

iPLUG Project Factsheet



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Main Results & Conclusions: WP1 & WP4

WP1: Design, Specification, Sizing & Location Optimisation of MPCs

 **Objective:** Define the concept, specifications, and optimal placement of multiport converters (MPCs) for different voltage levels, considering both economic and resilience-driven criteria.

Key Results & Case Study Highlights:

- Developed methodologies for **energy-based sizing** of MPC terminals for PV, BESS, EV, and grid interconnection.
- **Building case studies** (health centres, hospitals, offices from Infrastructures.cat) showed MPCs can reduce total converter costs by 10–30% depending on unit costs.
- **LV case study** (from Anell): 4-terminal MPC integration reduced grid imports, improved voltage profiles, and enabled higher PV & EV penetration without line overloading.
- **MV case study** (from Anell): Grid-based optimisation determined optimal MPC sizing based on bus voltage differences, improving system performance and deferring reinforcement needs.
- **Resilience-driven MV use case** (from Anell): Integrated hazard, vulnerability, and risk analysis with MPC deployment; results showed **risk reduction up to 25%** and improved service continuity in rural networks.

WP4: Operation & Control of Distribution Grids with MPCs

 **Objective:** Model, simulate, and validate MPC-based soft open points (SOPs) for enhanced grid operation, including local and system-wide control strategies.

Key Results & Case Study Highlights:

- Developed **average and dynamic models** of MPCs for large-scale studies (triple active bridge, non-isolated topologies).
- **Voltage analysis** (Anell LV grid): MPC improved voltage profiles in both 230 V and 400 V feeders, enabling DER integration without overvoltages.
- **Stability analysis** (IEEE 33-bus): Identified parameter ranges to ensure small-signal stability; grid-forming and virtual oscillator controls provided robust performance under low SCR.
- Designed **local controllers** for isolated & non-isolated MPCs, validated under normal and abnormal grid conditions.
- **Optimal dispatch via OPF** reduced losses by up to 12% and voltage deviation by up to 40%.
- **Frequency support from MPC** with successful restoration after generation shortages.
- **Lab-scale validation** (CHIL & PHIL): Confirmed control strategies, optimal operation algorithms, and physical feasibility using real-time simulation and hardware emulators.

Summary

WP1 and WP4 demonstrate that MPCs are not only optimally integrable into distribution grids but can also actively **enhance performance, resilience, and controllability** when combined with advanced operation and control strategies.

 For more information: www.iplug-project.eu



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