Microgrid configurations for energy communities: The Power Sharing Model

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Outline

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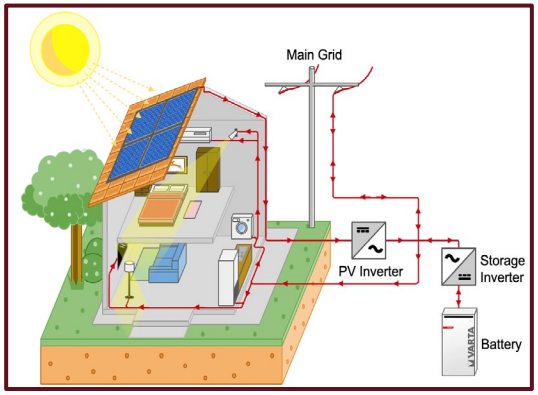
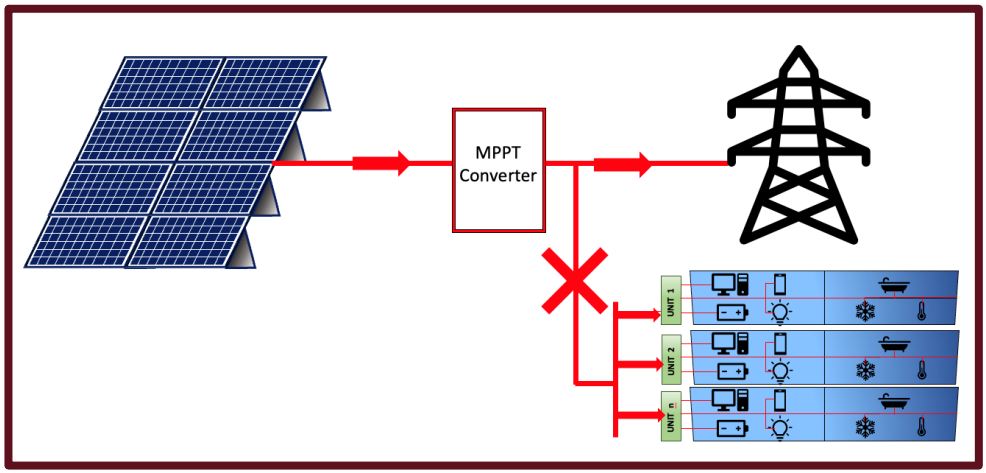
- PV Power Splitting Function
- LVDC «Power Sharing» model description
- LVDC «Power Sharing»: test results
- Conclusions

Introduction

Single User microgrid





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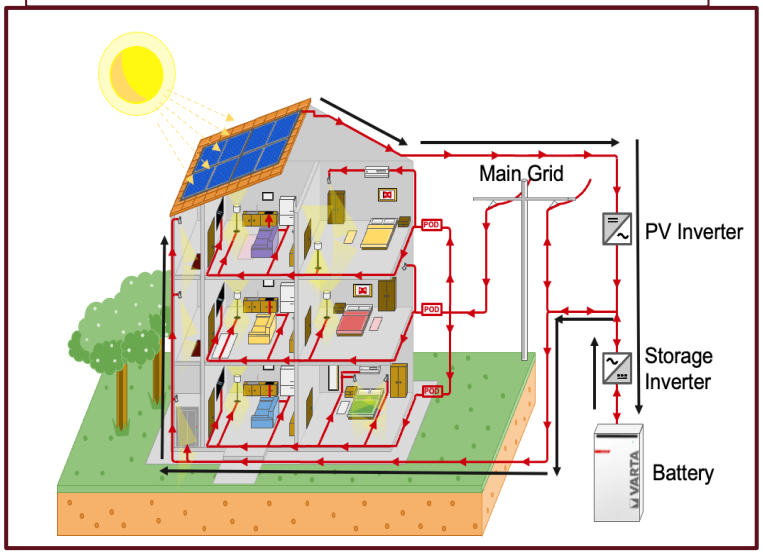
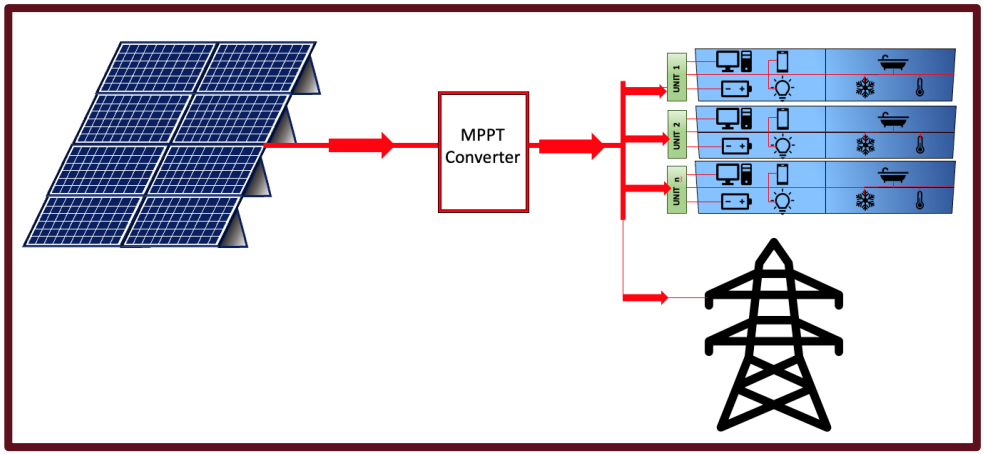
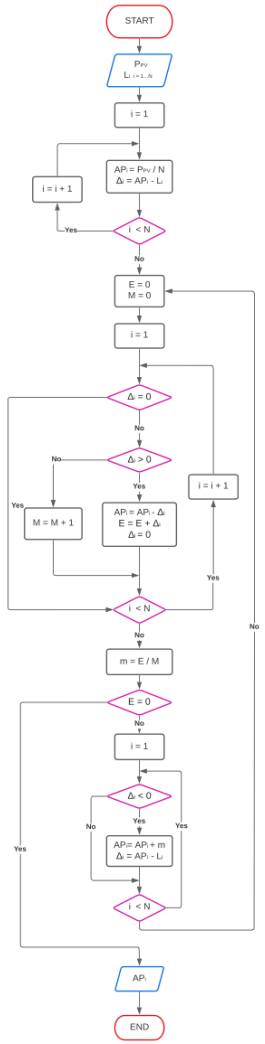




PV Power Splitting function



Democratic Splitting Function

$$(1)\ AP_i = \frac{1}{N} \cdot P_{PV}$$

$$(2)\ \Delta_i = L_i - AP_i$$

$$(3)\ m = \frac{E}{M}$$

$$(4)\ AP_i = AP_i + m$$

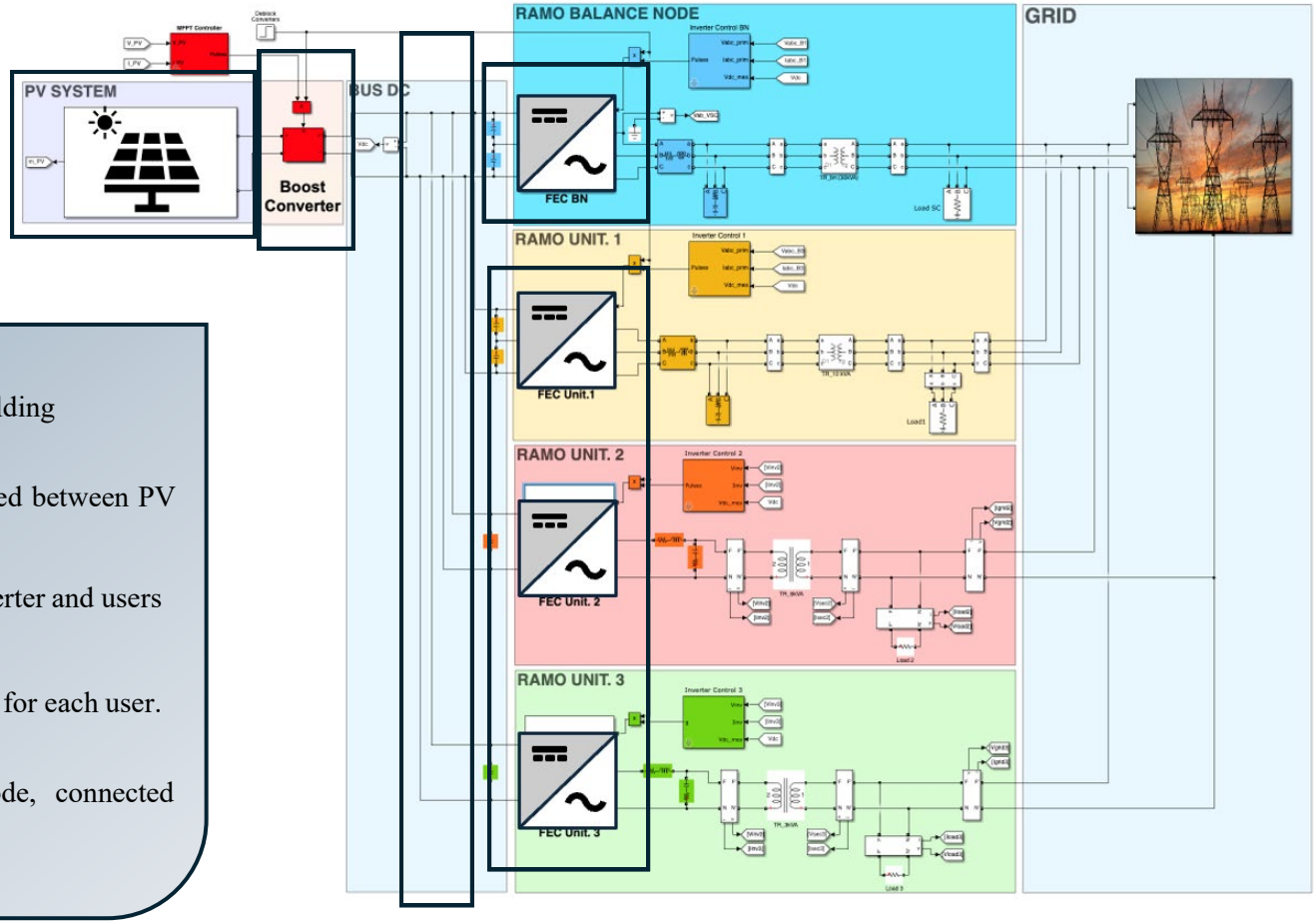
Number of loads: 3
Instant PV Power 6 kW
User 1 Load demand L1: 1 kW
User 2 Load demand L2: 2 kW
User 3 Load demand L3: 3kW

The system initially tries to allocate PV/N to all loads; in this case there are 3 loads and the current photovoltaic power is 6, so the system initially assigns 2 kW to each of the three loads

After this first allocation, it can be observed that load L2 is exactly satisfied, L1 requires less power than the amount assigned, while L3 requires more power

The system calculates that the excess resulting from L1 is 1kW and reallocates it to L3. In this case, at the end of the interaction, all loads are satisfied without excess power.

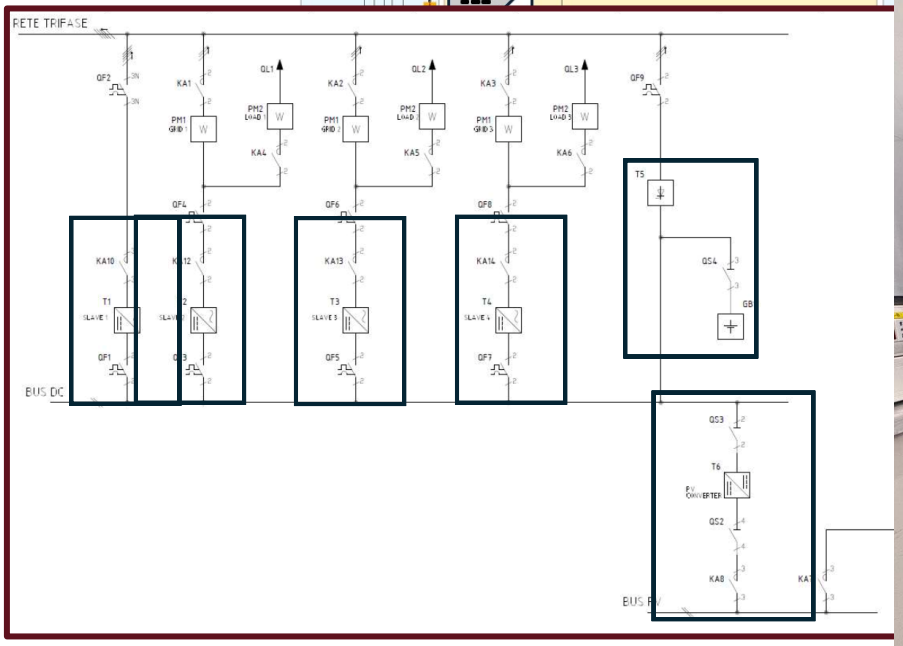
LVDC «Power Sharing» model description



- PV system on the rooftop of the building
- DC-DC converter with MPPT placed between PV system and DC bus
- DC link bus from the DC-DC converter and users
- N single phase or 3phase inverter, 1 for each user.
- 1 3phase inverter as balance node, connected directly to the grid.

LVDC «Power Sharing» model description

- 1 HMI with PLC inside, used to insert algorithm, data visualization and remote control
- 1 DC-DC converter da 6 kW con MPPT.
- 3 single phase inverter with 2kW power each.
- 1 3-phase inverter with power of 12 kW and balance node func.
- 1 NiCd battery with 7 kWh SOC.



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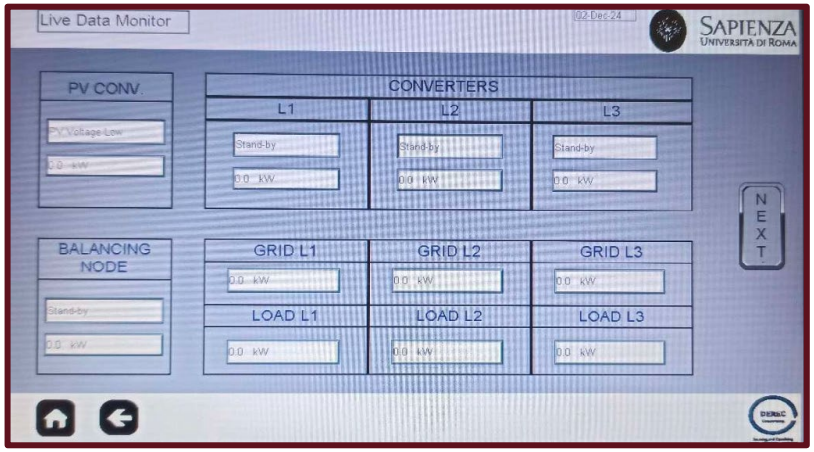
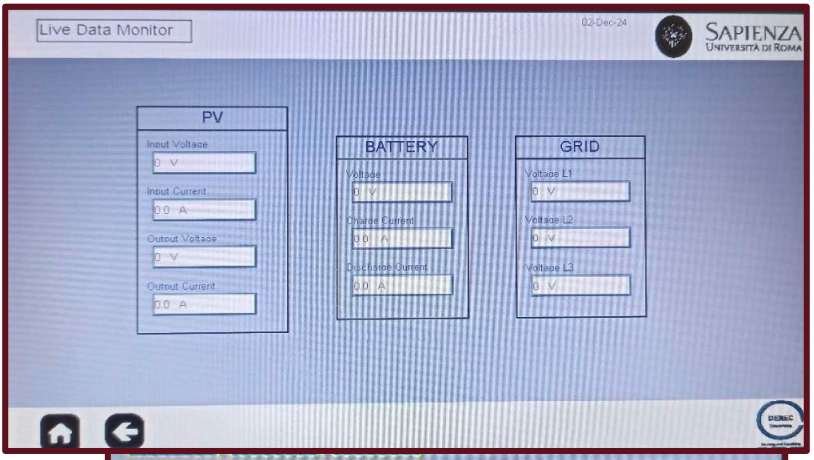
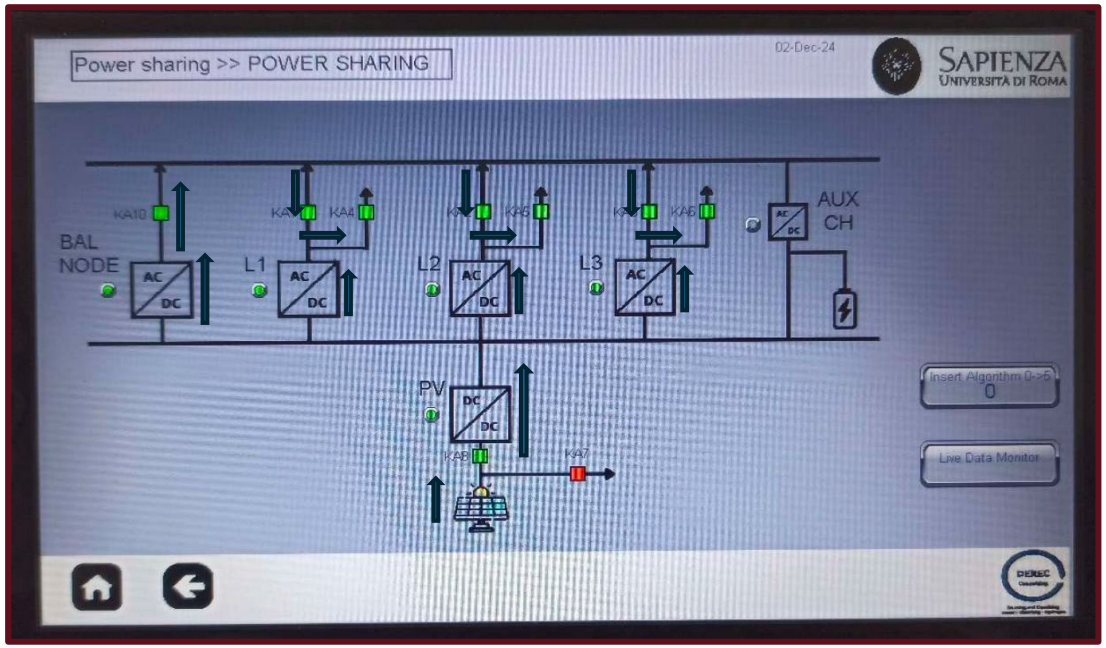
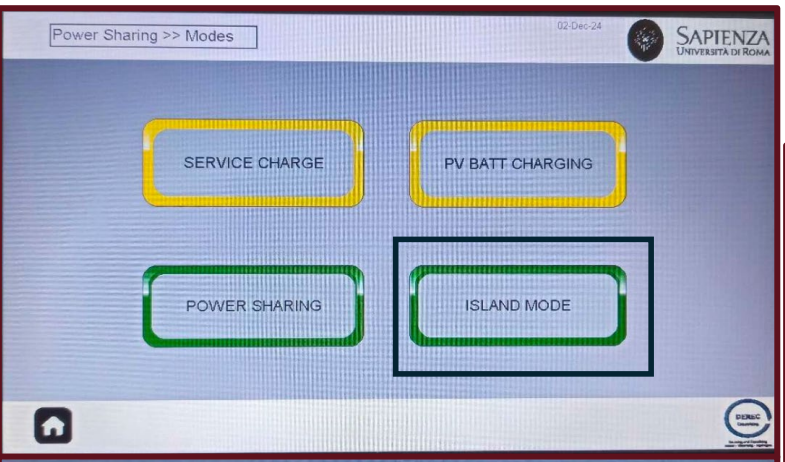
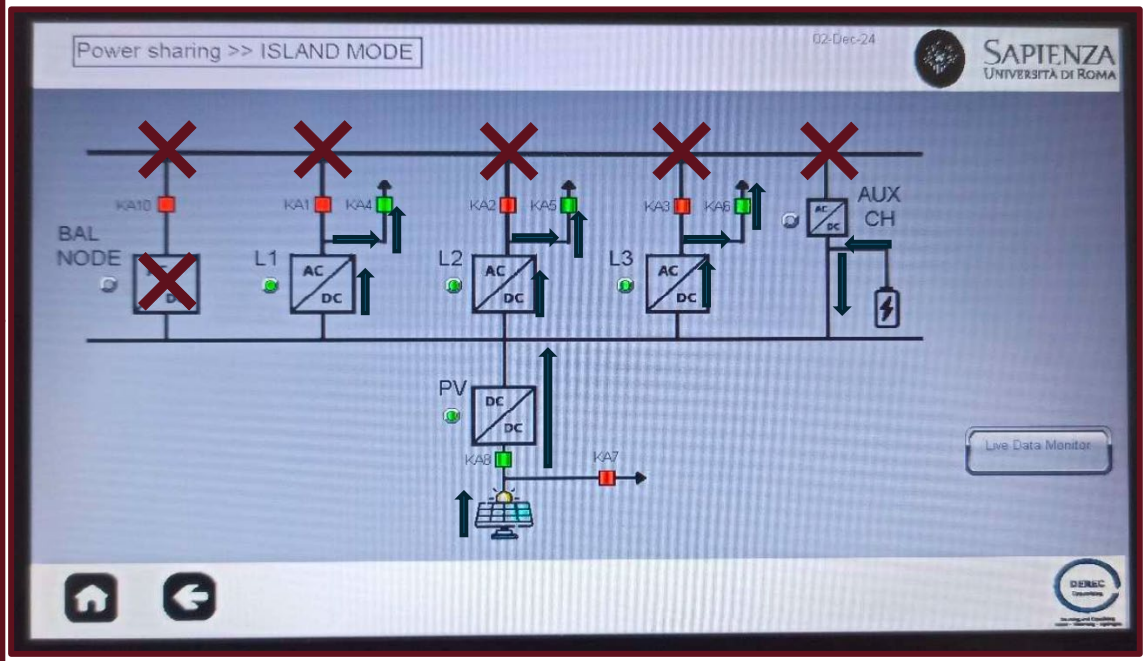




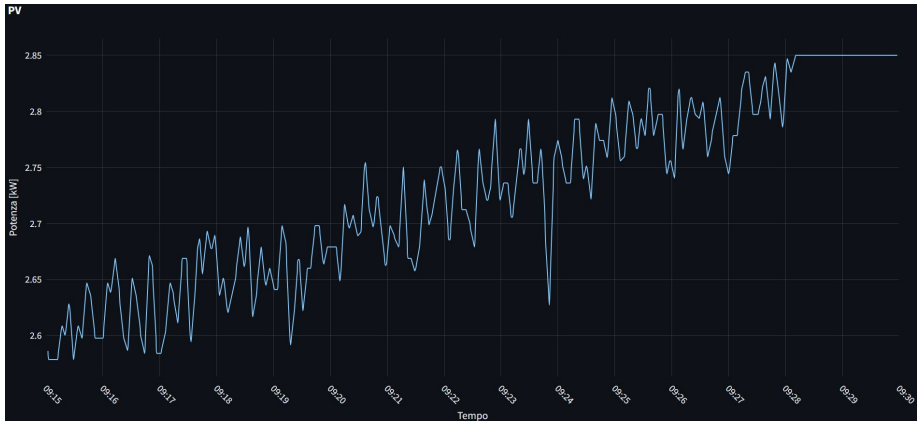


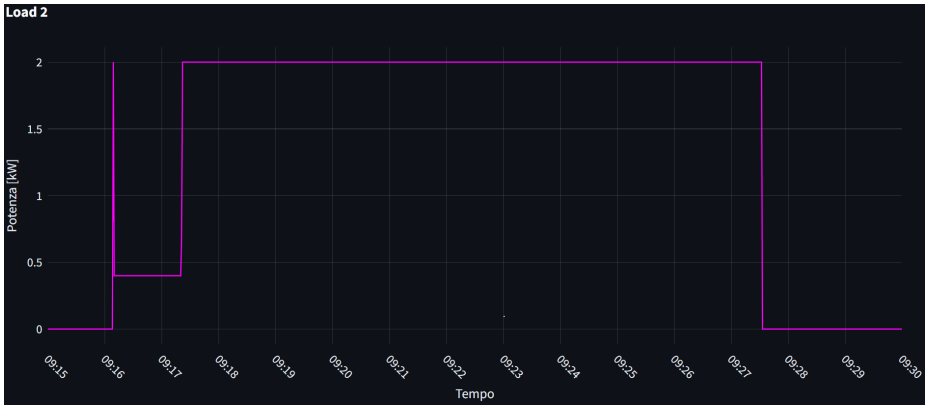
LVDC «Power Sharing»: model description

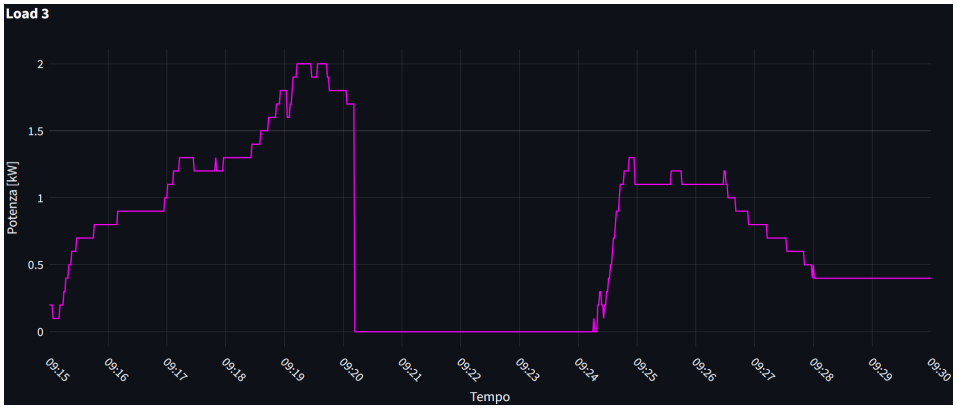




LVDC «Power Sharing»: test results







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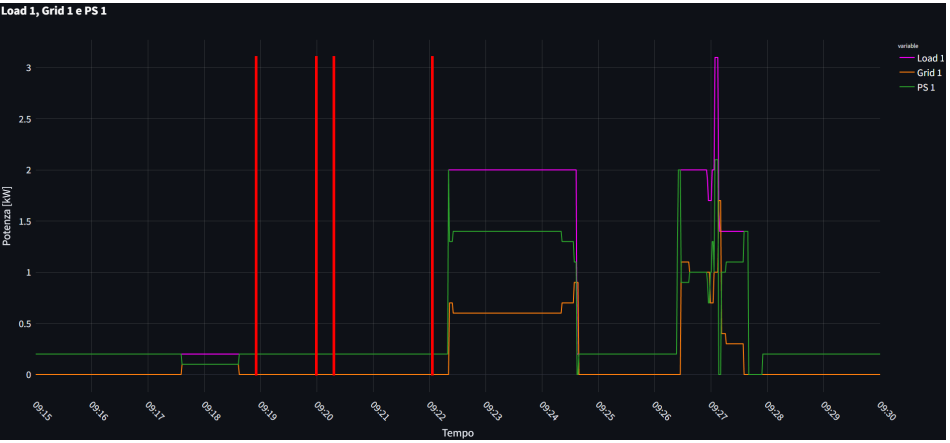

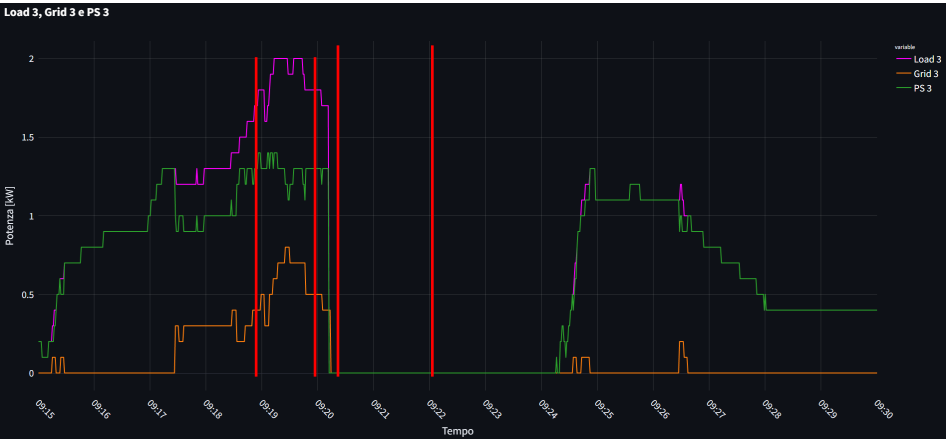

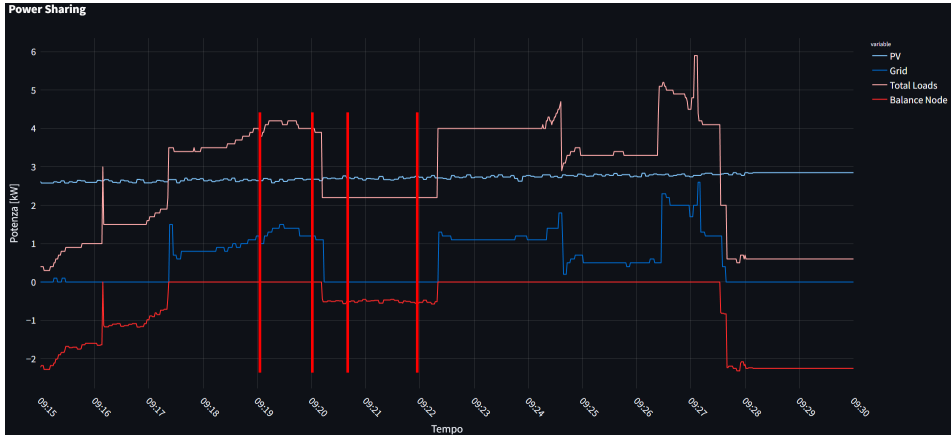

Conclusion

- The project presented a real case of a microgrid able to split the PV generated power among different users, allowing them to maximize the self consumption of the renewable energy.
- The first test cases have been performed to demonstrate the effectiveness of the algorithm implemented in the PLC. The results are good and show strong potential for applying the model in a real residential condominium.
- In future studies, further simulations are planned to verify that the model can operate over long periods. The protection system, highly critical for a DC system, is also the subject of current and future investigations.

Thank you for your attention!