POLICY TECHNOLOGY MARKET
ENERGY STORAGE Global Conference
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Optimal Location of Electrical Energy Storage Systems Based on Batteries

Session:2.7

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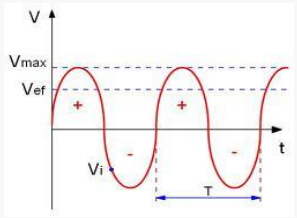
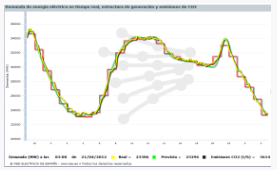
Batteries can provide multiple **services**



Higher level of **coordination between energy demand and energy supply**



Load balance

Peak demand reduction

Minimize demand peaks or move the generation profile towards times of the day with higher returns

Quality of supply improvement

Provide energy **backup** during network faults and **avoid outages**

Intermittent generation management

Reduce the intermittency inherent to solar and wind energy, minimizing network disturbances and ensuring frequency and voltage stability

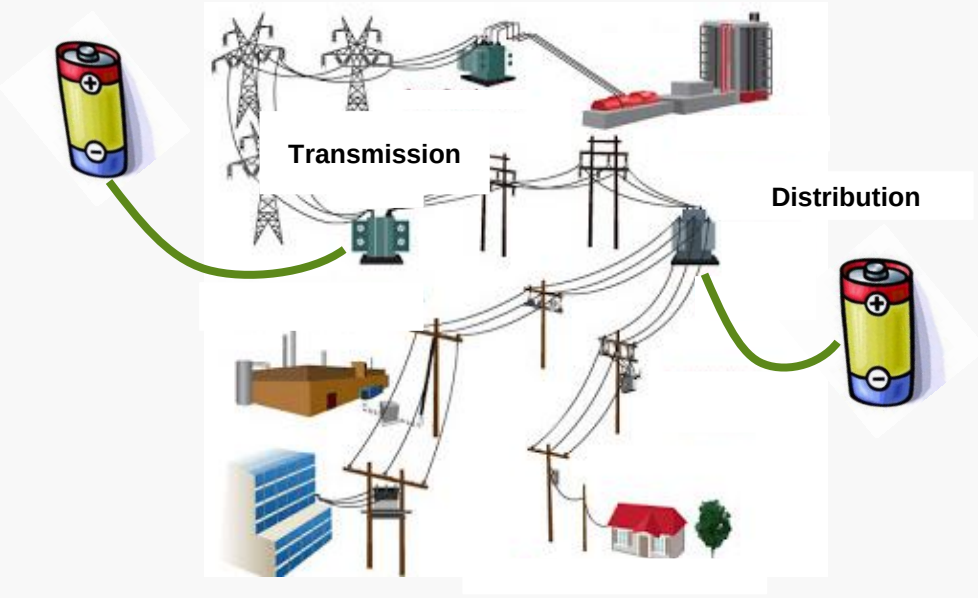
Voltage & frequency control

Ancillary services, such as voltage control, **frequency regulation or active power ramps control**

What are the optimal location and size for storage achieving the best use for the overall electrical system?

Study objective

Assess and compare the installation of batteries with a given budget analyzing two alternatives:



Installing batteries in Transmission (HV) 220 kV

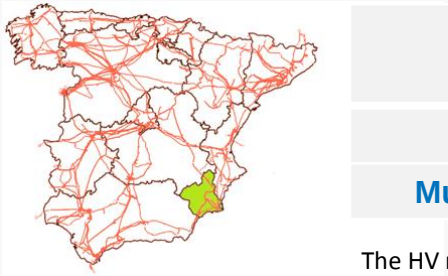
Or…

Installing batteries in Distribution (MV) 20 kV

The study **compares** the technical and economic solution for each alternative to **provide support during outages**

Study Methodology

Spanish HV transmission grid + Murcia network model provided by Iberdrola:



GRID	Nodes	Generators	Loads	Transformers	Lines
Transmission	2674	655	989	1243	3788
Murcia MV distribution	31721	3078	15388	94	33327

The HV model used in the study represents the full transmission network in Spain. The MV model is limited to the 20kV network in Murcia

Step by step methodology:

1. Definition of the **2025 scenario** and contingency analysis both for the transmission and the distribution networks
2. Optimal location and size for batteries to **minimize the Energy Non-Supplied** (ENS) during outages
3. Simulation of the **battery charge/discharge regime** that optimizes the electrical system operation
4. Assessment of **results and conclusions**. Comparison between location in transmission VS. distribution

2025 scenario analysis

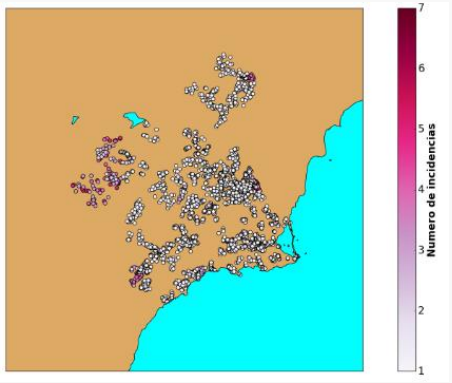
Calculation of *demand not-supplied* (DNS) and *energy not-supplied* (ENS) resulting from outages on the transmission and distribution network

Distribution network:

- **Winter peak**: 529 N-1 outages with 354.9 MW of demand not-supplied
- **Summer peak**: 418 N-1 outages with 285.5 MW of demand not-supplied

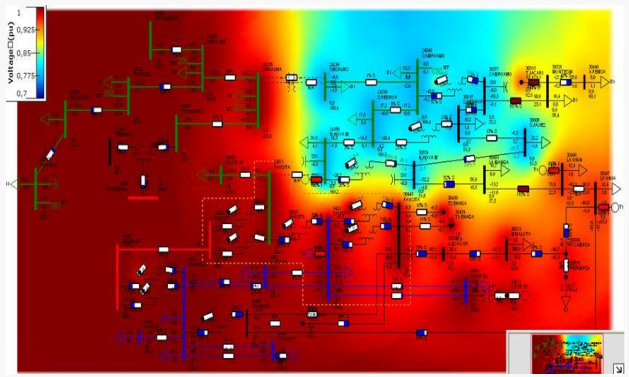
Transmission network:

- **Winter peak**: 51.6 MW of demand not-supplied
- **Summer peak**: 44.4 MW of demand not-supplied



Location of distribution outages (Winter peak)

Murcia 220kV transmission path affected by N-2 outage

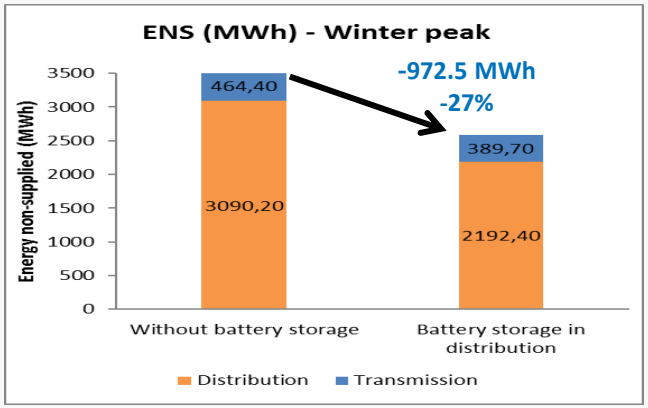


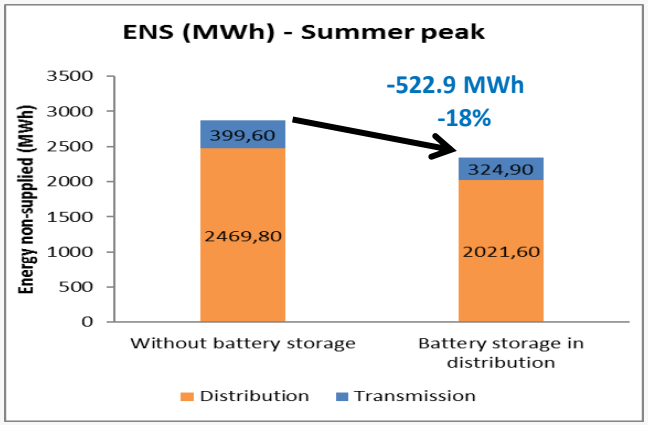
Voltage heat map after N-2 transmission outage

Results. Continuity of supply

Optimal location at distribution:

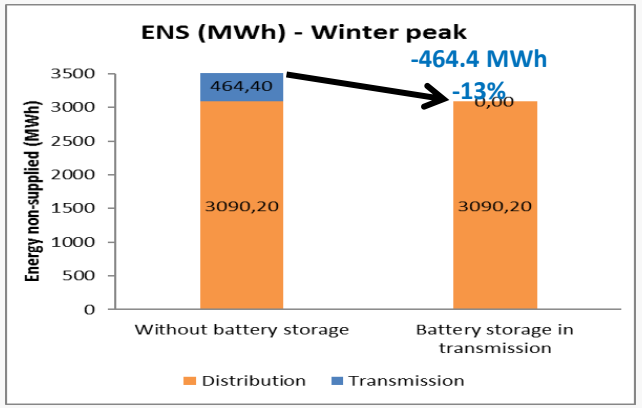
- ✓ 63 batteries: 76.5 MW / 433.5 MWh
- ✓ Total saved ENS = **1495 MWh**

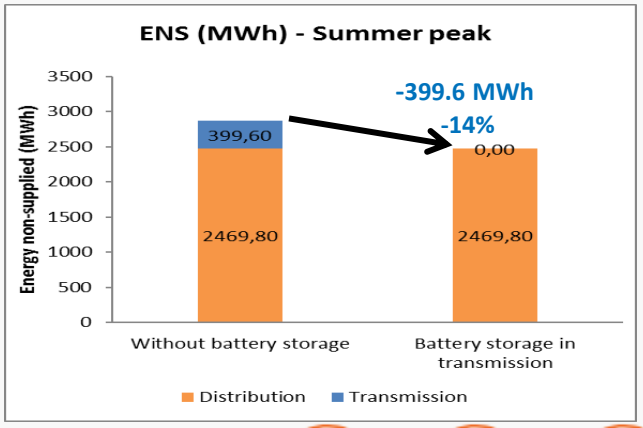




Optimal location at transmission:

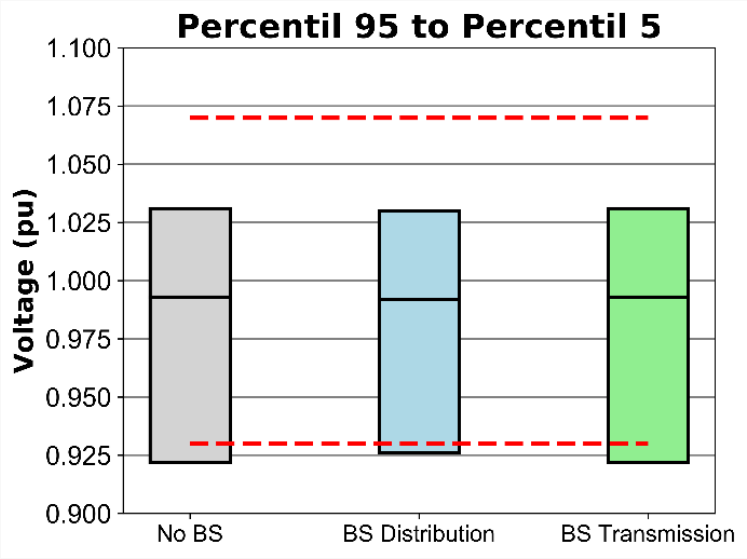
- ✓ 2 batteries 52 MW / 468 MWh
- ✓ Total saved ENS = **864 MWh**



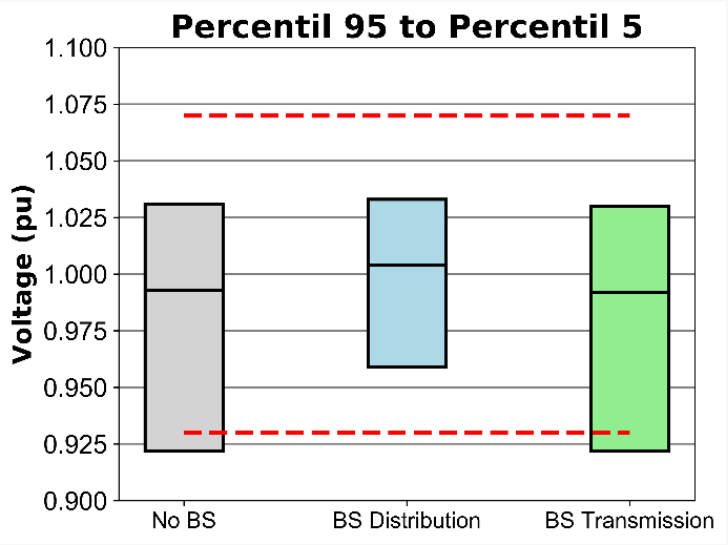


Results. Voltage profile

Batteries without voltage control



Batteries with voltage control

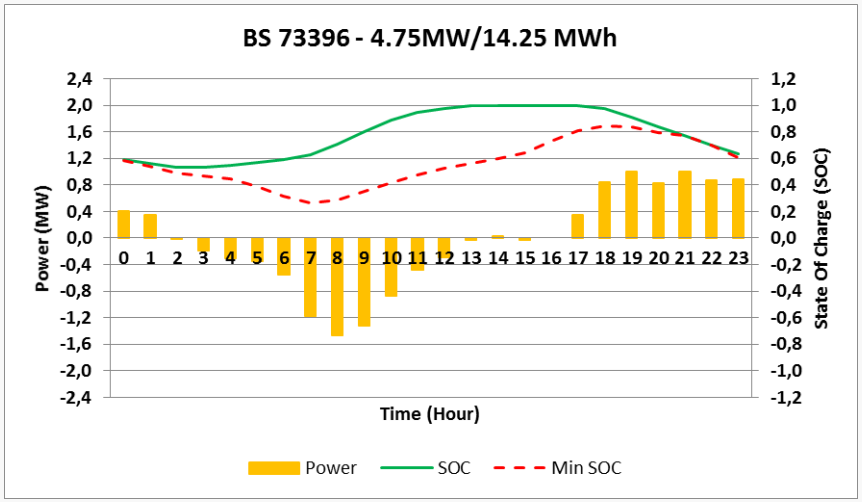


Batteries located in the distribution network improve the voltage profile

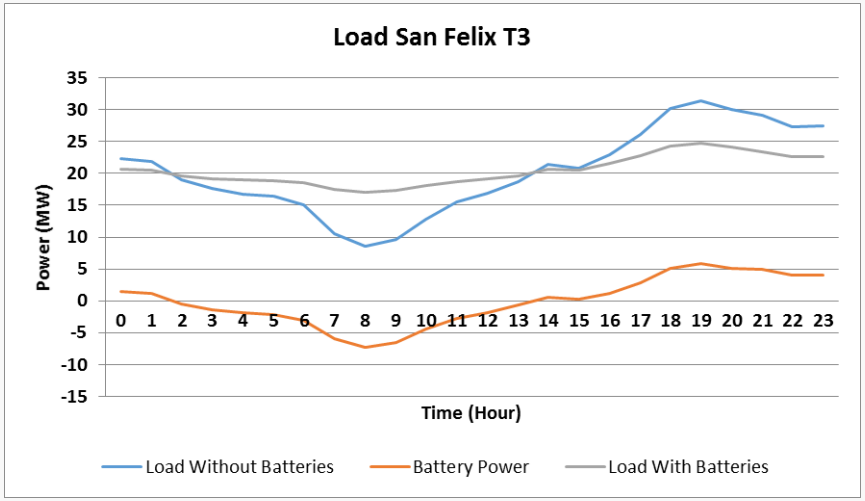
Results. Network load

Batteries dispatched to optimize the load profile (Demand + PV)

Operational restriction: limit state of charge to provide response to outages



Battery dispatch in bus 73396. Working day August 2025



Load transformer 3 San Félix. Working day August 2025

Batteries flatten the load curve while retaining the ability to respond to network outages

Conclusions

- Batteries **installed in the distribution network provide a better solution** to reduce unsupplied demand under outage conditions, and provide a **better voltage profile**
- Batteries **installed in the transmission network provide no support to distribution outages** leading to loss of supply.
- Batteries installed in the distribution network achieve an **ENS reduction about 2X higher** than batteries installed in the transmission network.

Installing batteries in the distribution network is the most efficient and effective solution to improve quality of supply

Thank you

OPTIBAT Report

http://www.ehu.eus/gisel