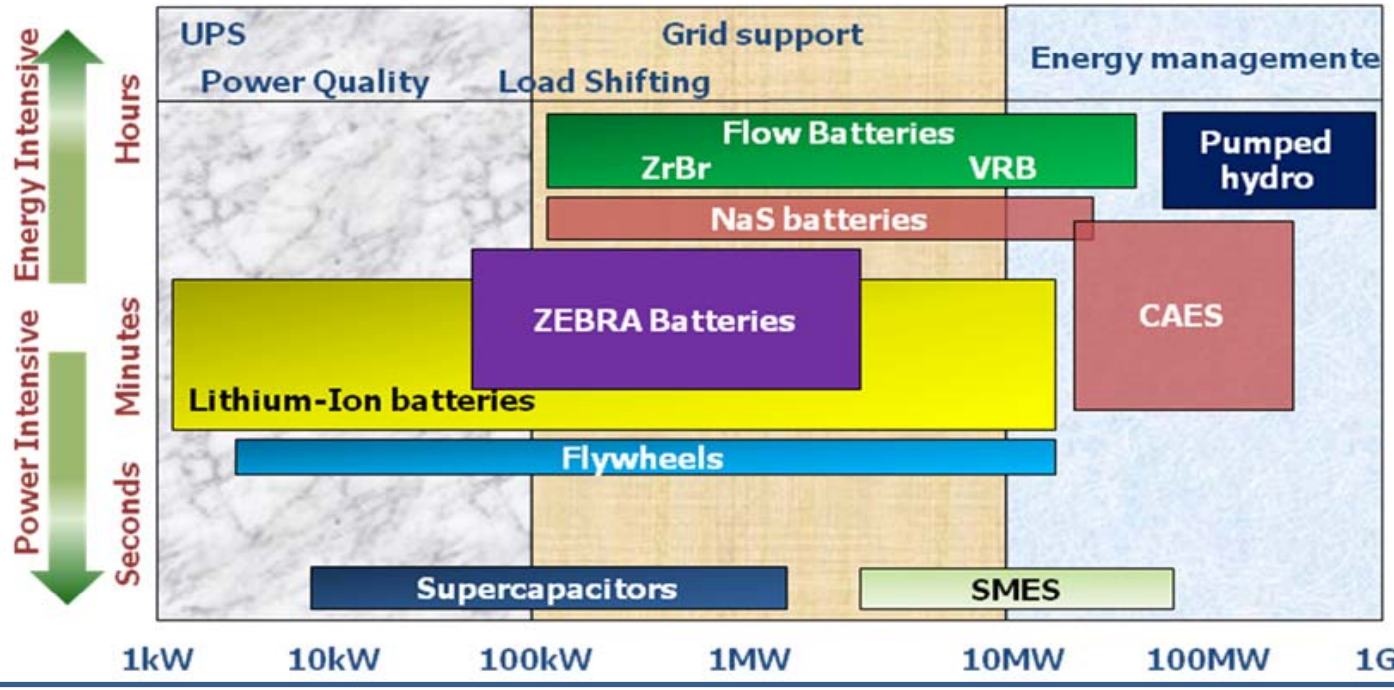
The net increase in **DG** makes this approach alone ineffective so new methods are necessary

Example 2011 Event in Sicily

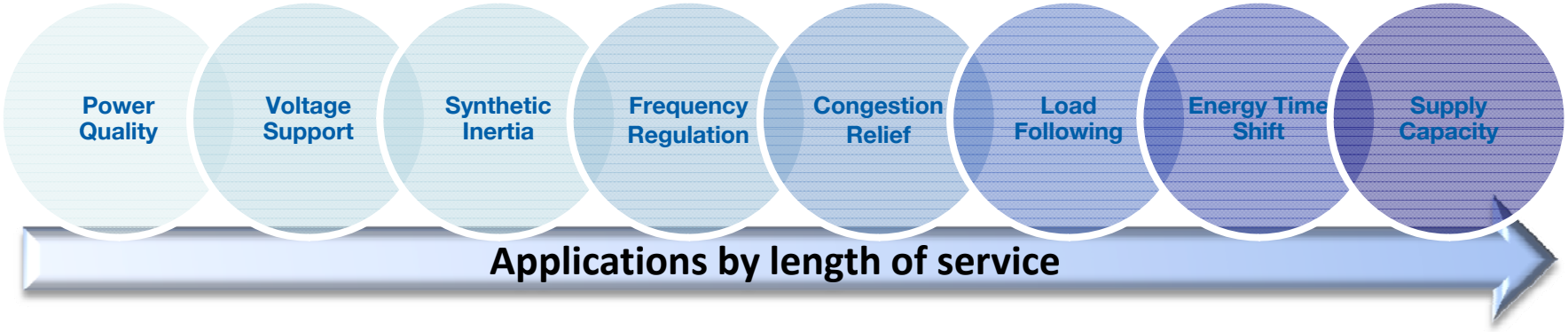
Loss of a Group coupled with the system's very low Inertia and the high amount of Distributed Generation caused a very fast Frequency drop and the activation of Emergency Load Shedding



The Case for Energy Storage



Storage Technologies offer a wide range of characteristics and length of service.



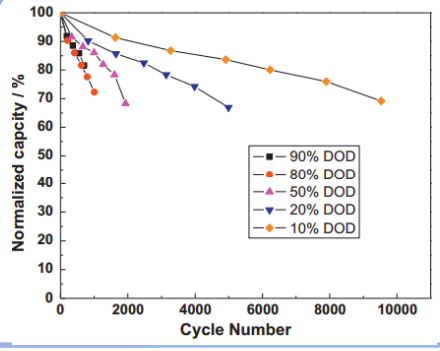
Technical Challenges and Possible Solutions

Missing technical standards for tests and commissioning

The lack of common standards for commissioning and testing Energy storage Systems is a key problem when integrating such assets in the modern electric power grid, safety aspect are also a concern.

IEC, IEEE, UNI, UL and other national and international standardization entities must receive feedback and support from System Operators as well as utilities in order to better compile such standards of connection and usage.

Uncertainty on life Cycle estimation



Storage Systems' life is affected by numerous parameters like temperature, DOD, SOC, discharge/charge current, etc… So far there isn't a common standard or a life simulation model able to foresee batteries' life expectancy for a given service

Risk-sharing could be a possible solution to these issues. Suppliers should be encouraged to sell a "service" and not just a Storage System, guaranteeing that same service for a given period, thus sharing the risk of premature end-of-life.

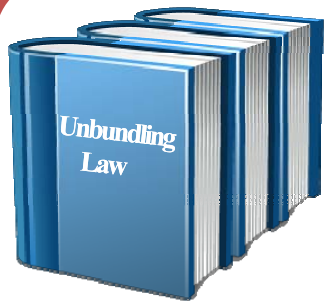
Lacking of operating experience

Energy Storage Systems are new and advanced assets available to all, System Operators, Utilities and Consumers, hence very little experience has been developed regarding O&M. Therefore long term costs are still largely unknown factors.

Numerous Energy Storage installations around the world have been operating in the past few years. International Cooperation, aimed at know-how sharing could be a solution when addressing the lack of experience.

Non-Technical Challenges and Possible Solutions

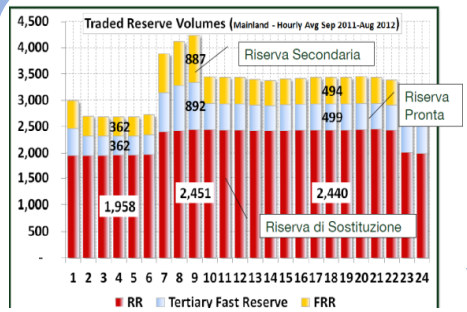
Clear Regulatory Context



Storage can behave as a load or as a generator, but it can also provide support to the safety of the grid. This multiple nature as well as its many possible uses throughout the entire energy value chain makes ownership of these assets a political as well as an economical issue.

The issue should not be the ownership of the asset as much as the *Service* for which it is used. Regulation should focus on defining <u>who</u> can provide <u>what</u> service and <u>how</u> instead of precluding subjects from outright owning a technological piece of equipment.

Fair Market Access



Most Ancillary Markets today are Capacity Markets: they are defined by the amount of Power that should be provided (indefinitely) to the Grid. This is an unfair disadvantage for Storage which is limited by its capacity.

Determine length of services based on credible events on the grid, taking advantage of all the different ancillary services and taking care not to overlap services, and allowing Distributed generation to access the markets. Favour bilateral agreements between Storage suppliers and Traditional Generators to provide cross-service reserves.

Sharing of Costs & Responsibility

Given that much of the issues that we are facing today are a result of the increase in RES, European consumers will find themselves having to pay for this increase twice: in developing the issue as well as in solving it.

Other Geographies (Puerto Rico, Corsica, etc) have imposed obligations to future RES developers to install their own Storage in order to neutralize some of the same issues they cause. Tax breaks, or convenient leverage in the investment could make adoption easier.

Food for Thought: *Possible New Ancillary Services ?*

Economic Benefits

Being able to slow down or even stop the imbalance from going too far, might indeed create a lesser need for Secondary/Tertiary Reserves. The savings for the System could be significant. This without taking into account the loss of Distributed Generation caused by volatile f signals.

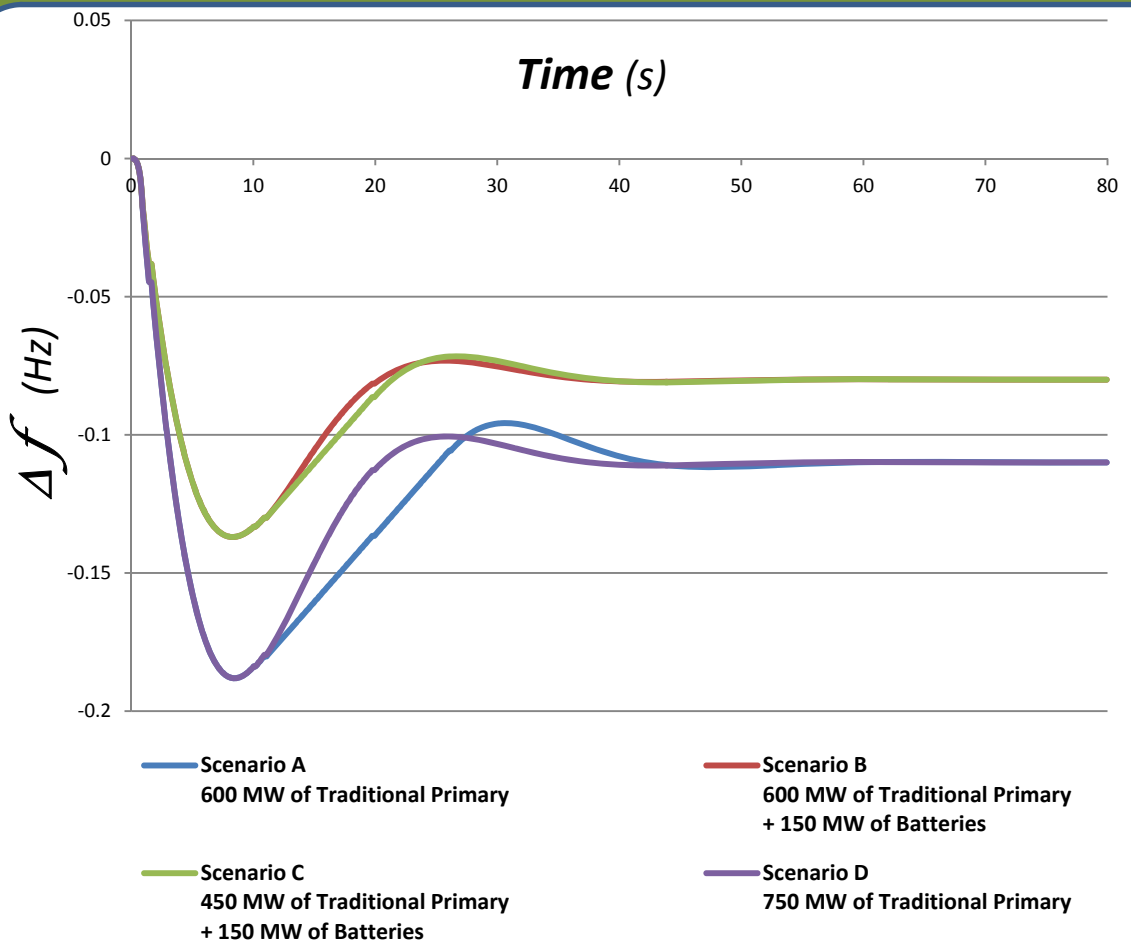
Disclaimer: this solution is only aimed at solving temporary imbalances.

Grid Safety Benefits

Fast reacting and flexible assets on the grid could act as a substitute for the constantly decreasing inertia of Continental Europe. This will slower the change in frequency allowing the System Operators to access other resources in time to avoid Shedding of loads and dangerous escalations of events.

Example of Simulation (*)

Simulations and studies are being conducted in order to evaluate whether ultrafast reserves (i.e. within Milliseconds from event), a.k.a. *Synthetic Rotational Inertia*, can resist the escalation of the imbalance, acting as a facsimile of a synchronous rotating mass.



(*) P_n=50 GW f_n=50 Hz ΔP_G=550 MW


The End