# Multi-service Microgrid in an Industrial Environment

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*This report presents a lean control architecture for microgrids, with an implementation in direct current (DC) microgrids. The purpose of this architecture is to combine local objectives (e.g., self-consumption of locally-produced energy) with system-level objectives (e.g., mitigation of power fluctuations). This patent-pending solution has applications in industrial environments with local power production and DC loads with high peak power and regeneration capability.*

With the cost of photovoltaic power generation below socket parity in many places, end-users have a clear financial interest in self-consuming the power they produce. On the other hand, recognition that infrastructure costs are mainly driven by peak power, rather than energy, is leading to an increasing fraction of retail electricity prices being based on peak power. This evolution presents a challenge for end-users with highly variable power profiles. Microgrids, especially with battery storage, are a promising way to manage the complexity of power networks with an increasing number of distributed, variable renewable energy sources (VRES) [1]. Through the DCSMART project, CSEM has developed a control architecture for microgrids to benefit both end-users and system operations.

## System architecture

The architecture of the DCSMART microgrid is shown on Figure 1. It is composed of a bidirectional grid-tied inverter, controllable and non-controllable loads, a photovoltaic installation and an energy storage system for energy and power buffering. The DC architecture eliminates conversion steps and eliminates synchronisation and balancing requirements associated with AC microgrids.

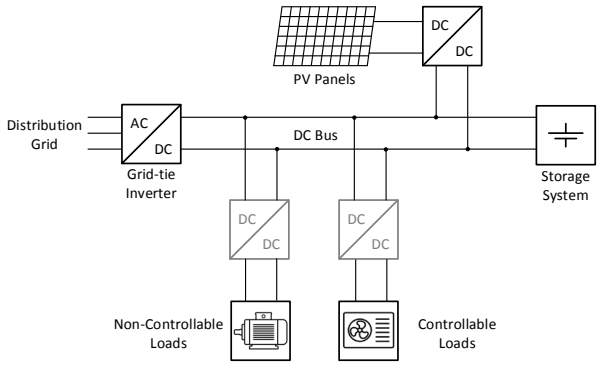


*Figure 1: Electrical architecture of the microgrid.*

## Control strategy

The purpose of the developed strategy is to control the charging/discharging of the storage system in order to achieve local and system-level objectives, namely:

- Increasing self-consumption → reduction of energy cost for prosumers
- Performing peak-shaving on the power exchanges with the grid → reduction in capacity charge for prosumers, reduction in peak load for DSO
- Performing ramp-rate control of the grid power → reduction in rapid fluctuations for DSO

A given fraction of the storage system capacity is allocated to each objective, virtually splitting the overall storage capacity [2]. This distribution can be freely adapted, thus the relative weight given to each service is flexible.

The implementation of the control strategy is split in three different levels (Figure 2): the physical system, the first control level characterized by fast and simple controllers, and the supervision level where more advanced and slower control techniques are used.

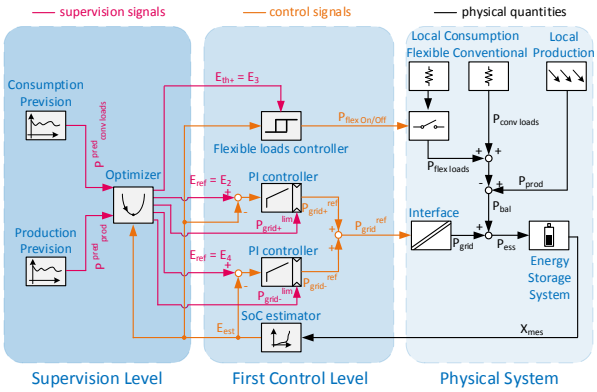


*Figure 2: Detailed implementation of the control strategy.*

## Economic benefit

The economic assessment of the developed solution demonstrated the benefit of its multi-service approach. When electricity prices have a large power-related fraction, savings of 16% compared to a basic control strategy can be achieved thanks to its peak-shaving capability.

Moreover, this solution makes profitable the use of a storage system sooner and in a greater extent than with a classic strategy when taking into account its levelized cost of storage (LCOS). Indeed, the system is profitable for an LCOS 0.10 CHF/kWh higher than with the classic strategy.

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[1] N. Hatziargyriou, H. Asano, R. Iravani, C. Marnay, "Microgrids," IEEE Power and Energy Magazine 5(4), 78–94 (2007) [doi:10.1109/MPAE.2007.376583].

[2] N. Koch, C. Rod, C. Ballif, P.-J. Alet, "Robust control strategy for the energy storage system of a multiservice DC microgrid," presented at CIRED Workshop, 7 June 2018, Ljubljana, Slovenia.