EDP Distribuição - Energy Storage Project

Accessing the potential of grid connected storage

28th September of 2017

Agenda

1. Brief introduction to EDP Distribution.
2. MV Storage - Project Overview.
3. Main Project Challenges.
4. Ongoing and Future Tasks.
5. Interaction with other projects – SENSIBLE.
6. Key Takeaways.

Project Overview / Technical Characteristics

Évora's storage pilot project

- **Located in Évora University Campus**
- **Commissioning Date - December of 2015**
- **Lithium Ion Batteries**
- **Power / Energy ratings - 480 kW/ 360 kWh**

- **Quality of service improvement:**
  - Continuity of service: backup to university
  - Quality of energy: voltage control.
- **Network CAPEX deferral:**
  - Resource providing flexibility (impact on network planning)
  - Peak Shaving of distributed energy.
- **Integration of distributed sources:**
  - Integration of a higher share of renewables

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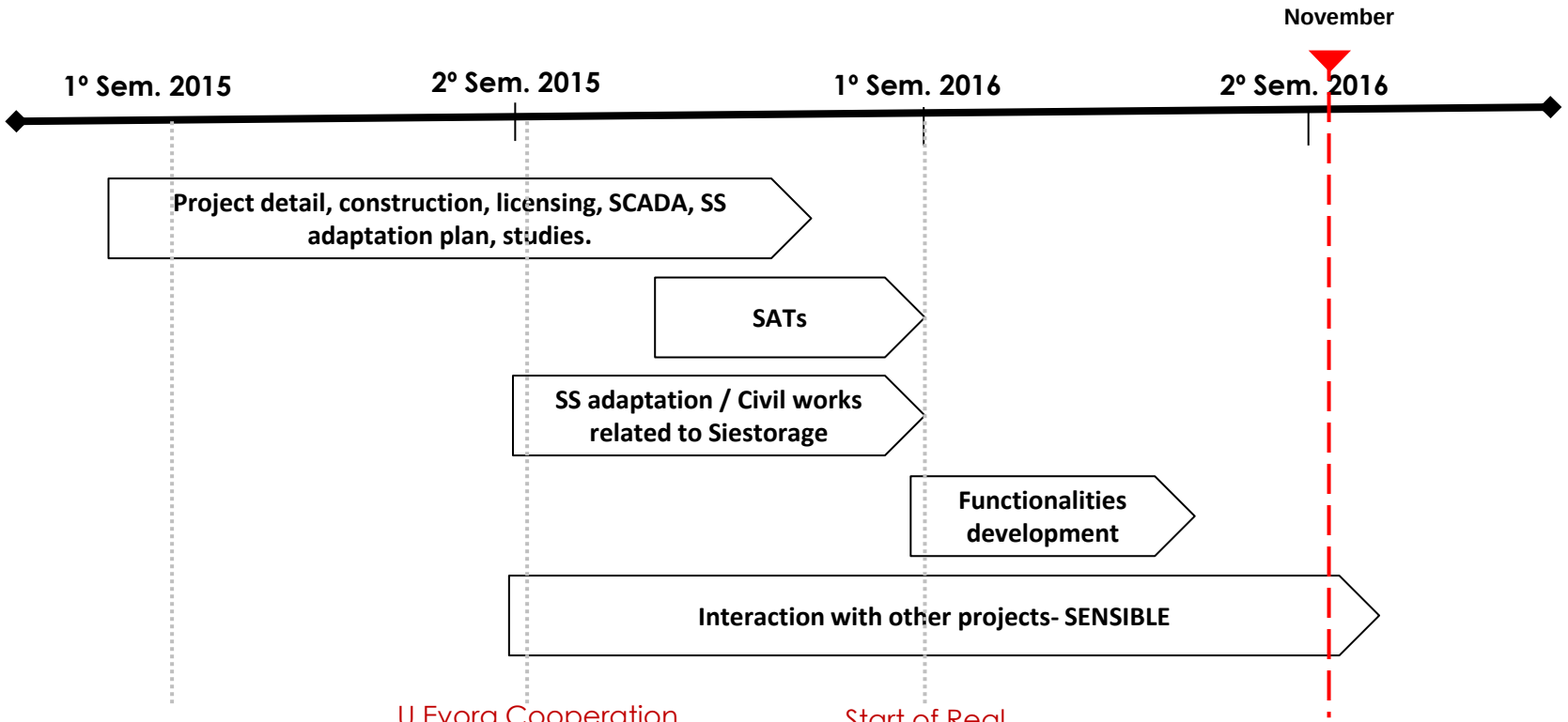
MV Storage Project Implementation Highlights



Kick-off

U.Evora Cooperation Protocol

Start of Real Operation

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Main Project Challenges

Legal and Regulatory

- Safety issues regarding the use of high power batteries
- Storage Licensing with specific Island Mode operation
- LV protection systems compliance with regulation requirements

Technical

- Secondary substation adaptation for storage test and commissioning
- System adaptation for all required functions (PQ, Vf, Hybrid mode)
- Corporate systems adaptation for the project (SCADA, GIS…)

Other Constraints

- Knowledge retention and transfer.
- Training on system operation and maintenance.

Main Project Challenges: LV protection systems compliance

Storage system behavior in controlled real operation context

- Real Short Circuit Test
- PQ operation mode and Vf transition
- Islanding operation
- Oscillographic analysis
- Clients' LV and storage MV protection schemes validation for safety concerns

Main Results

- Differences found between manufacturer simulations and actual results obtained.
- Minimum frequency while switching to islanding operation mode determined as well as drop and recovery times.
- No significant restraints to the storage operation were identified.
- **<u>Real tests were crucial for assuring safe operation!!</u>**

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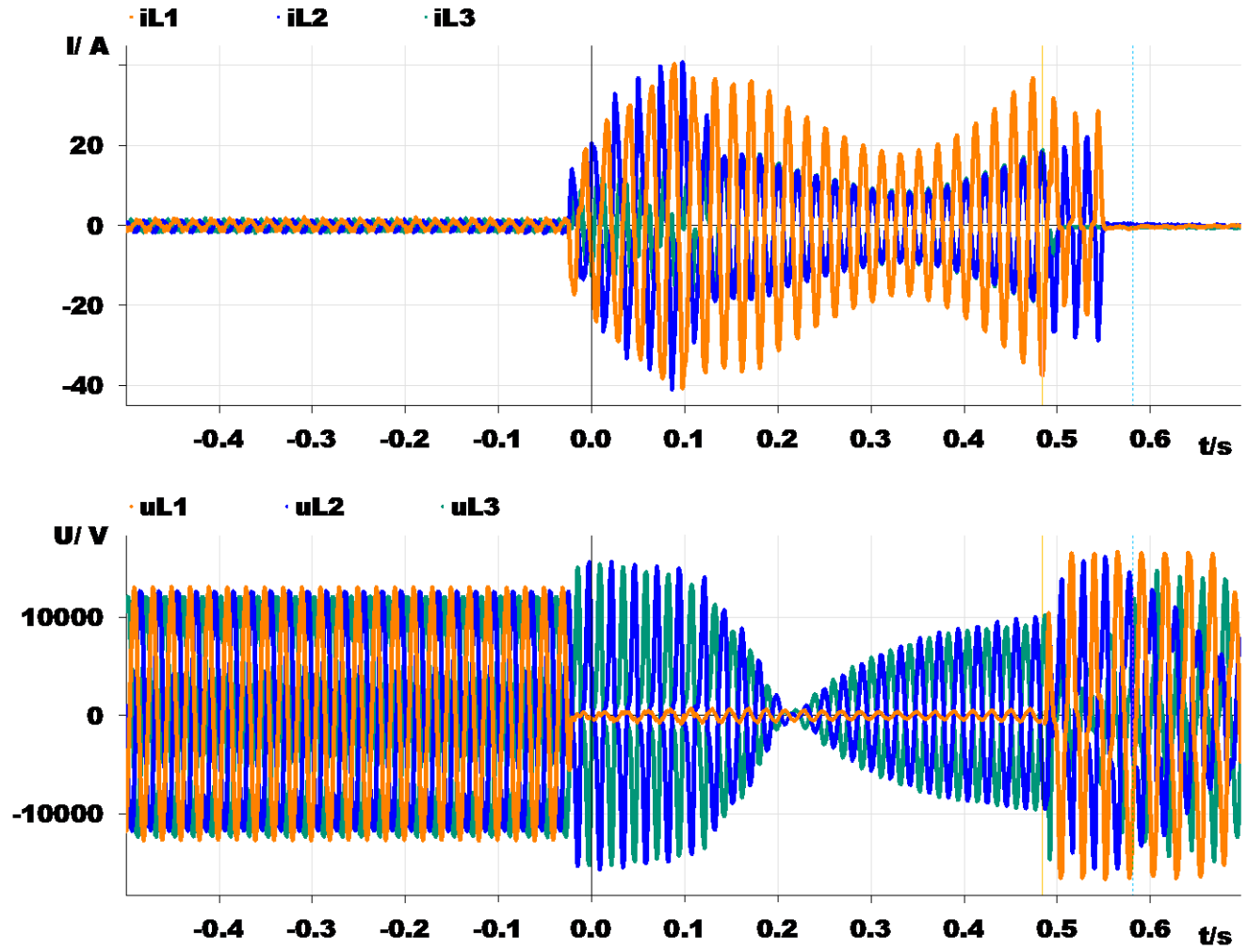
Main Project Challenges: Phase Neutral fault in island mode



Main Conclusions:

- Overvoltage values below expected in simulations.
- Fault current differs from the supplied simulation
- **Real tests were crucial for assuring safe operation!!**

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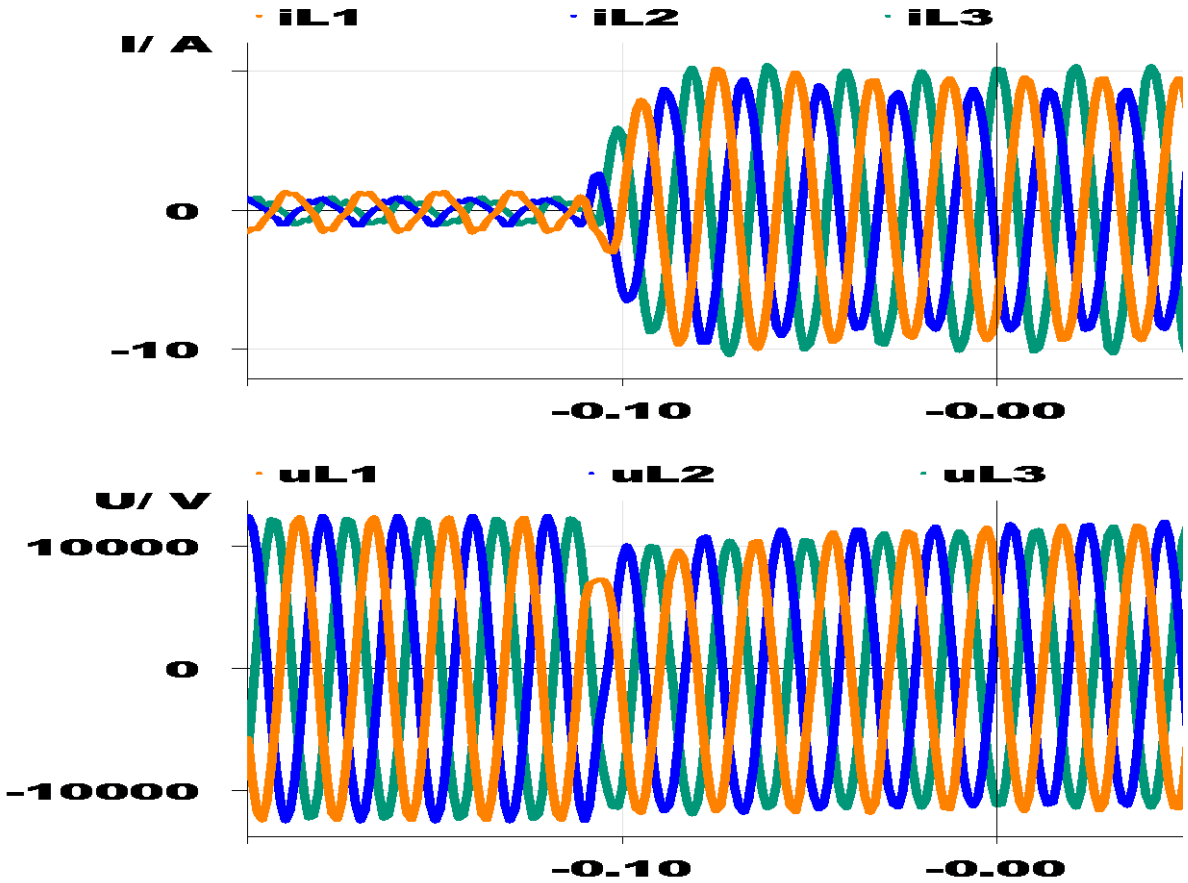
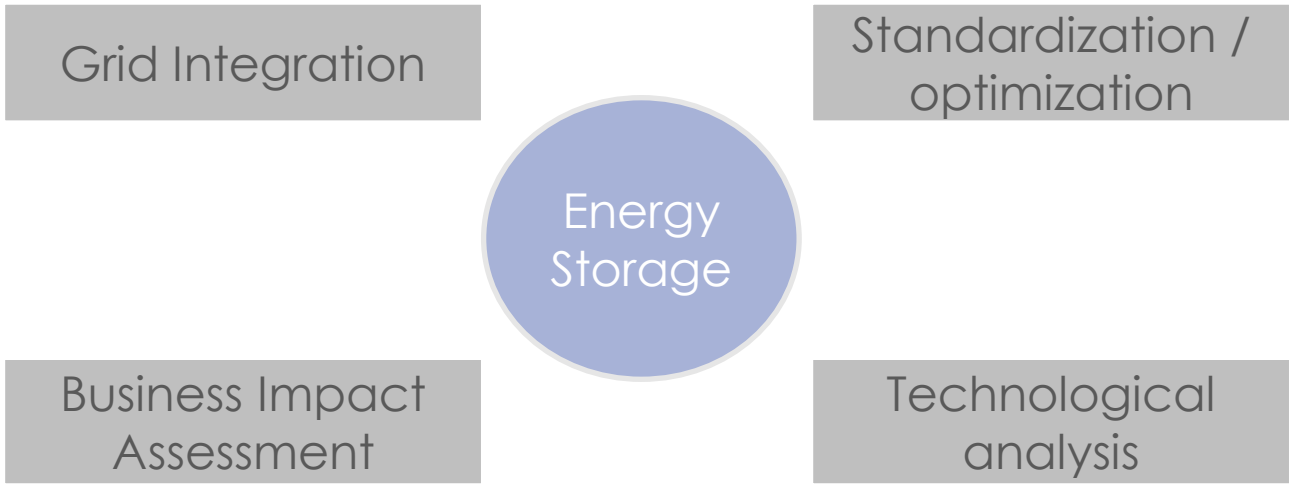
Main Project Challenges: Switching to island mode



Main Conclusions:

- Minimum frequency reached and drop time determined
- Currents assume load unbalance
- Recovery time for frequency determined
- Islanding tests had implication on protection parameters.
- **Real tests were crucial for avoiding unwanted trips!!**

Storage – New R&D Activities / Projects on Energy Storage



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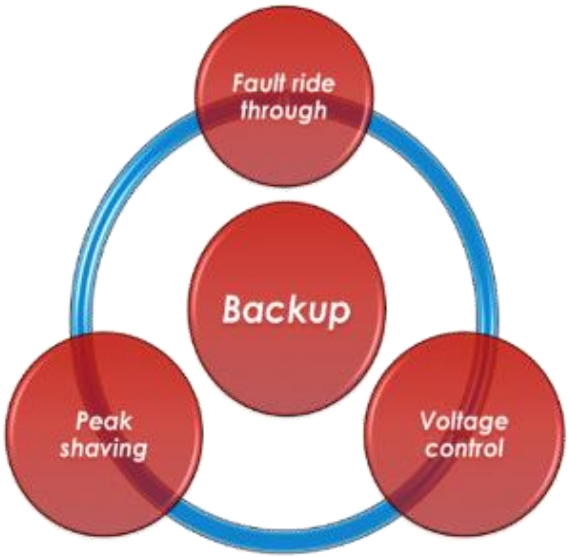
Ongoing and future tasks

Initial Use Cases



UC1	Island operation validation ✓
UC2	Performance Monitoring IN PROGRESS
UC3	Service Quality / Energy Quality IN PROGRESS
UC4	Advanced Peak Shaving IN PROGRESS
UC5	Extended Islanding Operation IN PROGRESS
UC6	Storage System Optimization
UC7	Business Models Evaluation

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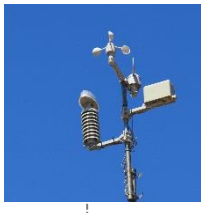
Performance Monitoring – Key activity for BM evaluation

System Monitoring Interface

Meteorological Station



Air Conditioned

Solar Panels – Auxiliary services and AC power consumption

Outside

Storage Container

Local Command Point

Interior Thermometer

Batteries

S7 Controller

Power Electronics

Medium Voltage Cells

Performance Monitoring

Must Have

- I,V P e Q MV Cells
- Temperature
- BMU Data
- Inverter Data
- AS Consumption
- AC Consumption
- Active Function Mode
- *State of health* (Batteries)

Should Have

- Energy Quality
- System Reliability
  1. SCADA
  2. Comms
  3. Hardware
- Individual Battery Rack Data

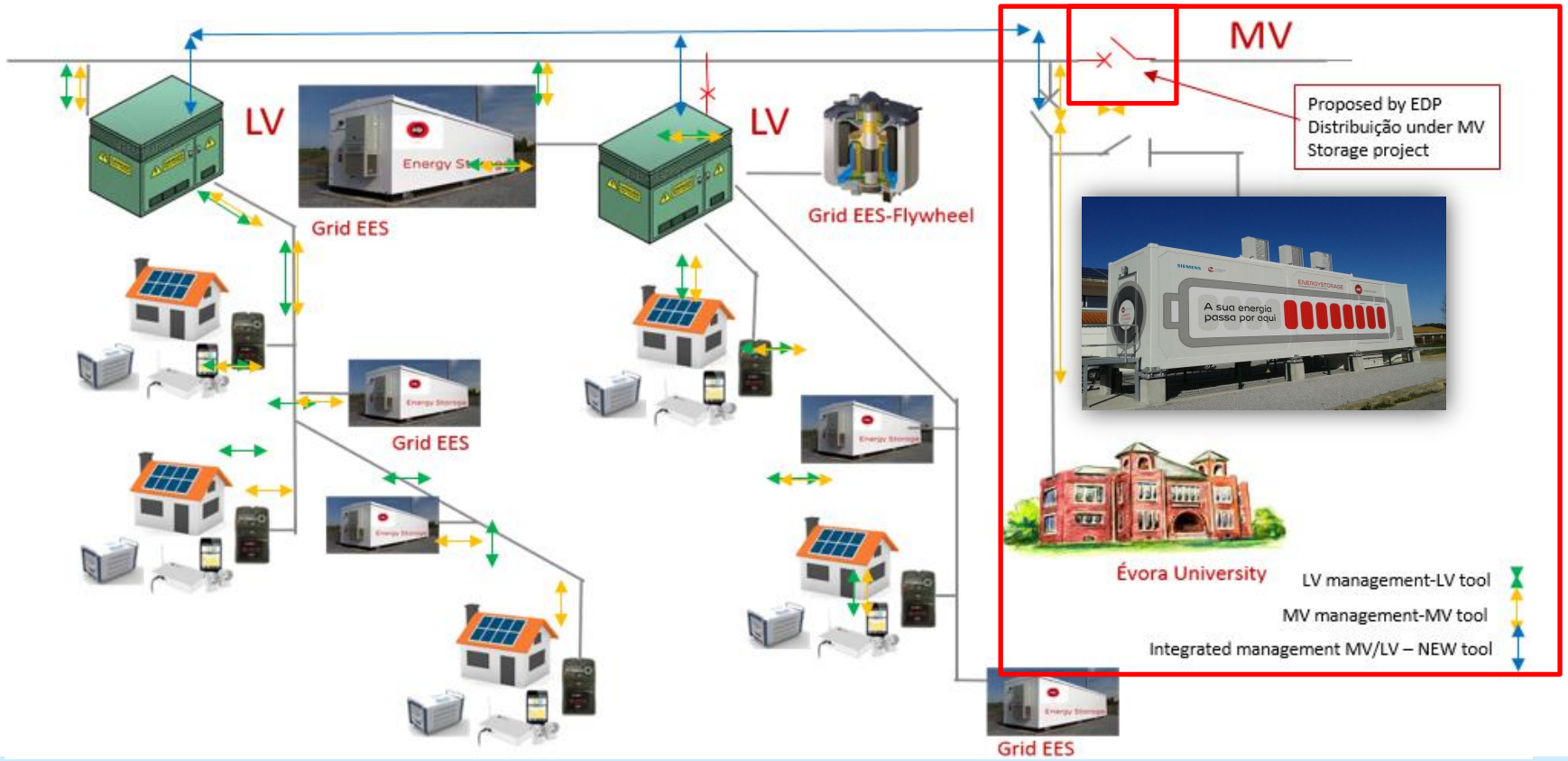
Overall Efficiency

Correlation Between Main Variables

KPI Evaluation

Battery Degradation Model

Next innovation steps on energy storage



Main Projects Objectives

- **Demonstrate concrete applications of distributed energy storage and energy management tools for the DSO.**
- **Enabling innovative Business Models.**
- **Understand how EDP's Smart Grid concept should evolve in order to facilitate the referred applications.**
- **Understand what regulatory framework and policy developments should be promoted.**

KEY TAKEAWAYS

1. Need for more standardization in network connected storage solutions
2. Lifecycle optimization of the use of storage, minimizing power losses and battery degradation.
3. Assessment of renewables integration benefits.
4. Further Interaction and coordination with other projects or new storage projects for new innovative business models
5. Continued cooperation with universities and R&D organizations.
6. Further exploring legal and regulatory issues.
7. Understanding storage impact for network planning.
8. Development of algorithms for automatic centralized control.