Energy and Environment 3.2

What is the energy performance of BIPV at component level?

In order to untangle some misconceptions about the environmental impact of BIPV, here we illustrate how energy and carbon payback times are well below the module's expected lifetime.

This sheet proposes an in-depth study ofn efficiency, taking into account the whole life-cycle analysis (LCA) of a BIPV installation on a building from the 70s (Archetype 4) [cf sheet 2.2]. The results can help overcome certain preconceptions that represent barriers to the large-scale deployment of BIPV.

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

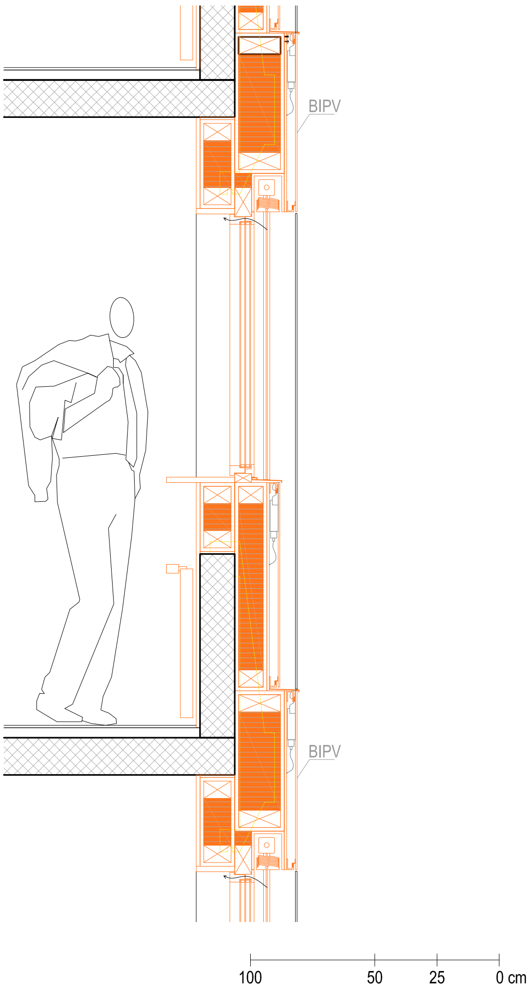

Fig. 1 Facade construction detail, S3-Transformation, Archetype 4 [1].

In choosing to implement scenario S3–Transformation [cf sheet 2.3], our objective and strategy were:

- To obtain highest energy performance and electricity production possible;
- To assess the building's potential; and
- To ensure aesthetic and formal coherence of the building as a whole (reference target performance: 2,000-Watt Society concept according to SIA 2040:2018 for operational energy consumption and construction materials).

Fig. 1 shows the layers and materials composing the prefabricated, ventilated, timber frame facade system proposed for the active renovation of Archetype 4, a building from the 70s [cf. sheet 2.2]. It includes all envelope components, modulated according to the standard size of BIPV elements and prioritizing low-carbon materials. Part of the existing window railing is demolished to enlarge the opening and provide the apartments with improved daylight and outdoor views.

BIPV elements on facade:

- Frameless PV panels with mono-Si cell technology (with an efficiency of 18% in STC);
- Size customization respecting manufacturers' recommendations for glass/glass modules (length 50-3800 mm, width 50-2400 mm) using 6" standard size solar cells [2];
- Visual customization (dark gray colored film)
- Final performance estimation about 14.5% in STC.

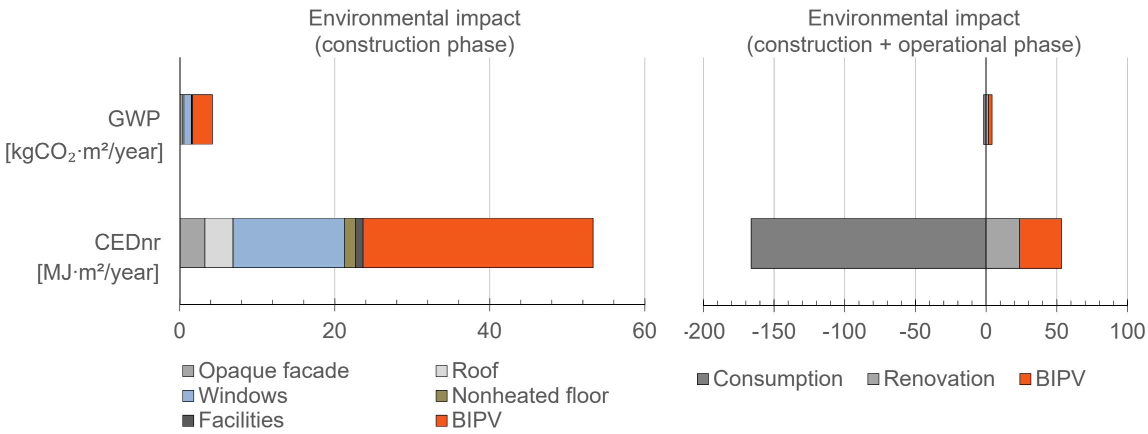

Fig. 2 Environmental impact of the different construction components (construction phase) and global results (construction + operational phase) [1] (©EPFL-LAST).

In the chart on the left in Fig. 2, we show the environmental impact during construction of the different components of the whole renovation project in scenario S3, Archetype 4, based on data from KBOB 2016 [3]. In the chart on the right, we show the global environmental impact considering both construction (materials) and operation (energy consumption) phases.

In terms of photovoltaic performance, the price of the electricity produced is 6.2 to 8.6 cts/kWh, much lower compared to the standard price of electricity from the grid, about 20-25 cts/kWh.

The environmental impact of each kWh produced by this installation corresponds to 0.153-0.222 kWh_{NRE}/kWh_{pv} in terms of non-renewable primary energy (CEDnr) and 0.04-0.058 $kgCO_2/kWh_{pv}$ in terms of carbon emissions. We can thus observe that the impact of the electricity produced by the BIPV installation is much "cleaner" than that obtained using electricity from the Swiss grid [3]: 2.52 kWh_{NRE}/kWh_{grid} and 0.102 $kgCO_2/kWh_{grid}$.

In terms of energy payback time (EPBT) and carbon emissions payback time (GPBT) of these BIPV installations, we obtain 3.4 (S1), 3.6 (S2), and 3.3 (S3) years of EPBT and 15 (S1), 15.3 (S2), and 13.9 (S3) years of GPBT. These values are well below the expected lifetime of the PV installation (25 years and beyond).

These results help to clear up some misconceptions related to the environmental impact of BIPV installations and their feasibility on facades without optimal orientation / inclination.

References

[1] S. Aguacil, E. Rey (dir), Architectural Design Strategies for Building-Integrated Photovoltaics (BIPV) in Residential Building Renovation. EPFL Thesis nº9332, 2019.
[2] metsolar, BIPV solutions for future buildings, 2018.
[3] KBOB, Eco-building database, 2016. https://www.kbob.admin.ch/kbob/fr/home.html (accessed May 5, 2018).

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