EVALUATING THE IMPACT OF CLIMATE CHANGE ON THE TECHNO-ECONOMIC PERFORMANCE OF BUILDING INTEGRATED PHOTOVOLTAICS SYSTEMS IN PROTECTED CONTEXTS

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Background

- BIPV (building integrated photovoltaics) technologies may play a key role in the transition towards low-carbon energy communities
- Simulation and optimization tools usually do not assess the techno-economic performance of a PV system under different climate boundary conditions during its entire lifespan
- A large public residential estate located in a protected district of Milan which led to the choice of hidden colored BIPV modules [1]

Scope of the work

1. To investigate the possible impacts of climate change on some relevant key performance indicators (KPIs) for BIPV installations
2. To assess the techno-economic profitability of BIPV systems and foster a more accurate design of these systems in urban contexts

Methodology

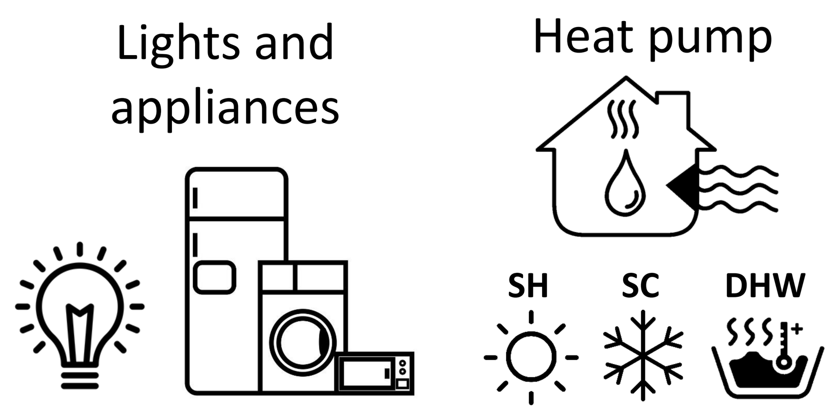
- Energy simulations via an optimization tool [2] able to provide the best configuration of a BIPV system according to selected optimization target, and different weather scenarios (2020 and 2050) and load profiles, including lights and appliances (EL) and heat pump (HP).
- Chosen optimization function able to minimize the levelized cost of electricity (LCOE) and constrain the self-sufficiency (SS) of the system to be greater than 55%

ID SIMULATION	Weather scenario	Demand profile	Optimization target
2020 EL	2020	Lights and appliances	min LCOE, min SS=55%
2050 EL	2050	Lights and appliances	min LCOE, min SS=55%
2020 EL+HP	2020	Lights and appliances + heat pump (SH, SC, DHW)	min LCOE, min SS=55%
2050 EL+HP	2050	Lights and appliances + heat pump (SH, SC, DHW)	min LCOE, min SS=55%
2050 EL (PVS conf 2020)	2050	Lights and appliances	-
2050 EL+HP (PVS conf 2020)	2050	Lights and appliances + heat pump (SH, SC, DHW)	-

SIMULATION INPUTS

Buildings and context geometry

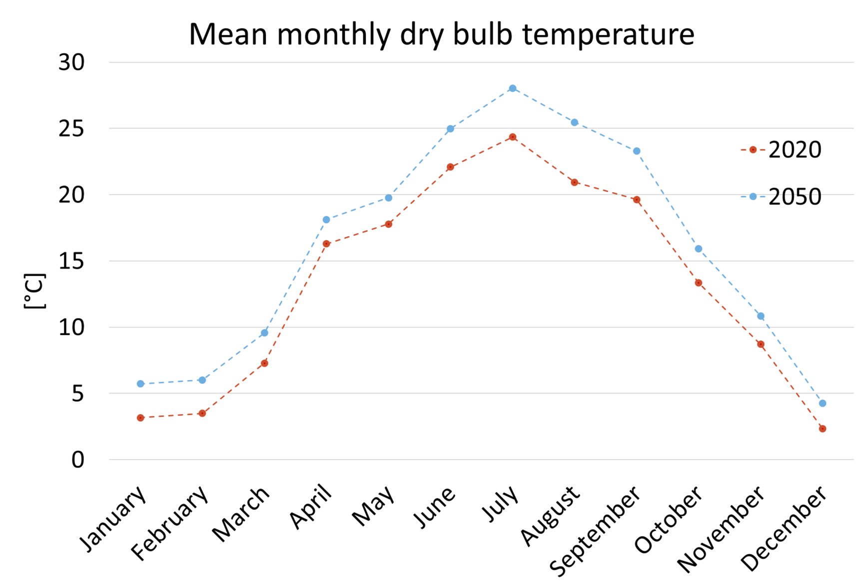
Demand profiles

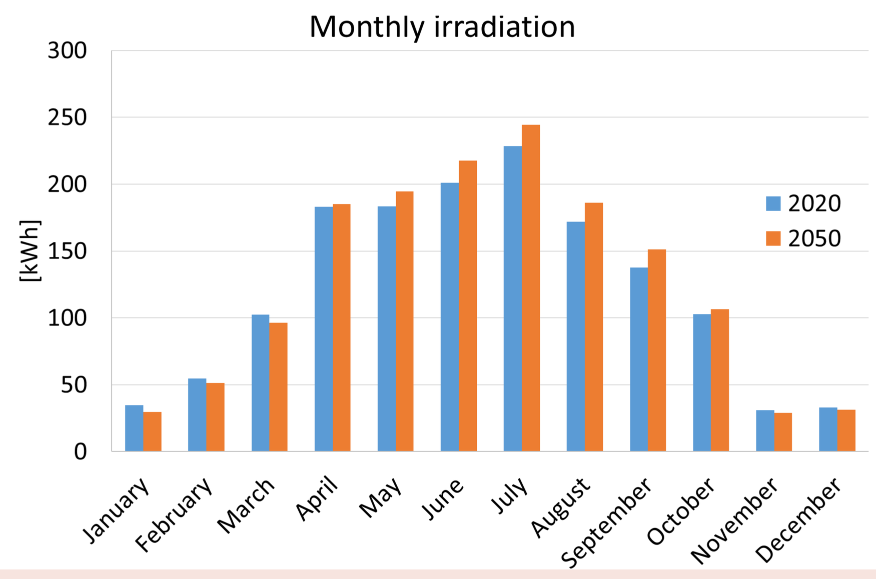


Techno-economic parameters

PARAMETER	2020	2050
Cost of the finished PV system €/kWp	3000	1647.1
Cost of the storage system €/kWh	563.4	126
Annual maintenance costs €/kWp year	62.7	34.42
Price of electricity for the consumer €/kWh	0.2226	0.2226

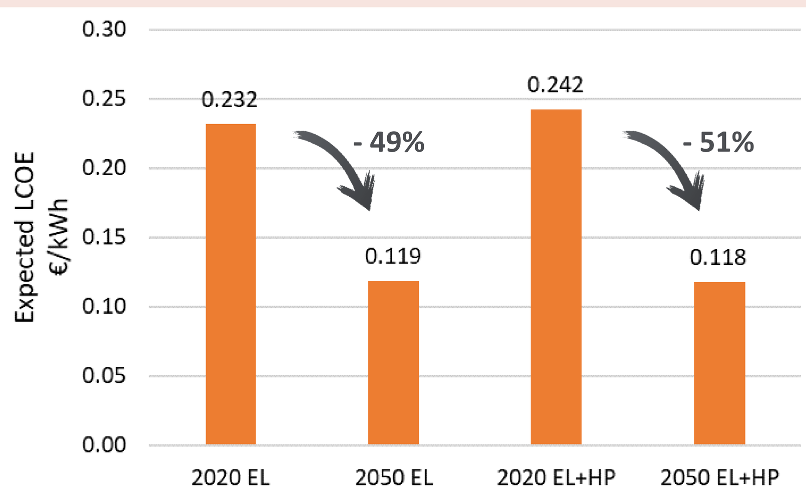
Weather datasets

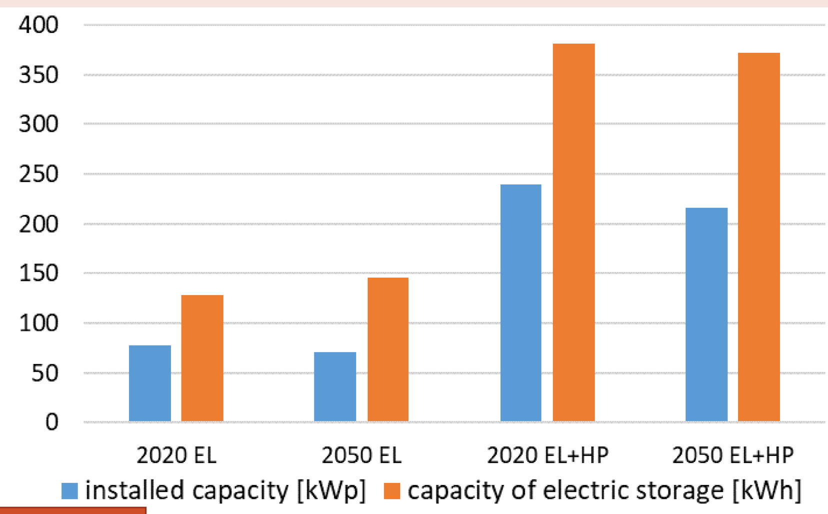


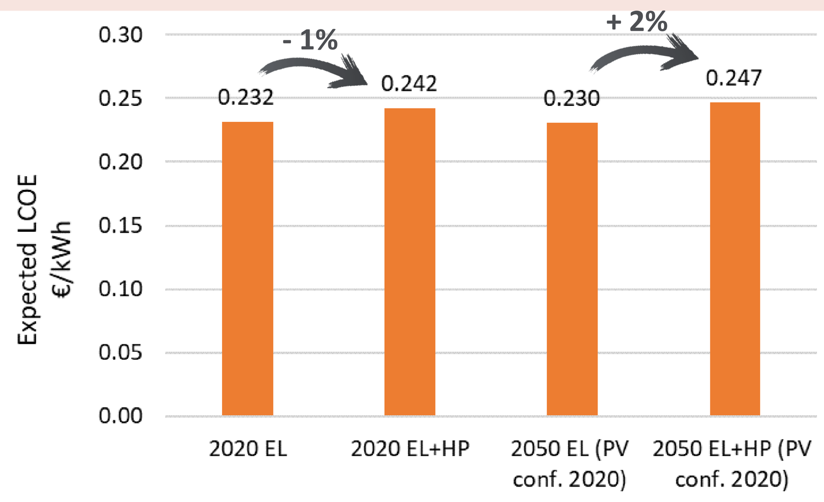


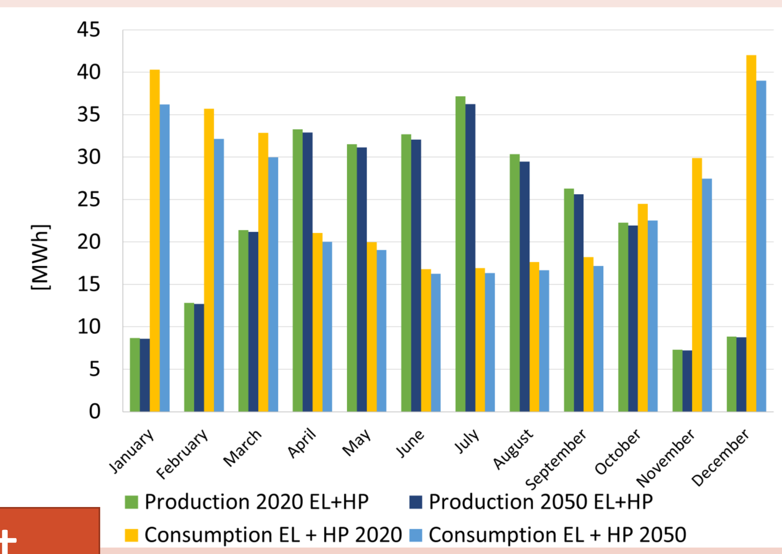
Results

- The optimizations in 2050 scenario provide a noticeable impact on the LCOE, that decreases of about 50%
- Nevertheless, the LCOE of a system optimized for operation in 2020 and performed under 2050 weather conditions slightly decrease considering EL demand profile (- 1%, but in this case the SS target is not met), while slightly increase in case of EL+HP demand profile (+ 2%)









Conclusions and future perspectives

The study provides an innovative approach to optimize BIPV systems in the early design phase by considering different climate conditions (2020 and 2050). Future improvements of this work would investigate the effect of dynamic variation of the weather conditions during the system lifespan and the separate influence of each varying-parameter on the PV systems performance, through sensitivity analysis.

References and acknowledgment

[1] M. Pelle, E. Lucchi, L. Maturi, A. Astigarraga, and F. Causone, “Coloured BIPV Technologies: Methodological and Experimental Assessment for Architecturally Sensitive Areas,” Energies, vol. 13, no. 17, p. 4506, Sep. 2020.
[2] M. Lovati, G. Salvalai, G. Fratus, L. Maturi, R. Albatici, and D. Moser, “New method for the early design of BIPV with electric storage: A case study in northern Italy,” Sustain. Cities Soc., vol. 48, no. December 2018, p. 101400, Jul. 2019.

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