Energy and Environment 3.3

What is the energy performance of BIPV at building level?

After the life-cycle analysis (LCA) at component level [cf. sheet 3.2], we now focus on the environmental impact of an active renovation project at building scale.

This sheet proposes an in-depth study of the whole LCA of a renovation project with BIPV installation on a building from the 70s (Archetype 4) [cf. sheet 2.2]. By illustrating the energy performance of BIPV, these results can help overcome certain misconceptions that prevent the large-scale deployment of BIPV.

Keywords: BIPV architectural integration; Renovation project; Energy performance; LCA.
Target audience: Regulation makers; Architects & engineers; Suppliers & companies.

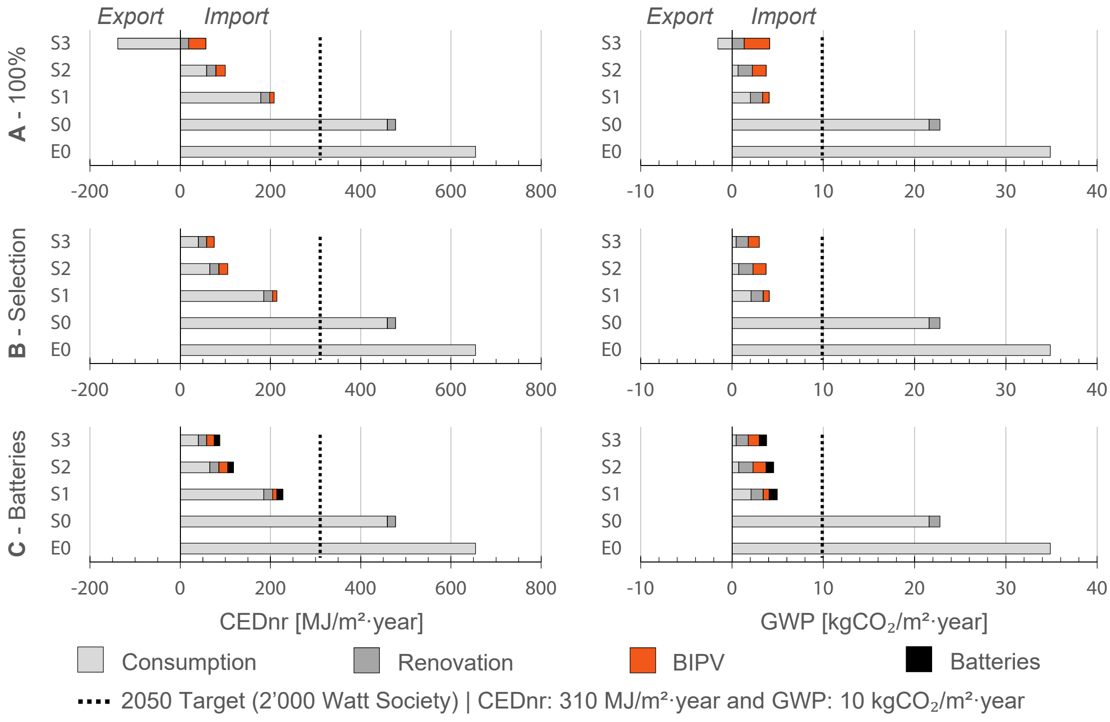

Fig. 1 LCA results (feed-in tariff approach injecting overproduction into the grid) in terms of non-renewable cumulative energy demand (CEDnr) and global warming potential (GWP), considering construction phase (materials) and operational phase (consumption), taking into account the different energy-use variants A) 100% of potentially active surfaces, B) selected surfaces, and C) batteries [1] (©EPFL-LAST).

Life cycle analysis (LCA) is a well-known method to evaluate the potential environmental impacts of products and services and their resource consumption. This method is used in particular in the building sector, where it is a crucial part of the assessment of sustainable buildings, considering the energy consumption and emissions due to the use of the building (e.g. heating) but also the due to the construction material fabrication (e.g. concrete, wood, BIPV element) [1].

This sheet presents an in-depth LCA study of a renovation project with BIPV installation on Archetype 4, a building from the 70s. Fig. 1 presents the results of the LCA regarding the whole renovation project including BIPV strategies and the replacement of the exiting oil-boiler by an electric heat pump. In addition, we propose three comparative energy-use scenarios related to the sizing of the BIPV installation and the implementation of storage systems. Results are presented as follows:

- **A-100%** takes into account the activation of 100% of the possible surfaces detected during the implementation of each renovation scenario [cf sheet 2.3].
- **B-Selection** takes into account a selection of active surfaces that allow an equilibrium between self-consumption and self-sufficiency, resulting in a better adapted installation according to the demand of the building. The rest of the possible active surface will present the same visually but without PV cells.
- **C-Batteries** takes into account the selection criteria from B-Selection and adds a battery system in order to increase self-consumption and self-sufficiency potential.

Regarding batteries, we consider a variable lifetime in function of the expected number of charging-discharging cycles each year. We use Lithium-ion batteries - a mature technology - with about 5,000 cycles of lifespan, corresponding to about 10 years, depending on the sizing and the energy-use scenario.

The environmental impact values for construction materials, PV elements, and HVAC systems are obtained with ECO-BAT software [2], using the KBOB database [3] and considering lifespans of 60, 30, and 20 years respectively. A global (building) lifespan of 60 years is considered for the results. The values of non-renewable cumulative energy demand (CEDnr) and global warming potential (GWP) used in this project correspond to the BAU (business-as-usual) scenario published in [4]. To take into account the photovoltaic industry trend of reducing environmental impact mainly through increasing manufacturing efficiency, we implement a reduction of these impacts following a real scenario, with -19% from current values from the ECO-BAT software [2], to conduct calculations oriented for a horizon between 2020-2050. The final values used for each m^2 of monocrystalline BIPV panel are 104 MJ/m^2·y for CEDnr and 6.70 kgCO$_2$/m^2·y for GWP; the values per each kWh of storage capacity are 189 MJ/m^2·y for CEDnr and 11 kgCO$_2$/m^2·y for GWP.

As Fig. 1 shows, only the renovation scenarios integrating BIPV strategies achieve the 2050 targets defined by SIA 2040:2017 “The SIA pathway to energy efficiency” [5] (CEDnr: 310 MJ/m^2.year and GWP: 10 kgCO$_2$/m^2.year). Batteries could play a key role if the injection of overproduced PV electricity were to become impossible. In conclusion, our project demonstrates that the integration of BIPV elements during the energy renovation projects can contribute to the 2,000-Watt Society targets for 2050 [5].

References

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