

SUCCESS CASE 14.2026

Unlocking capacity through flexible connections in LV

AI DRIVEN ASSESSMENT: FIRM VS. FLEXIBLE CONNECTION CAPACITY IN LV NETWORKS.

+66 k

Customers area

423

LV grids in Benidorm area

166

EV Charging stations

19 MW

New requests

THE CHALLENGE

As electrification accelerates across Europe - driven by EV adoption, heat pumps and distributed generation - DSOs face growing pressure to connect new loads to existing LV networks without compromising power quality. Flexible demand connections offer a promising path to unlock additional hosting capacity, but two key questions remain: how should LV network consumption be characterised to properly define flexible connection scenarios, and what is the real impact of flexible connections on unlocking capacity and improving grid efficiency?

i-DE, Iberdrola's distribution company, set out to answer these questions across a real-world pilot covering the city of Benidorm - a grid serving 66,000 customers across 420 LV networks (58 MW peak demand) - where 166 EV charging stations requesting 19 MW of new capacity were placed aligned with the city's sustainable mobility plan.

THE SOLUTION

The project has developed a methodology for characterising LV network consumption and planning flexible connections to unlock additional hosting capacity.

The methodology addresses the two challenges identified. To characterise network behaviour, the initial analysis confirmed that standard regulatory tariff periods do not adequately reflect real LV consumption patterns. Instead, an AI-driven clustering approach was developed to segment the 8,760 annual hours into representative clusters using one year of hourly smart meter data. The segmentation is built on five business-driven criteria, ensuring that the resulting clusters are predictable, simple to apply and interpretable - while remaining adjustable to reflect local priorities and grid characteristics.

To assess the impact on capacity, the methodology runs unbalanced AC power flow simulations for each network and cluster using Adaion's digital twin engine, checking voltage, transformer loading and line capacity thresholds. This simulation engine was used to run and compare two scenarios — firm and flexible connections — across all networks, enabling a direct assessment of the applicability and real impact of flexible connections on capacity unlocking. Each network is then classified as suitable for firm connection, flexible connection at full or partial power, or requiring reinforcement. Where constraints are identified, the system also evaluates what grid reinforcement solutions are needed to accommodate incoming connection requests

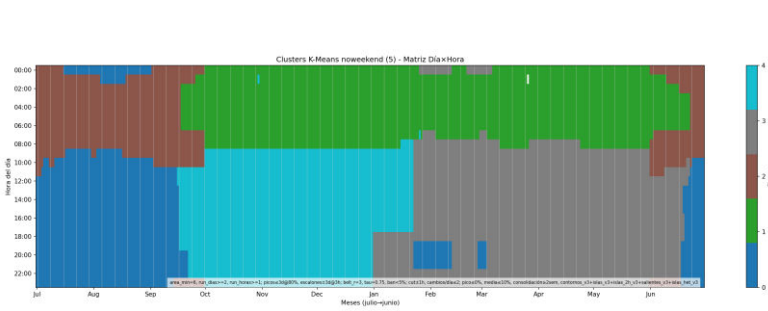


Fig 1: Temporal clustering results: Day x Hour matrix showing the assignment of each hour of the year to one of five clusters, revealing distinct seasonal and intraday consumption patterns across the network

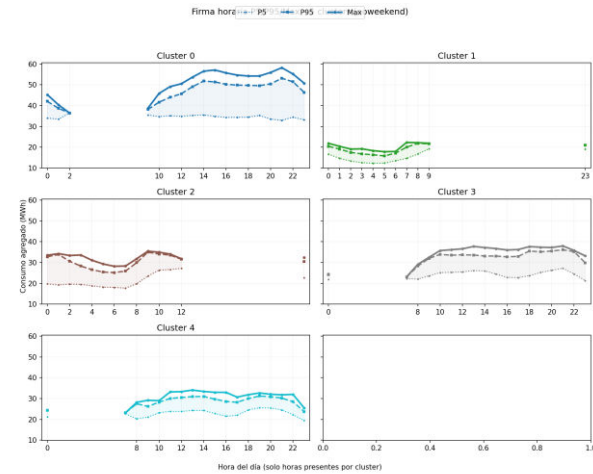


Fig 2: Aggregated load profiles for each cluster, showing hourly consumption patterns (P5, P95 and mean)

The five clusters capture the dominant temporal consumption regimes present across the network over a full year. As shown in Fig. 1, the day × hour assignment matrix reveals clear seasonal and intraday structure: summer daytime hours, winter off-peak periods, and transitional seasons each tend to concentrate within distinct clusters. Fig. 2 shows the corresponding aggregate load profile for each cluster — expressed as median consumption with P5 and P95 bands — reflecting both the typical demand level and its variability within that regime. These profiles are the direct input to the power flow simulations: rather than simulating all 8,760 hours of the year, the methodology runs one simulation per cluster per network, making the analysis computationally tractable while remaining fully grounded in real observed consumption behaviour.

MAIN ACHIEVEMENTS

- Under a firm connection approach, 12.5 MW out of 19 MW requested can be allocated within existing grid capacity; the remaining 6.5 MW require network upgrades at an estimated ~89 €/kW.
- Flexible connections unlock 14.3 MW without any grid reinforcement - 14% more capacity than the firm scenario - and reach 17.3 MW in total, covering over 90% of requested capacity, at an estimated cost below 45 €/kW.
- For equivalent capacity outcomes, the flexible approach achieves a 50% reduction in estimated unit costs compared to the firm scenario, enabling significantly more efficient use of existing infrastructure.
- The methodology has been validated end-to-end on a real urban network (420 LV grids, 66,000 customers, 166 EV charging stations), confirming that flexible connections can accelerate electrification by making better use of available grid capacity.

KEY SUCCESS FACTORS

- Close collaboration and agile interaction between i-DE and Adaion, enabling fast iteration cycles from data ingestion to actionable results.
- High-quality network and consumption data provided by Iberdrola, essential for reliable simulation and clustering outcomes.
- A modular, configurable methodology that adapts to local grid priorities and can be tuned by the DSO.
- AI-driven clustering grounded in DSO-defined business criteria, ensuring results are interpretable and operationally actionable.

WAY FORWARD

The next step is to scale the methodology to additional LV networks and municipalities beyond Benidorm, and to extend the approach to medium voltage (MV) networks where flexible connections can address larger-scale capacity constraints. In parallel, the results can support ongoing regulatory development.

