TOWARDS INTEGRATED DESIGN STRATEGIES FOR IMPLEMENTING BIPV SYSTEMS INTO URBAN RENEWAL PROCESSES: FIRST CASE STUDY IN NEUCHÂTEL (SWITZERLAND)

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Overview

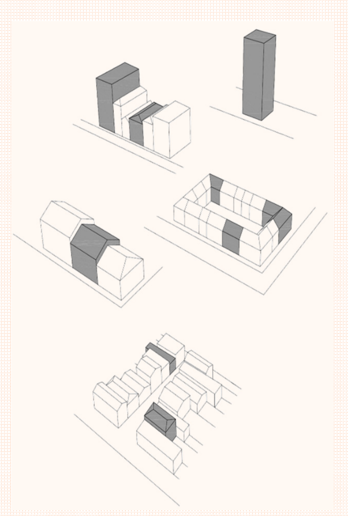
In view of the importance of urban renewal processes, building-integrated photovoltaic (BIPV) systems can potentially provide a crucial response to the challenges of the energy turnaround.

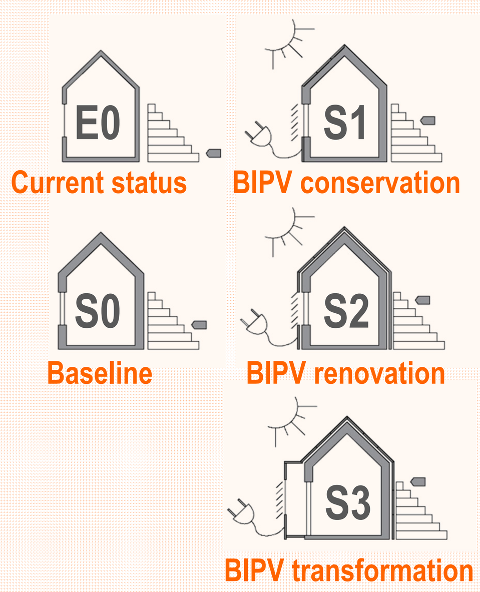
Functioning both as envelope material and electricity generator, they can simultaneously reduce the use of fossil fuels and greenhouse gases (GHG) emissions while providing savings in materials and electricity costs. In Switzerland for instance, one way to achieve the objectives of the "Energy strategy 2050" is to install PV systems to cover 1/3 of the annual electricity demand.

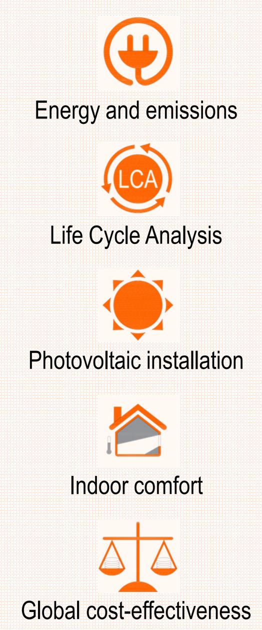
However, despite continuous technological and economic progress, the significant assets of BIPV remain broadly undervalued in the current practice. This project is focusing on the architectural design issues and it presents the first results of the first case study carried out in the city of Neuchâtel (Switzerland).

Research methodology

Phase 1 Identification of archetypes (residential buildings) > **Phase 2** Detailed analysis of the case study > **Phase 3** Design strategies with BIPV solutions > **Phase 4** Multi-criteria assessment



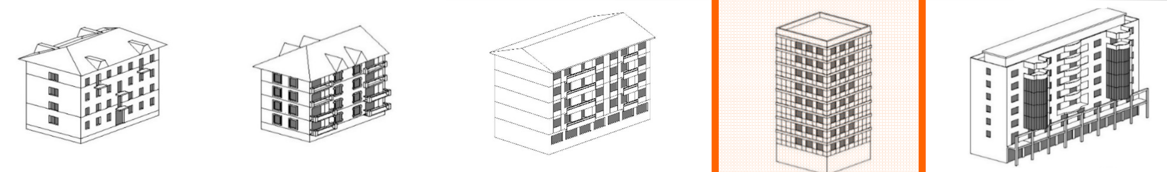




/////Phase 1

Identification of archetypal situations

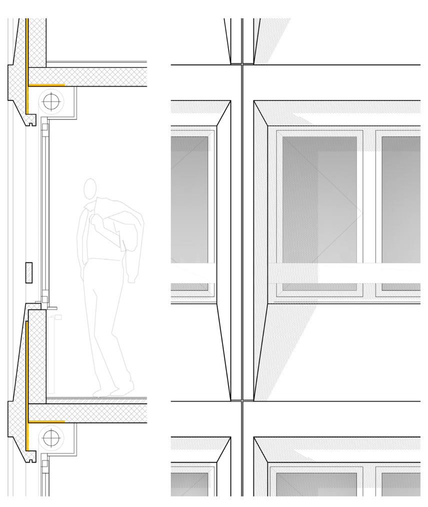
	Arch. 1	Arch. 2	Arch. 3	Arch. 4	Arch. 5
A - Construction period	before 1919	1919-1945	1946-1970	1971-1985	1986-2005
B - Urban context	Isol / Adj. building	Isolated building	Isolated building	Isolated building	Isolated building
C – Roof potential	Sloped roof	Sloped roof	Sloped / Flat roof	Flat roof	Flat roof
D – Façade potential	1-4 floors	1-4 floors	1-4 floors	>7 floors	5-7 floors
E - Architectural quality Level of protection	Common II	Common II	Common II	Common II	Common/Unattractive II / III
Categories of residential buildings					



/////Phase 2

Detailed analysis of the case study

E0 - Current status



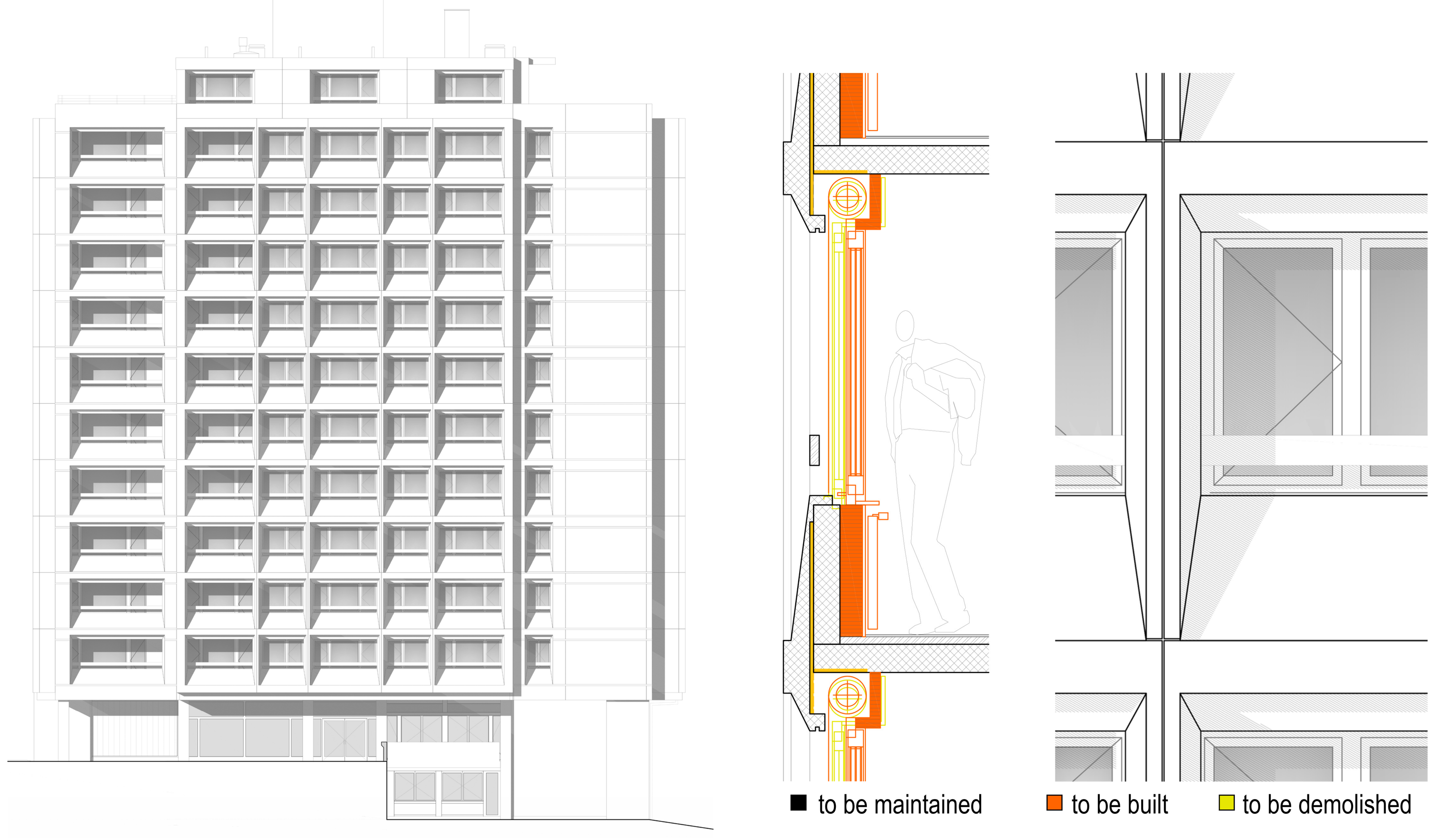
The building presented in this paper corresponds to the **archetype 4**. It is a typical residential building of the 70's, constructed at the beginning of the oil crisis (1972-1976). Consequently, thermal considerations have had a rather small influence on the design of the envelope. It presents eleven-stories, consisting of 52 apartments and **5,263 m²** of living floor area.

Façades are made with concrete prefabricated elements consisting of: 12 cm of reinforced concrete, 4 cm of expanded polystyrene (EPS) insulation, and an exterior facing concrete of varying thickness coated with a crushed stone agglomerate. **Openings** present double glazing and wood-metal frame. The **flat roof** is composed by 22 cm of reinforced concrete, 6 cm of EPS insulation, and 5cm of gravel. In terms of active systems, the building is connected to a central heating covering heating and domestic hot water (DHW) needs.

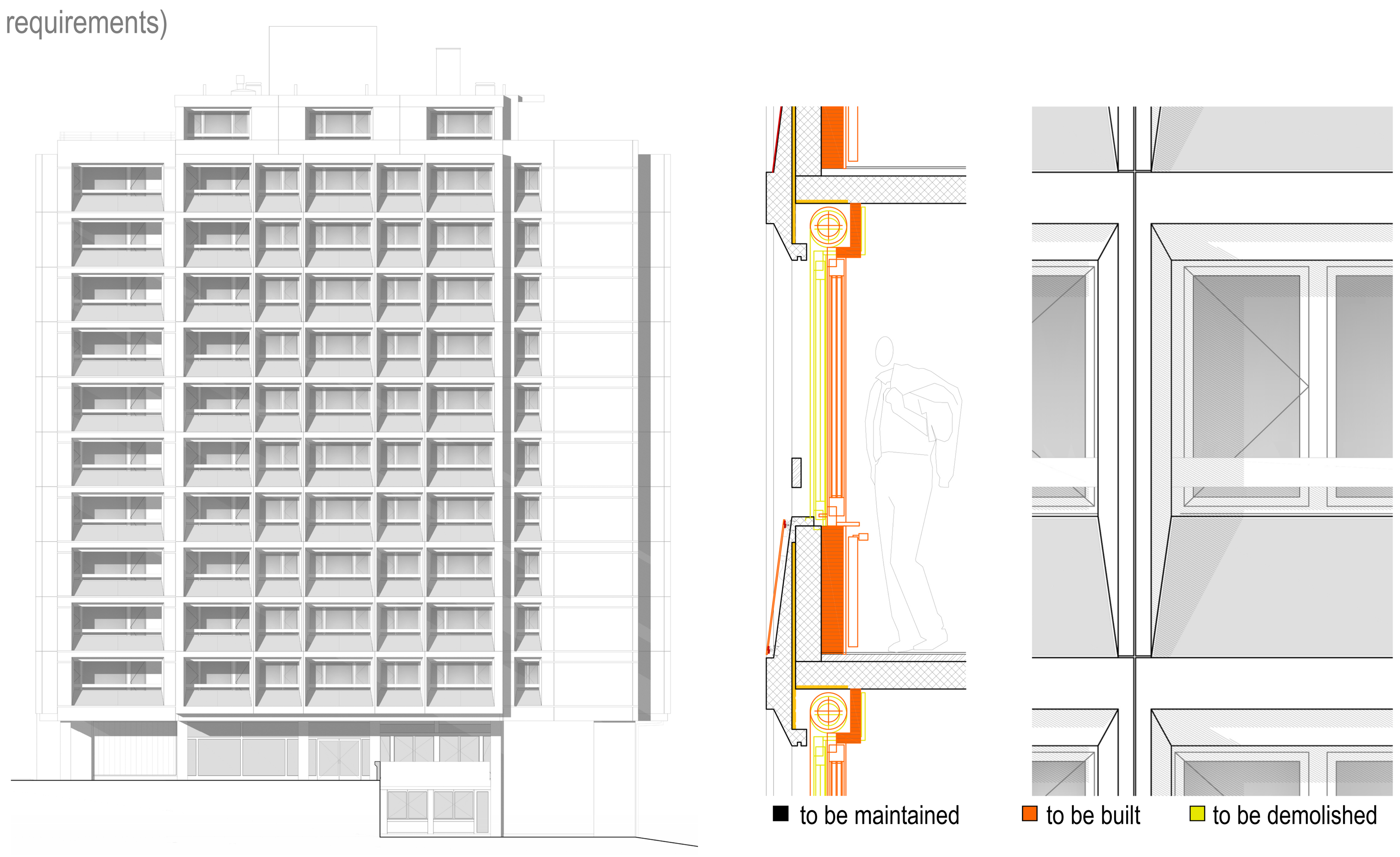
/////Phase 3

Design strategies with BIPV solutions

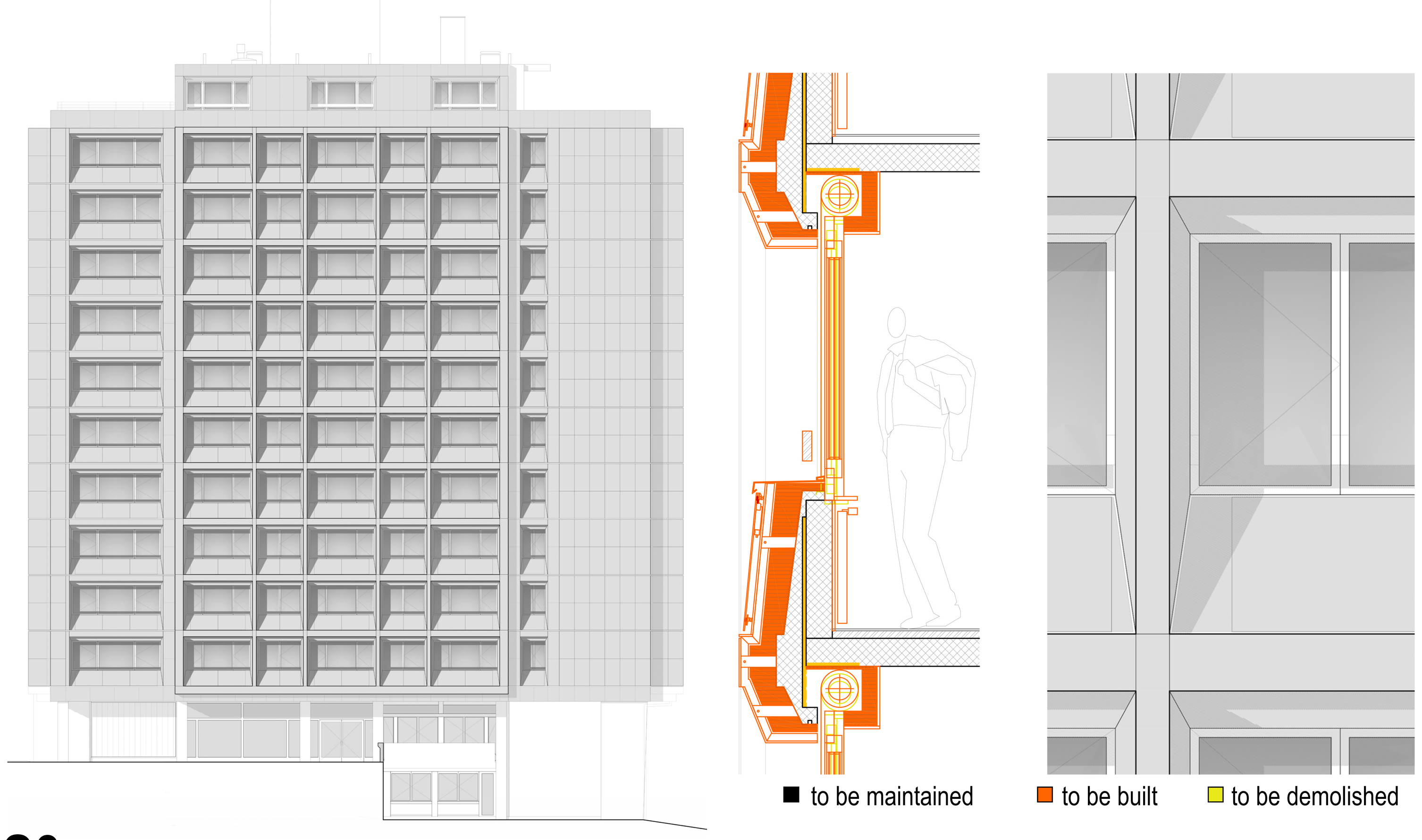
S0 - Baseline: Compliance with current legal requirements (which represents current practice)



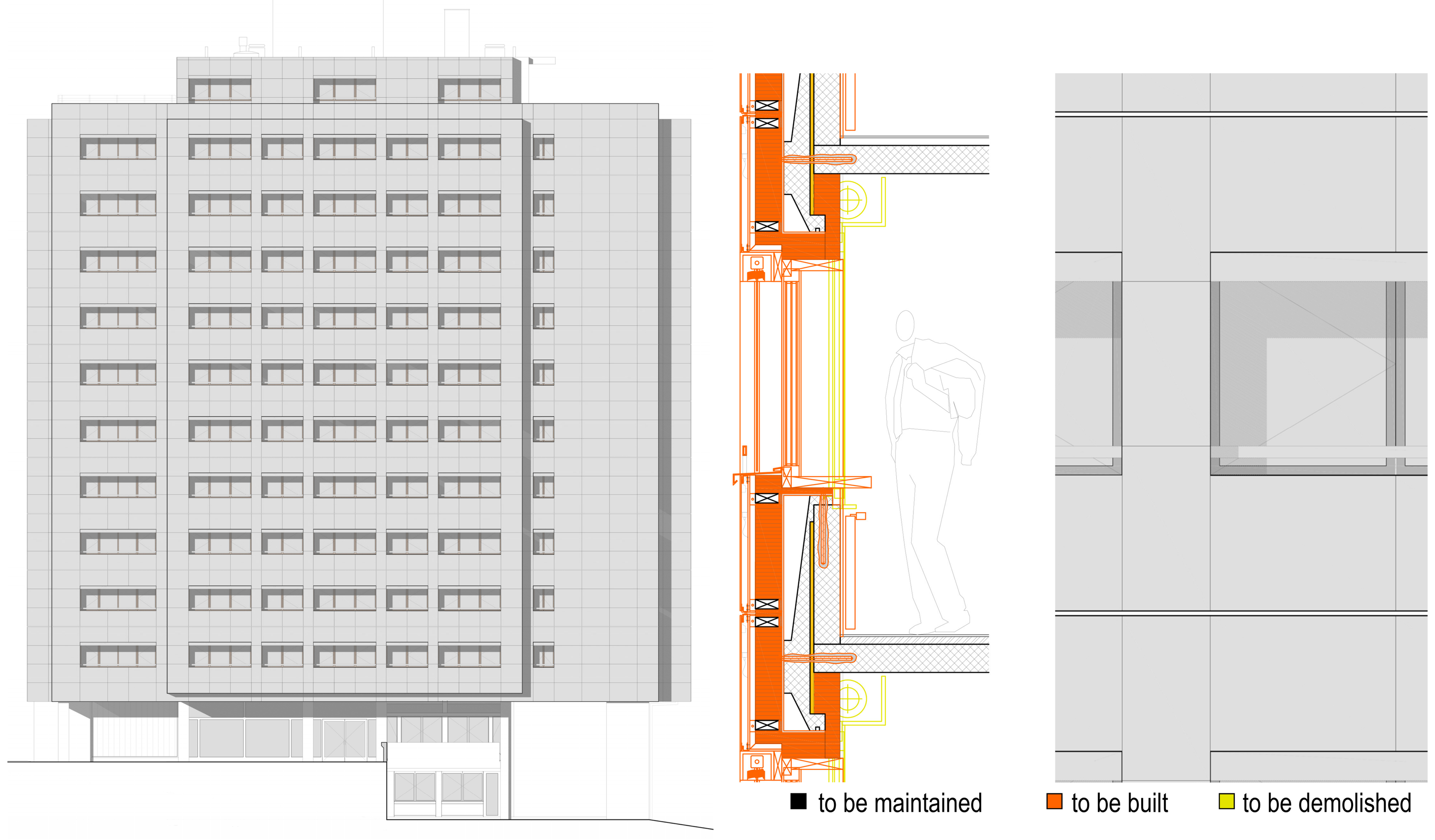
S1 - BIPV conservation: Maintaining the expression of the building while improving the energy performances of the building (at least current legal requirements)



S2 - BIPV renovation: Maintaining the general expressive lines of the building while reaching high energy performances (at least Minergie standard)



S3 - BIPV transformation: Best energy performances and maximum electricity production possible with aesthetic and formal coherence of the whole building (at least 2000 Watt Society | Energy strategy 2050)



/////Phase 4

Multi-criteria assessment

S0

- **175** kWh/m²·year — Primary energy consumption
- **59** $kgCO_2/m^2$·year — Global warming potential
- **-** MWh/m²·year — Onsite PV Electricity production
- **31,53** % — Spatial Daylight Autonomy
- **31** years — Payback time estimation

S1

- **98** kWh/m²·year — Primary energy consumption
- **15** $kgCO_2/m^2$·year — Global warming potential
- **75** MWh/m²·year — Onsite PV Electricity production
- **31,53** % — Spatial Daylight Autonomy
- **26** years — Payback time estimation

S2

- **55** kWh/m²·year — Primary energy consumption
- **10** $kgCO_2/m^2$·year — Global warming potential
- **128** MWh/m²·year — Onsite PV Electricity production
- **29,67** % — Spatial Daylight Autonomy
- **25** years — Payback time estimation

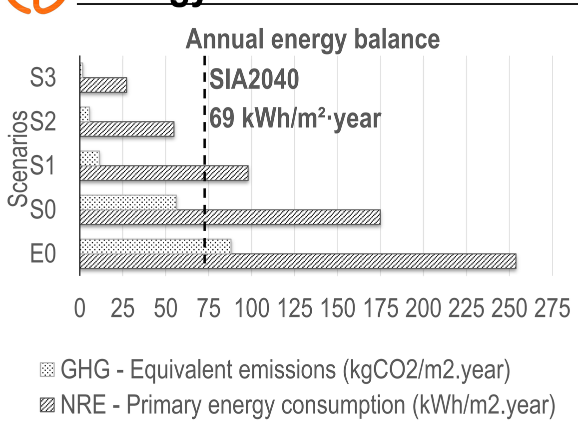
S3

- **27** kWh/m²·year — Primary energy consumption
- **7** $kgCO_2/m^2$·year — Global warming potential
- **174** MWh/m²·year — Onsite PV Electricity production
- **28,23** % — Spatial Daylight Autonomy
- **29** years — Payback time estimation

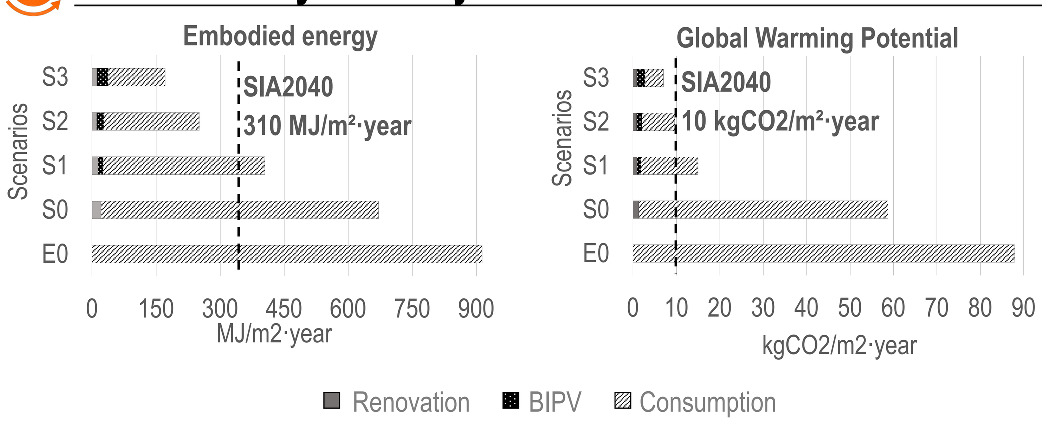
Conclusion / Outlook

Based on the results of the evaluation, it seems clear that energy renovation projects without the integration of renewal energy in general and BIPV in particular are no longer an option if we want to achieve the objectives of the "Energy strategy 2050". Today, renovation projects improving the building envelope with a very high level of thermal energy performance are necessary, but not sufficient. Compensating buildings' energy consumption by producing electricity on site has become the number one priority. In this sense, by proposing new adapted BIPV solutions for urban renewal processes, the research contributes to advancing architectural and construction design practices in this direction. The results of this application case study highlight several interesting elements, such as the best cost-effectiveness of the BIPV scenario and that we can achieve more than 89% of total savings by introducing mixed strategies (passive, active and renewable energy systems)

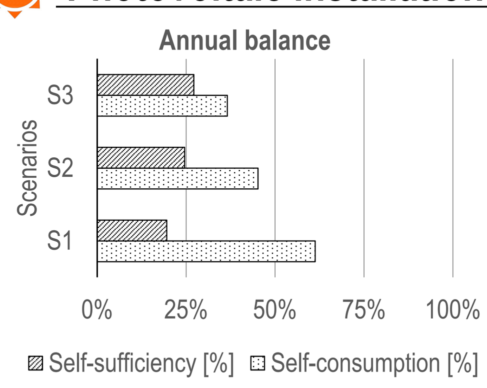
Energy and emissions



LCA - Life Cycle Analysis



Photovoltaic installation



Indoor comfort

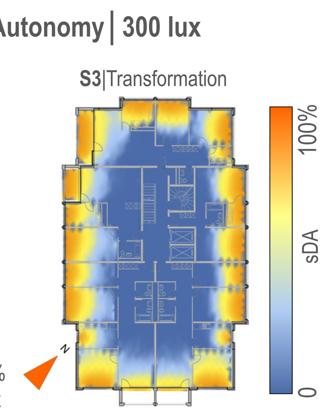
sDA-Spatial Daylight Autonomy | 300 lux

S1|Conservation — sDA: **31.53%**

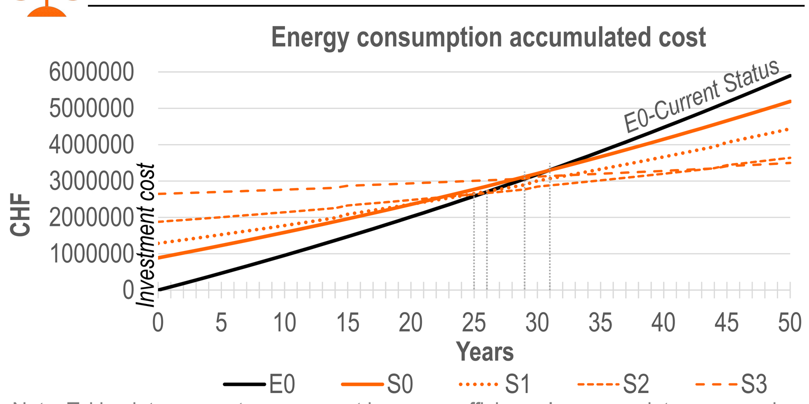
S2|Renovation — sDA: **29.67%**

S3|Transformation — sDA: **28.23%**

sDA: Surface ratio with > 50% of time with more than 300 lux



Global cost-effectiveness



Note: Taking into account: energy cost increase, efficiency losses, maintenance and repairs-replacements costs.

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/////active interfaces
www.activeinterfaces.ch

70 NRP Energy Turnaround National Research Programme
FNSNF Swiss National Science Foundation

Acknowledgements: This research project is part of the National Research Programme "Energy Turnaround" (NRP 70) of the Swiss National Science Foundation (SNSF). Further information on the National Research Programme can be found at www.nrp70.ch. The authors also thank Ecole Polytechnique Fédérale de Lausanne (EPFL) for their support.