



Architectural Design Strategies for Building-Integrated Photovoltaics (BIPV) in residential building renovation processes

Sergi Aguacil | dipl. Arch/Ing. PhD EPFL/UPC

Head of Building2050 group

EPFL Fribourg | Smart Living Lab

***sergi.aguacil@epfl.ch**

Context | Switzerland

Current practices and existing regulations are far from Swiss objectives



Architectural design could accelerate the process of linking BIPV with renovation of residential building stock

View from Microcity building roof | Neuchâtel



Objectives | Main research outcomes

- Development of **convincing reference design examples** of renovation projects with BIPV using real buildings.
- Detailed multi-criteria **assessment** of proposed BIPV solutions :
 - **quantitative** (energy, environment, comfort, global costs, LCA)
 - **qualitative** (acceptance) – workshop with experts and non-experts

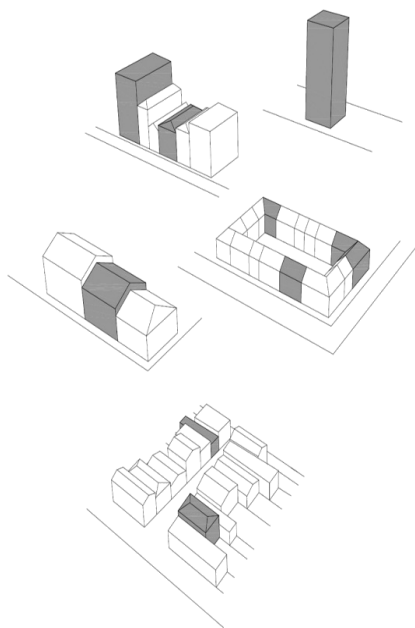
View from Ch. de Belleruche | Neuchâtel



Methodology | Four main phases

Phase 1

Identification of
archetypes
(residential buildings)



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Phase 2

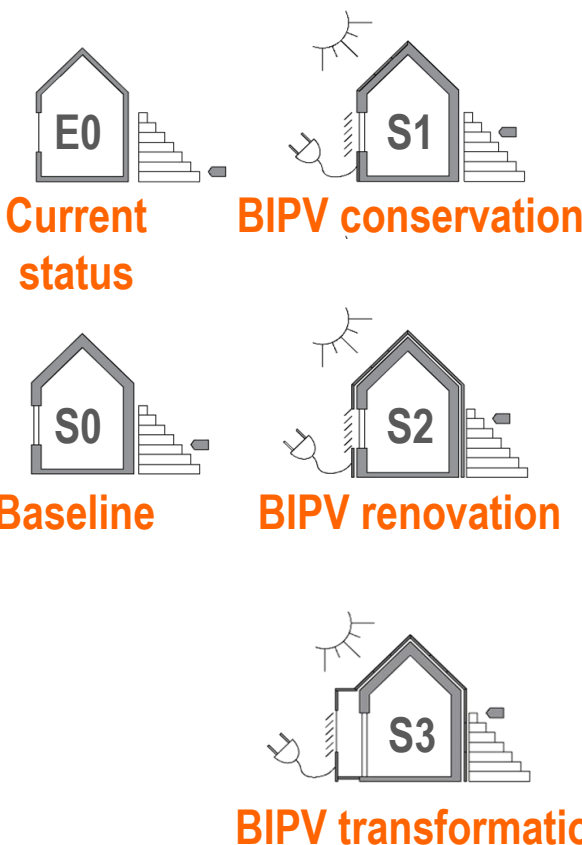
Case study
selection



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Phase 3

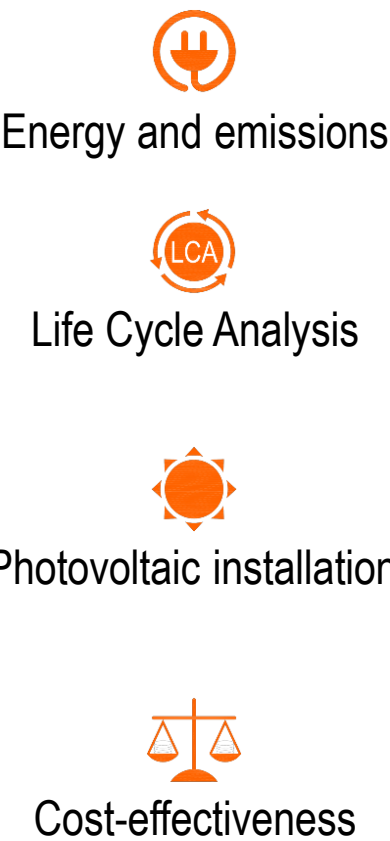
Design scenarios with
BIPV solutions



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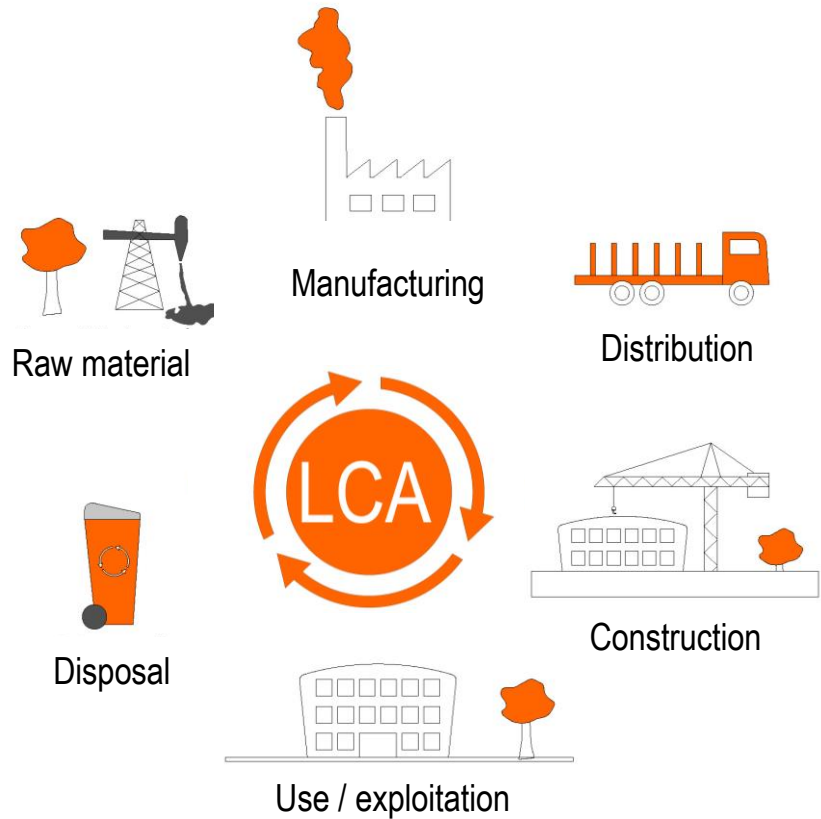
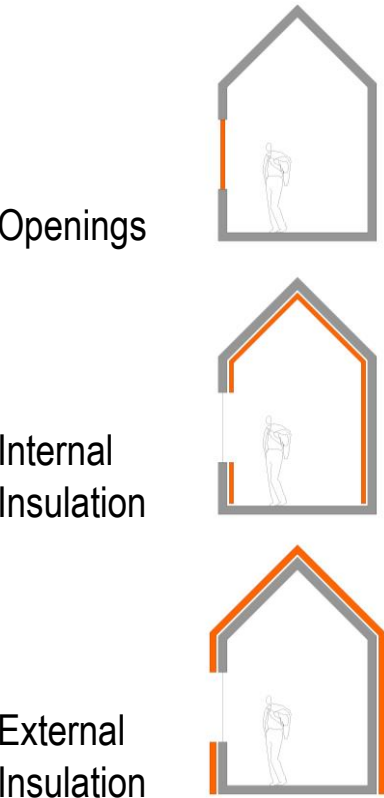
Phase 4

Multi-criteria
assessment

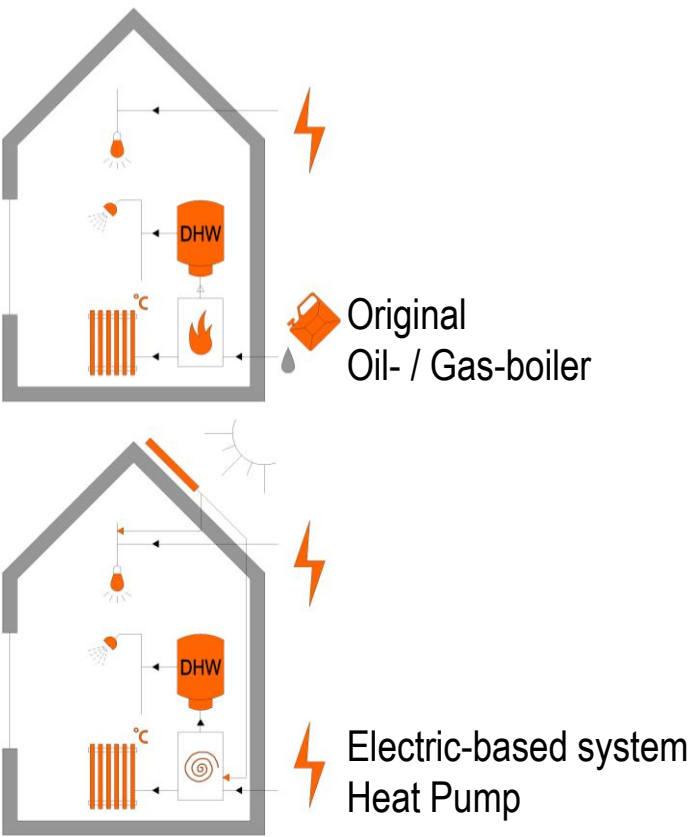


Design scenarios implementation | LCA approach

Passive strategies



Active strategies



Architectural design | Archetypes

Archetype 1 – built in 1909



Rue du Beauregard 1
2000 Neuchâtel (Switzerland)

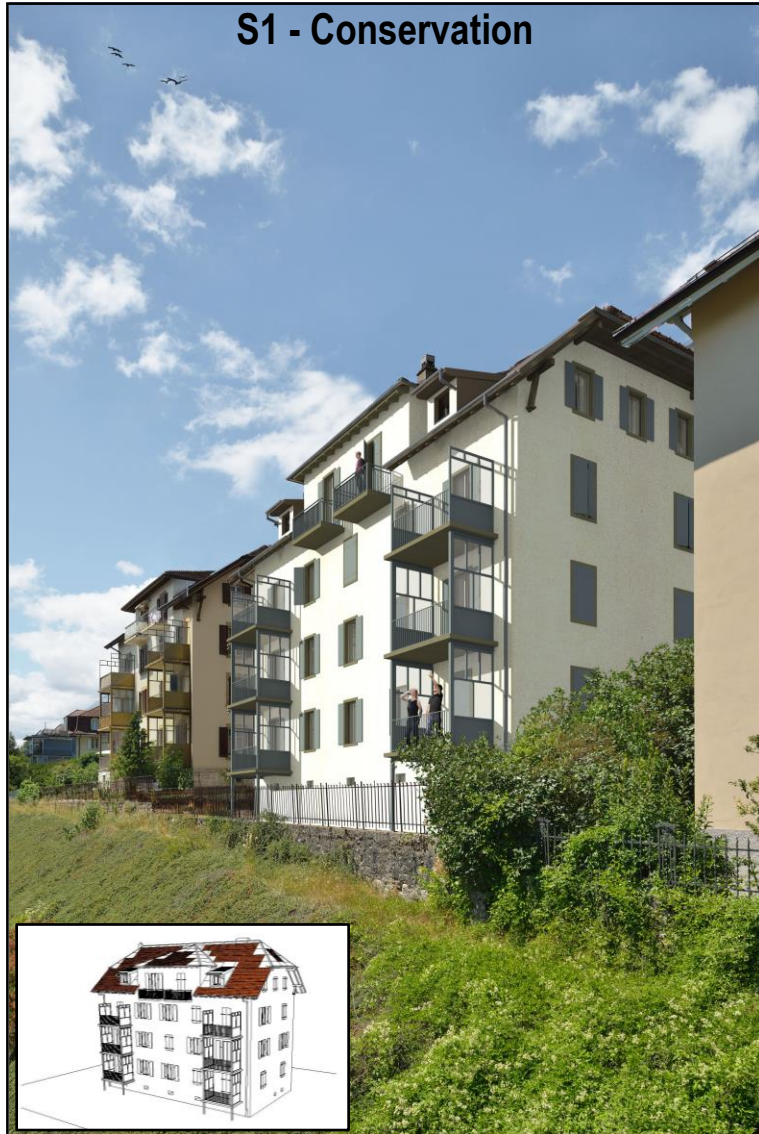
Archetype 4 – built in 1972



Rue Troncs 12 and 14
2000 Neuchâtel (Switzerland)

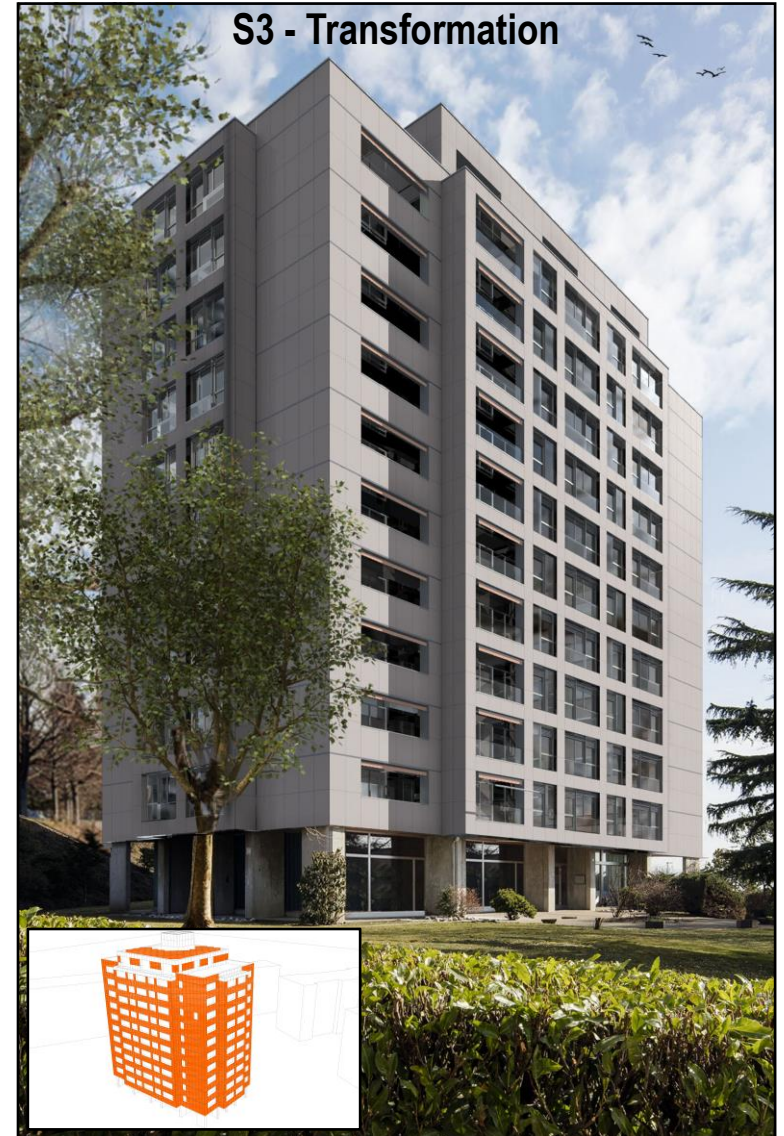
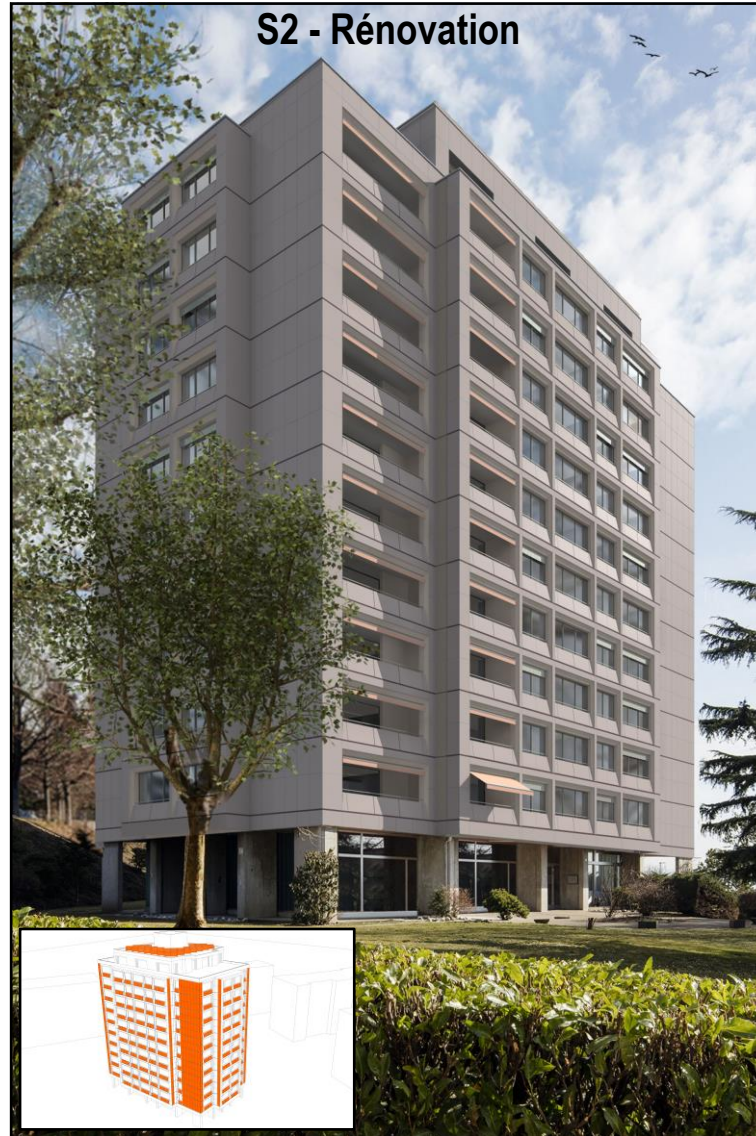
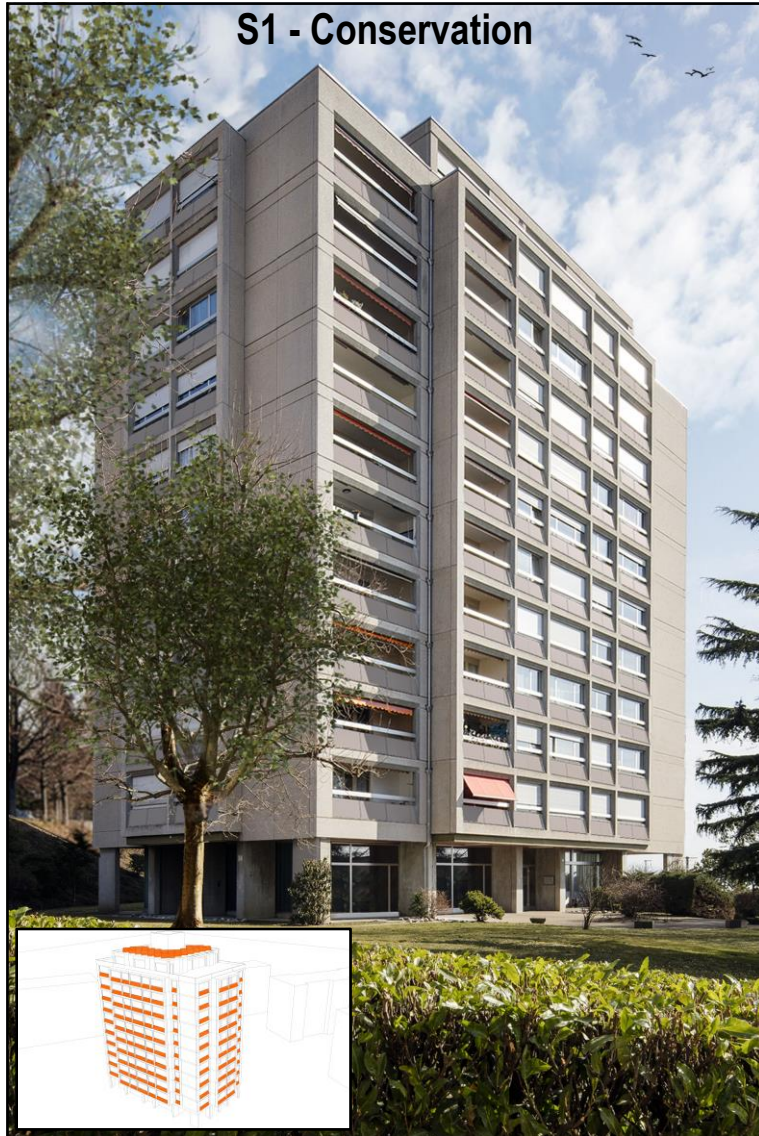
Archetype 1 | BIPV scenarios

Rendering



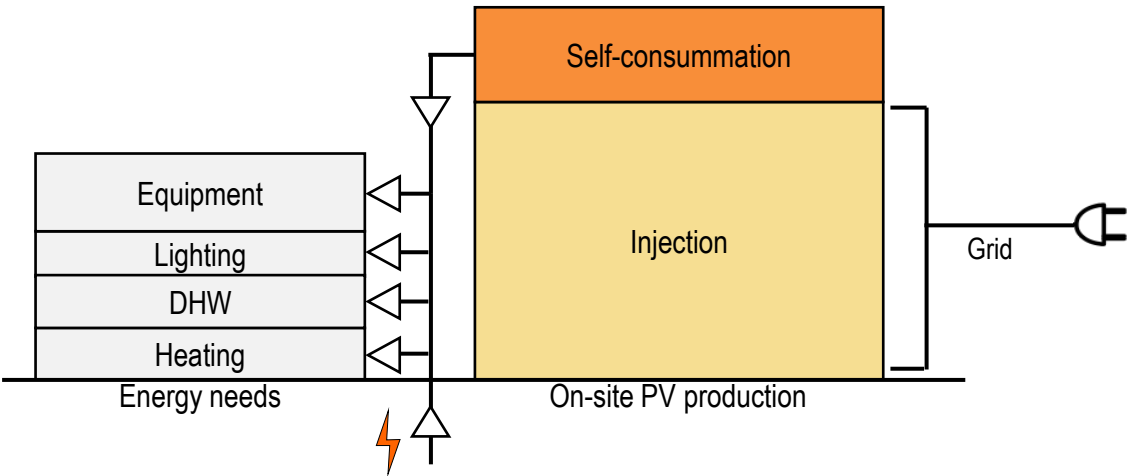
Archetype 4 | BIPV scenarios

Rendering

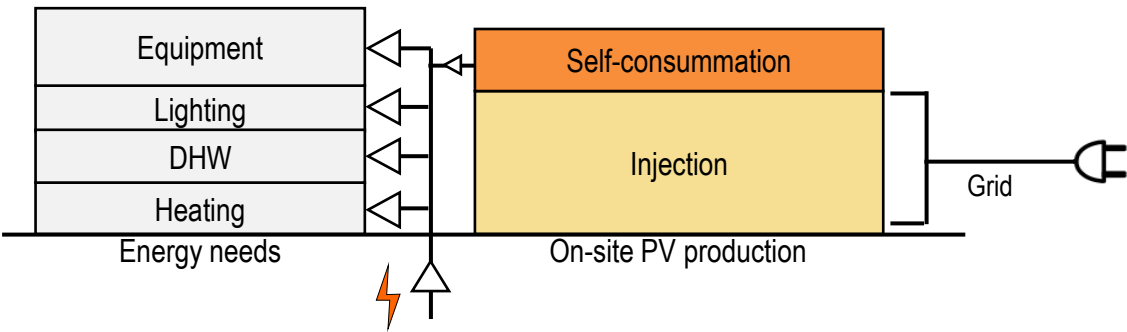
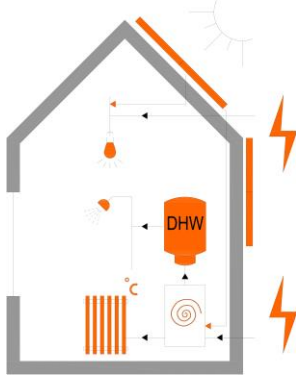


Energy-use scenarios | Tested scenarios

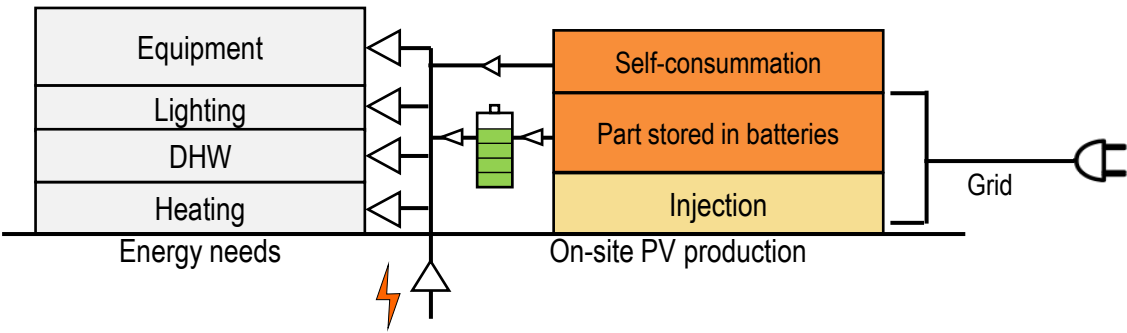
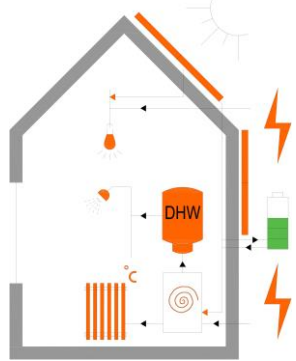
A - 100%



B - Selection



C - Batteries



Selection of active surfaces | S3 – Transformation | B - Selection

Irradiation threshold

200 kWh/m²·year

400 kWh/m²·year

800 kWh/m²·year

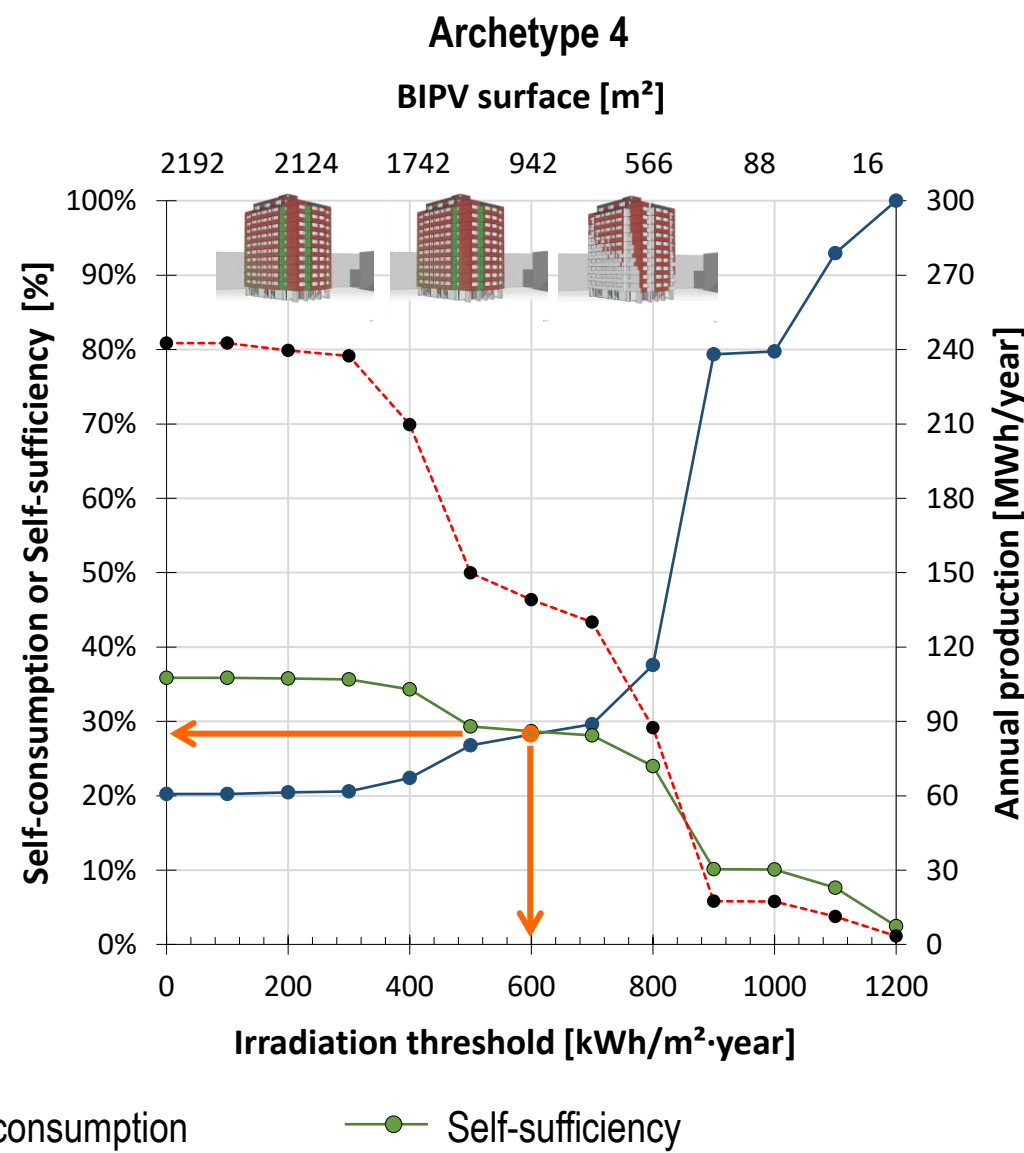
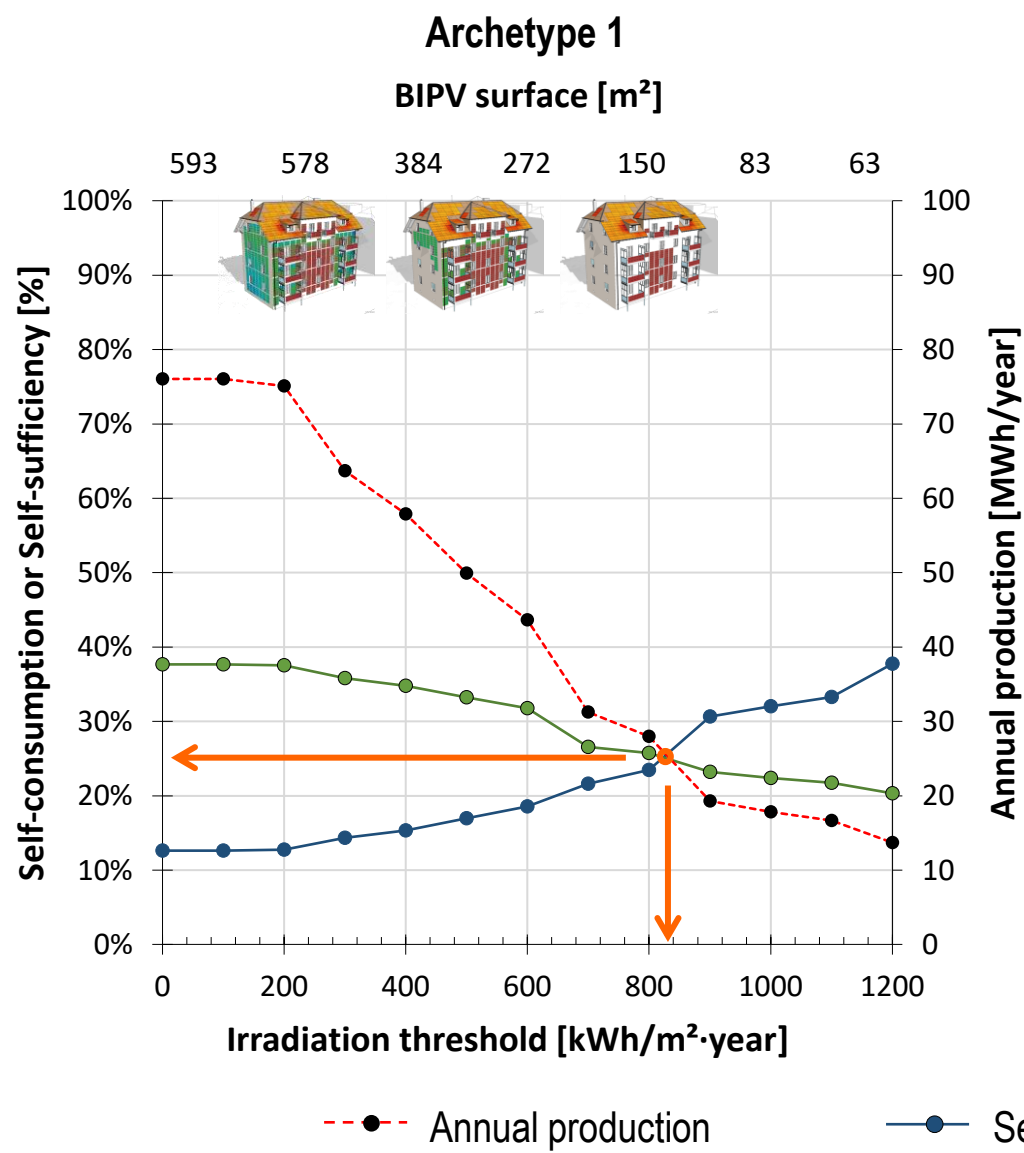
Archetype 1

Façades SE/SW

Archetype 4



Selection of active surfaces | S3 – Transformation | B - Selection

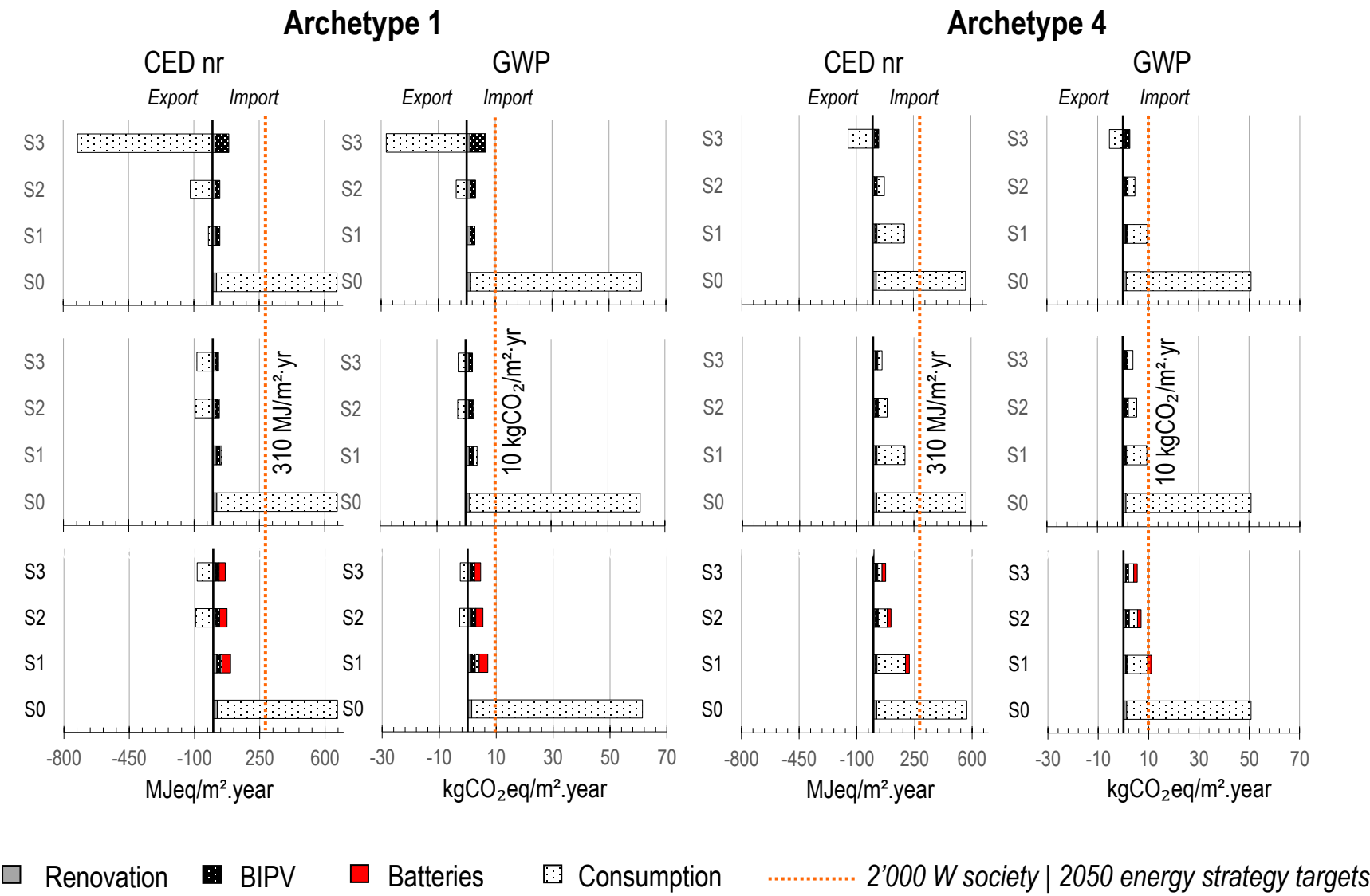


Results | LCA – Life-cycle analysis

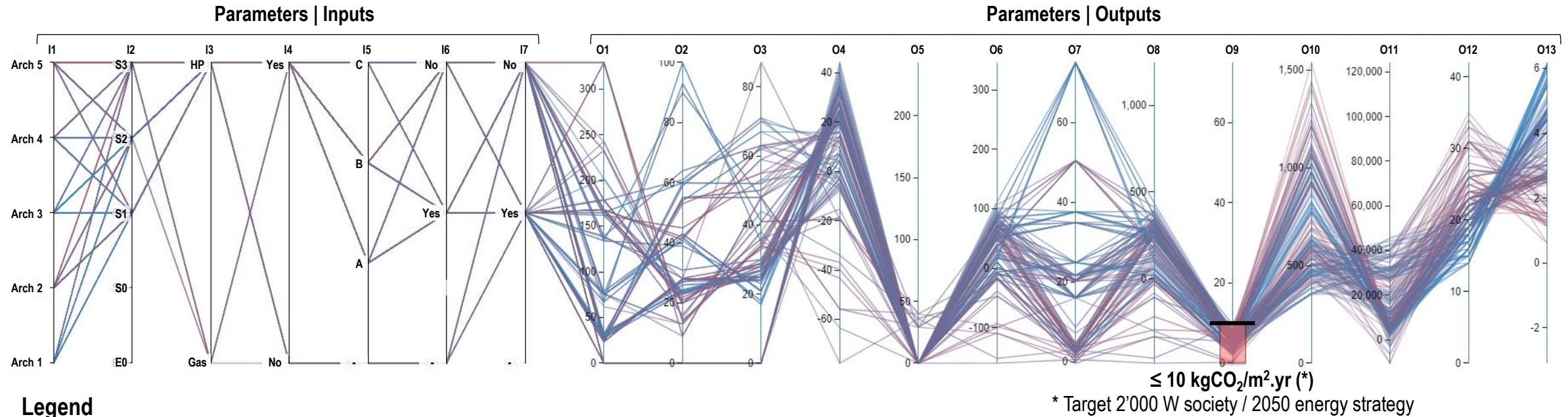
A) 100% active surfaces

B) Active surface selection

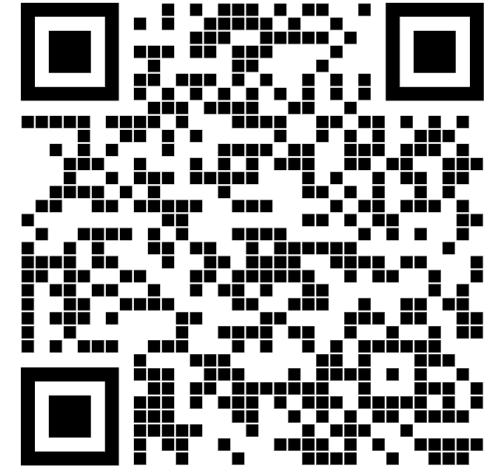
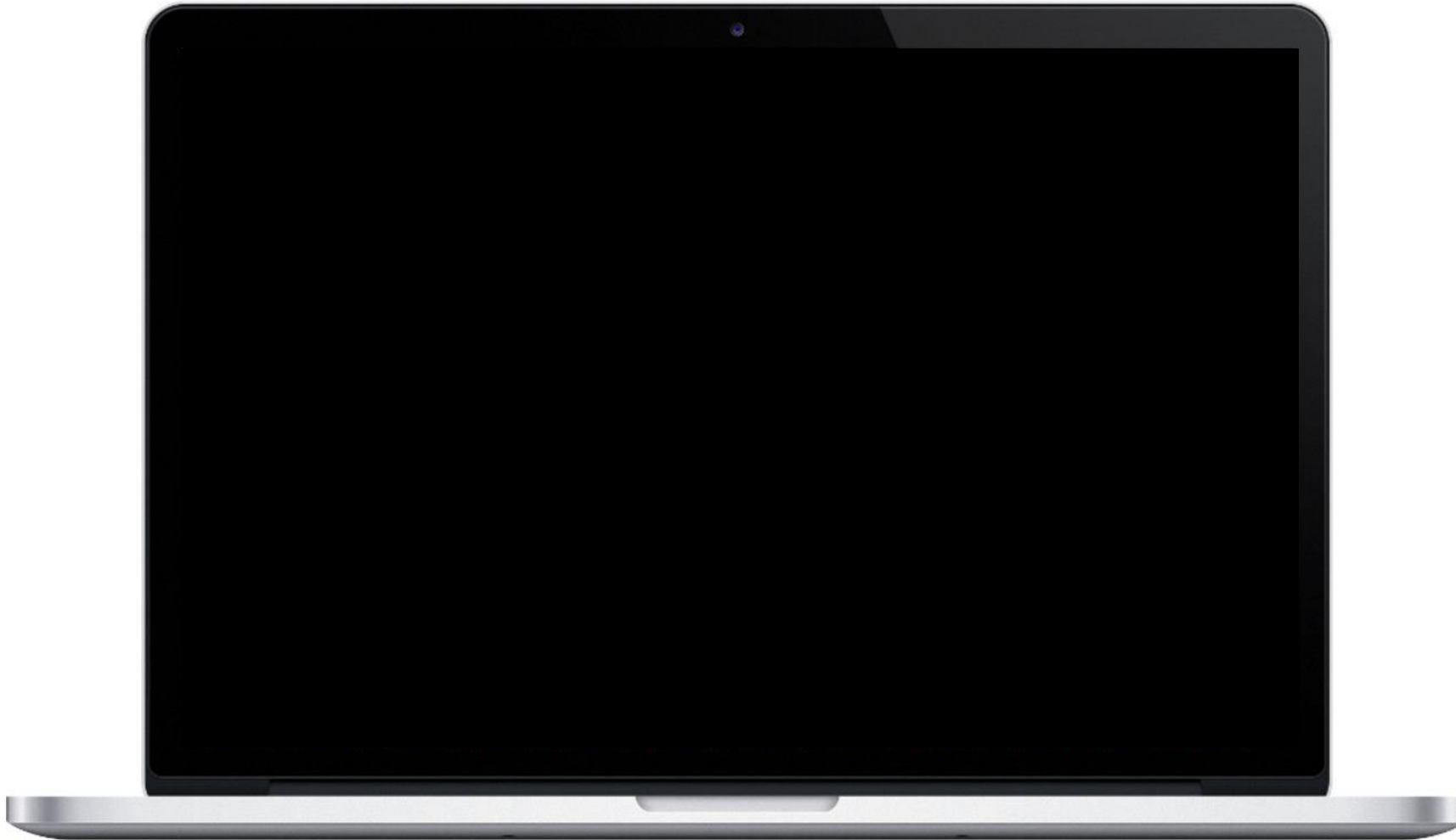
C) Active surfaces selection + batteries



Results | Parallel Coordinate Plot



Results | Parallel Coordinate Plot

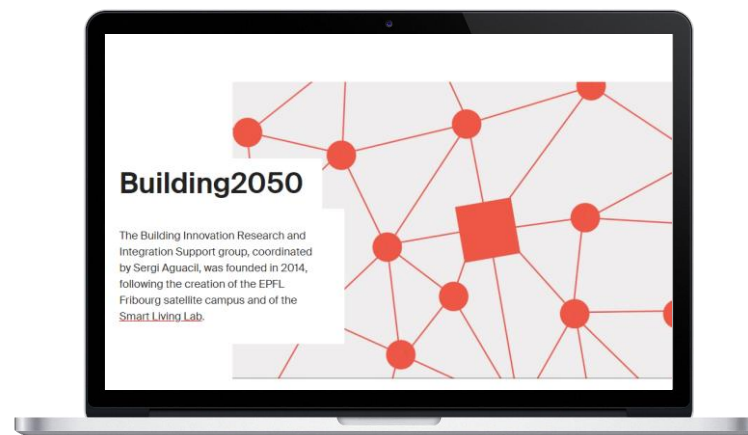


<http://design-explorer.epfl.ch/>

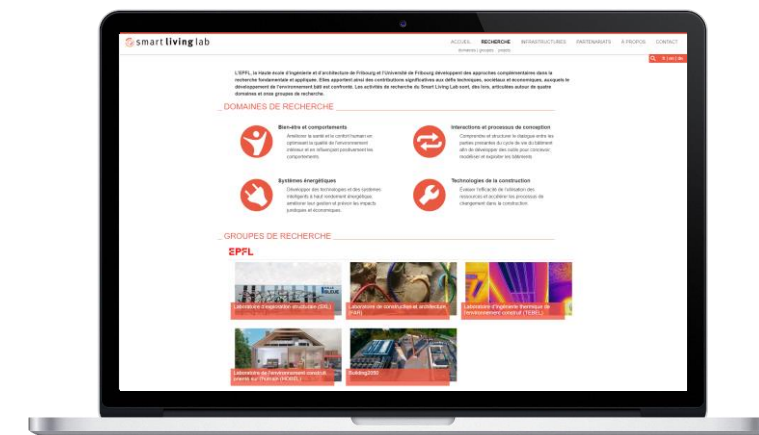
Aguacil Moreno, Sergi. 2019. **Architectural Design Strategies for Building Integrated Photovoltaics (BIPV) in Residential Building Renovation**. (Thèse N° 9332). École polytechnique fédérale de Lausanne (EPFL). <https://infoscience.epfl.ch/record/265585>

Special highlights | Contributions

- Energy renovation projects without PV integration are **no longer an option** if we want to achieve **long-term carbon and energy targets**.
- Results of the two case studies highlight that **BIPV scenarios are the most cost-effective** and the **importance of selecting the active surfaces** to achieve carbon neutrality.
- These elements allow us to achieve the performance objectives **in a more rational way by sizing the PV installation to minimize the grid-injected energy**. This in turn allows avoiding the intrinsic problem linked to **decreasing prices of injected electricity and the incompatibilities with the existing grid**.
- **Batteries could play a key role** to achieve Swiss targets if injection into the grid is no longer possible.



<https://building2050.epfl.ch>



<https://www.smartlivinglab.ch/>

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BUILD - Building2050 group
EPFL Fribourg | Smart Living Lab

* sergi.aguacil@epfl.ch

Publications

Research project (SNSF)

www.activeinterfaces.ch

Design Explorer

<http://design-explorer.epfl.ch/>

Thesis EPFL

<https://infoscience.epfl.ch/record/265585>

Habitation magazine

www.habitation.ch/numero-actuel/



2018-2

Romande association of public utility owners (ARMOUP)

(2018). **Rénovation «active»: des opportunités à ne pas manquer!**

Habitation n. 2(2018), 24-28.

(2021). **Rénovation «active»: une aubaine à saisir à tout prix!**

Habitation n. 3(2021), 6-10.



2021-3