



*The Role of Energy Storage in EDF's Concept Grid Project:
An Experimental Platform to Prepare the electrical Systems
of Tomorrow*

System integration of storage solutions using EDF's Concept Grid platform

EDF R&D

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Storage – Key criteria

Storage is an energy reserve

Several technologies, each with strengthes and weaknesses

- Safety
- Amount of energy for a given volum or weight
- Power / energy ratio
- Charge power (or time) sometime lower than Discharge power
- Lifetime (number of full cycles or calendar time)
- Price
- Other constraints : efficiency, footprint, implementation,...

Various applications can be envisaged

- Voltage plan management
- Peak shaving
- Islandind
- Frequency regulation
- ...

Frequency control

A key application of storage for the system

When generation = consumption

- Frequency = 50Hz, imposed by the rotating machines connected to the grid



When generation > consumption

- The frequency increases
- Risk of overspeed for rotating machines
→ Losse of powerplants



When generation < consumption

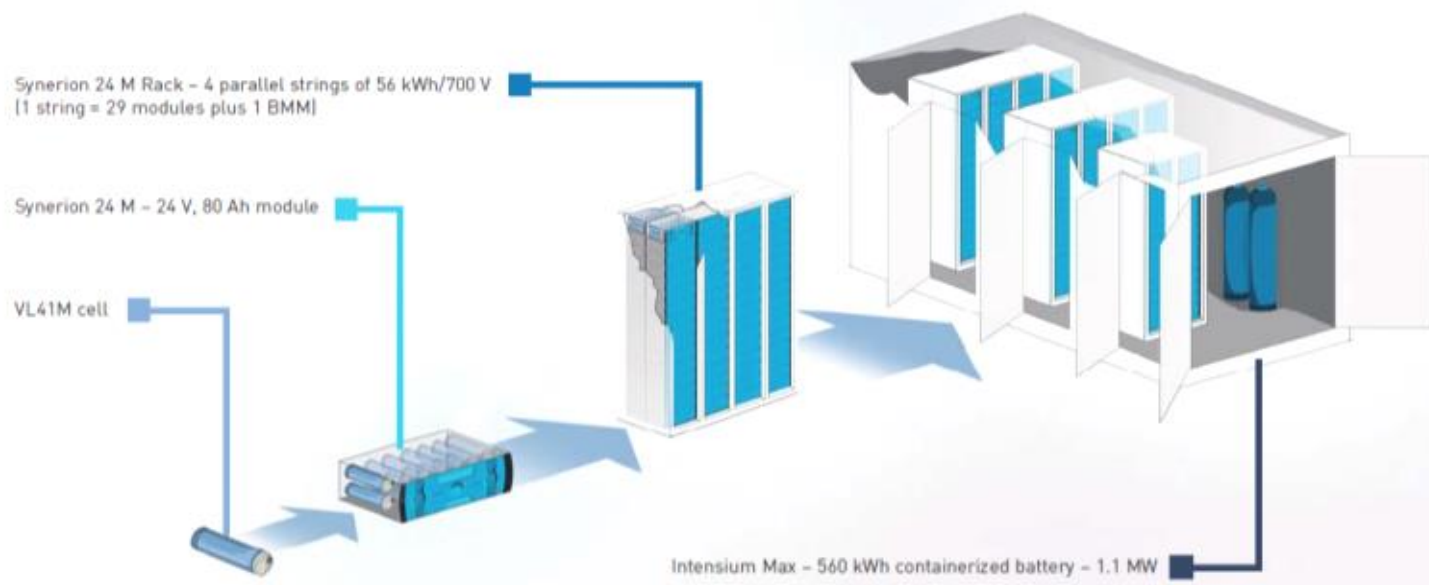
- The frequency decreases
- Risk of underspeed for rotating machines
→ Losse of powerplants - it is a viscous circle as the frequency will decrease even more



A requirement for a power reserve at EU and national scales .
650 MW primary reserve in France – 27MW for a 1300MW powerplant

A storage technology : Li-ion batteries

- Li-ion batteries are now mature
- A lifetime around 2.000/3.000 full cycles
- Flexible, doesn't need periodic full charge (Pb), no memory effect (Ni)
- A large scale battery in a container is based on the same elementary as smaller batteries (for example 4kWh for residential customers)
- A Fire Safety System can be added in the container



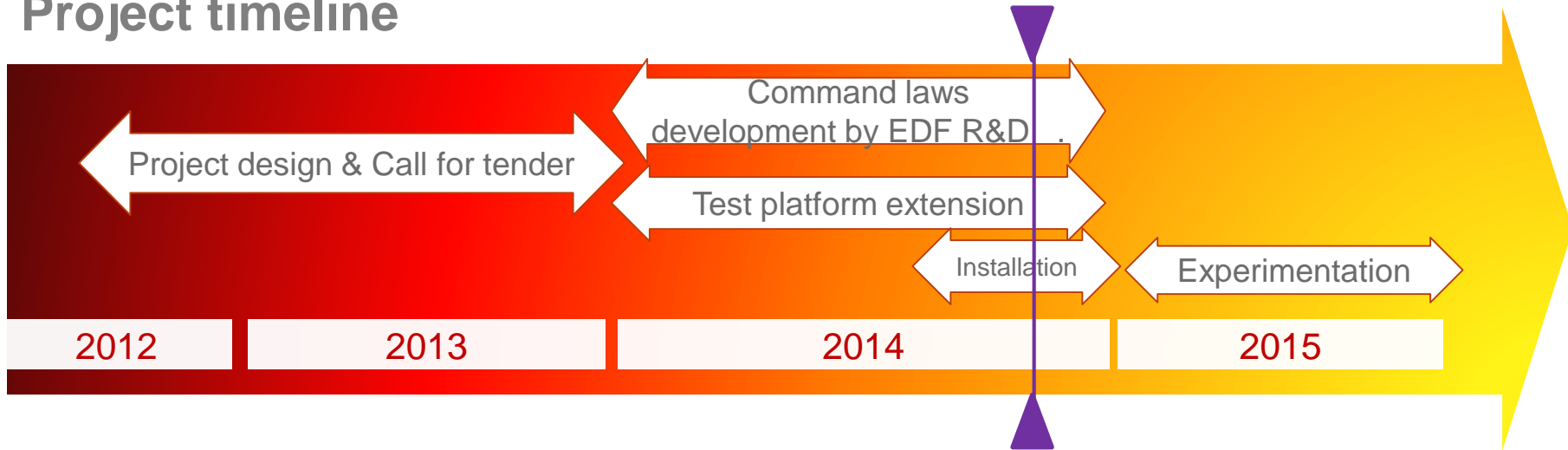
EDF launched in 2012 a project to test frequency regulation with Li-ion batteries

Objectives

- 1 Get a practical experience of large scale battery integration into the electrical system
- 2 Develop the command laws in-house at EDF (State of Charge management)
- 3 Validate lifetime with accelerated tests at cells level and with instrumentation
Miniumum expected lifetime : 10 years

After the experimentation, the system is to be transfered to field operations, possibly to an EDF powerplant

Project timeline



Suppliers of the system:

- **SAFT** : supplier for the 1MW battery
- **ALSTOM** : supplier for the inverter

Suppliers for the test platform extension:

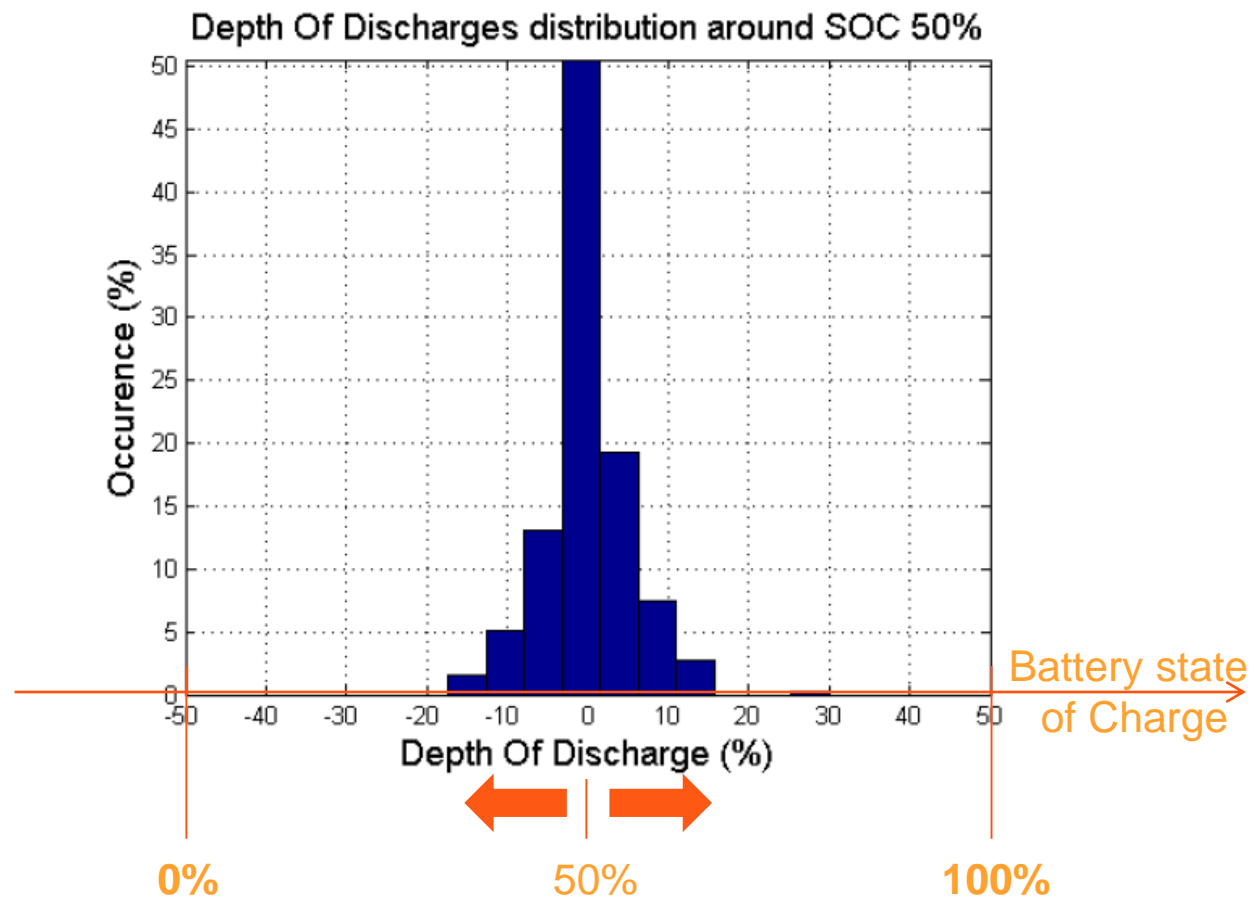
- Eiffage, Ormazabal, SDEL



Battery lifetime evaluation

1/2

- Li-ion battery has an estimated lifetime of 3.000 full cycles
- Frequency control application requires a lot of 'small' cycles



Battery lifetime evaluation

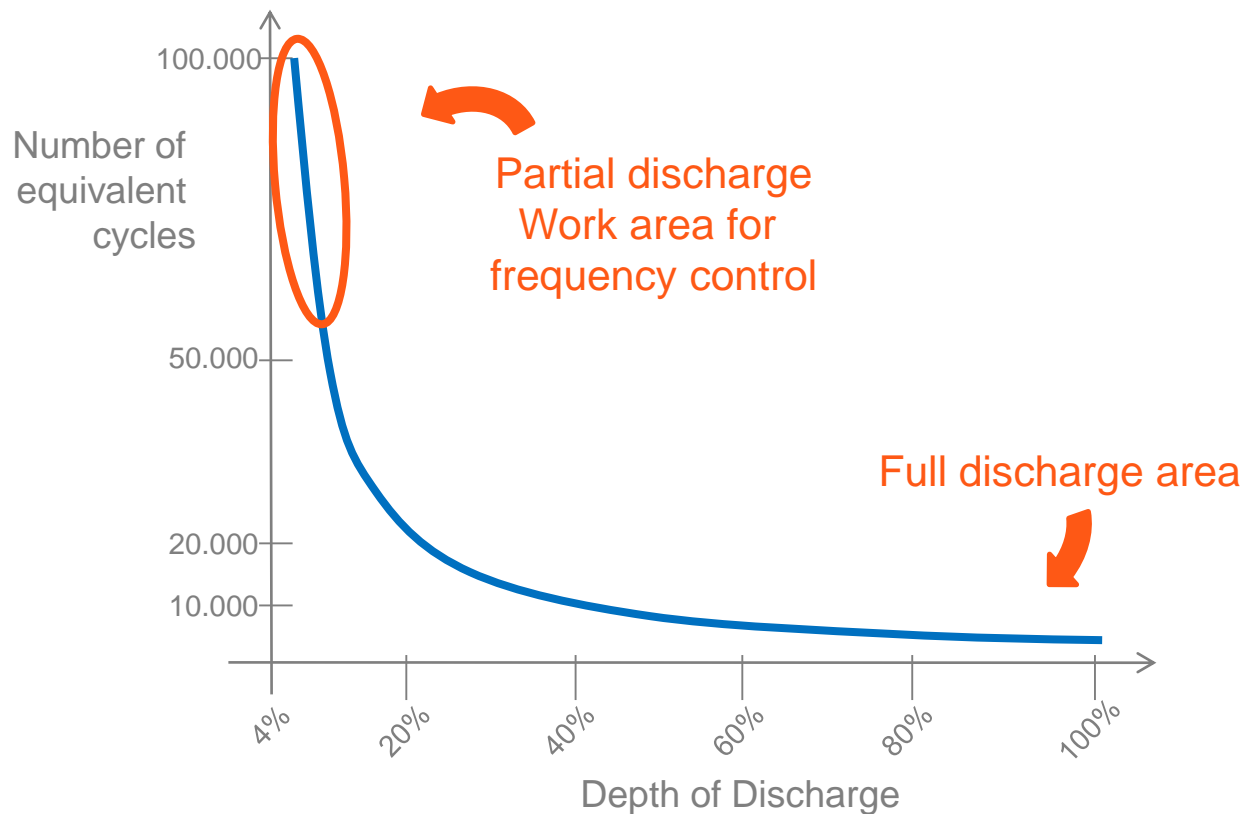
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Over a year, the cumulated 'small' cycles are equivalent to 700 full cycles

10 years of operation corresponds to 7.000 cycles

→ What about lifetime ?

The number of cycles increase exponentially with the decrease of the depth of discharge



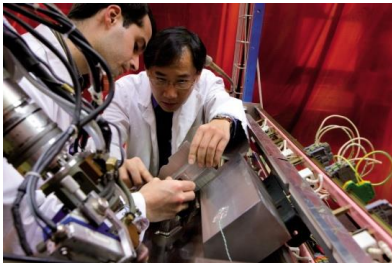
Concept Grid - a unique test facility

A true **'electric system – laboratory'** to validate **innovative** solutions (equipments, algorithms, services) through **testing** and **demonstration in real conditions**.

Concept grid performs test campaigns for all **EDF group business units** and is **open to external customers** (academics, manufacturers, SMEs, ...)

'TRADITIONAL' LABORATORY

Unit / Standard Tests



CONCEPT GRID

✓	Applied constraints	++
✓	System representativity	++

FIELD TRIALS With customers





Elements Composing Concept Grid

NETWORKS

3 km MV
7 km LV



3 grounding options

Resistance
Peterson coil
Active neutral



RESISTORS INDUCTORS & CAPACITORS BANKS

120 km equivalent



TELECOM

IP network
PLC & radio



AMPLIFIER Coupled to a SIMULATOR



Simulator



Amplifier

**REPRODUCE
THE CHARACTERISTICS
OF LARGER SIZE
DISTRIBUTION NETWORKS**

RESIDENTIAL AREA



Photovoltaic



Wind



Charging station
for electric vehicles



Heat pump

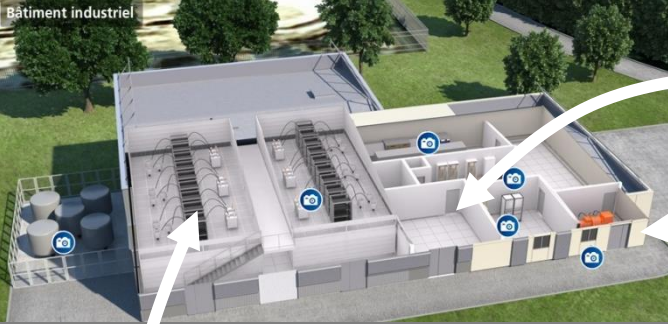


Storage



Smart meters

Bâtiment industriel



Amplifiers for real time simulation
'hardware in the loop'

Motor Generator

Control Centre

'RLC' cells
120km
network



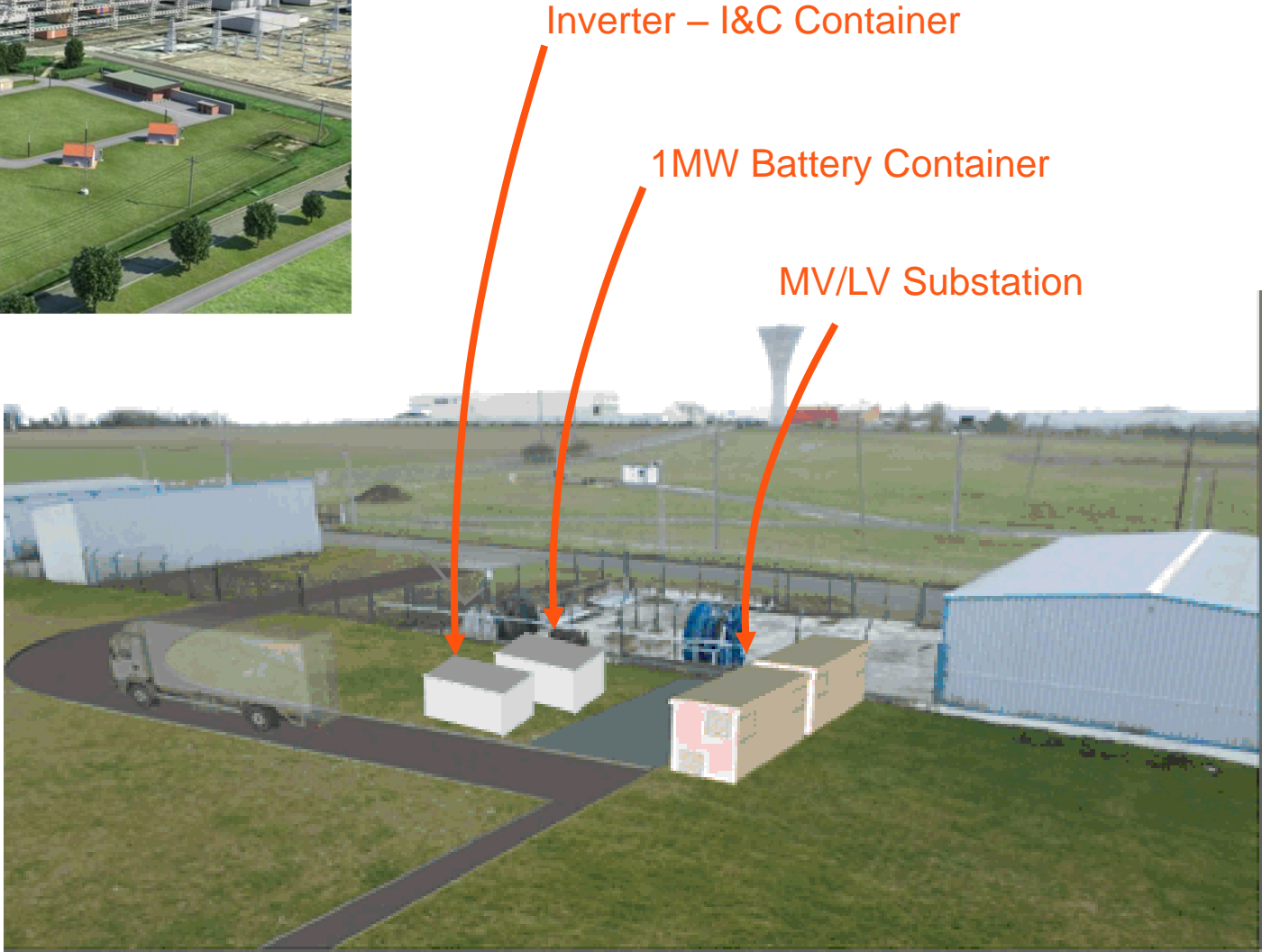
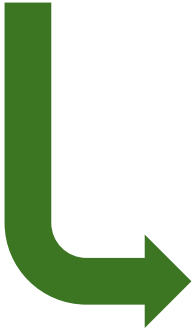
Overhead lines

Low voltage
Residential area

Quartier d'habitation



Battery installation at Concept Grid



Tests to be performed at Concept Grid

- **Within the LV network, power up to 100kVA with amplifiers**
 - Commissioning & reception test
 - Network perturbation tests – frequency variations, voltage drops
 - Bespoke scenarios – using hardware in the loop capabilities
- **Within MV network**
 - Tests at full power (1MW)
 - Readiness for operationnal site transfer

Benefits with Concept Grid : reduced risks and get fast learning

In 12 month of test, a comprehensive series of sollicitations
that happen very rarely in real conditions

Another example : islanding

Test NiceGrid's 33kW battery using Concept Grid

- **NiceGrid** : a 4 year 30 M€ ERDF demonstration project in France - part of Grid4EU
 - Batteries installed at 3 levels : residential, community, HV substation
 - Community level : a 33kW / 100kWh Li-ion battery (SAFT / SOCOMEC)
- **Tests to be performed** :
 - Validation prior to site deployment near a 90kW PV plant
 - Test algorithms to control the battery/inverter system and the islanded LV network
 - In nominal & extreme situations, using real PV, consumption, disturbances, and specific hardware in the loop scenarios
 - Check reliability of switching from/to islanding



Benefits with Concept Grid : get confidence in the system reliability

A 'customer free' environment to test extreme cases

Test of storage solutions with Concept Grid : what else tomorrow ?

Concept Grid's capabilities will enable to test :

- **Other applications and associated algorithms...**
 - Peak shaving, voltage management, grid investment deferral, etc.

- **... and all types of technologies for distributed storage**
 - Advanced Lead batteries
 - RedOx flow
 - Fly-Wheels
 - Super Cap
 - Etc.

Thank you for your attention

Questions ?

