ACTIVE INTERFACES. Holistic design strategies for renovation projects with building-integrated photovoltaics (BIPV): case study from the 1900s in Neuchâtel (Switzerland).

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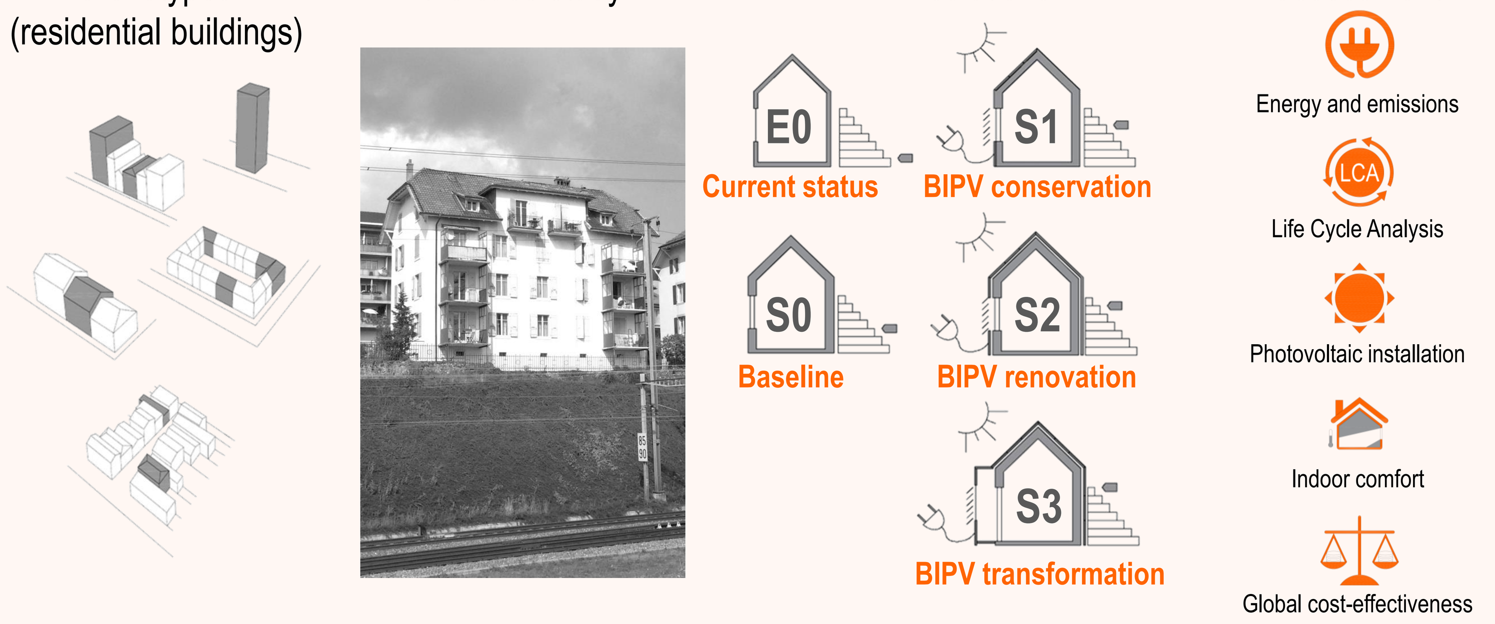
Overview

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 gas (GHG) emissions while providing savings in materials and electricity cost. 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 benefits of BIPV remain broadly undervalued in the current practice. This project is focusing on the architectural design issues and this poster presents the results of the second case study carried out in the city of Neuchâtel (Switzerland). The building presented in this poster corresponds to the archetype 1. It is a typical residential building of the pre-war period, constructed in 1909, a period when thermal considerations had a rather small influence on the design of the envelope. The building has four-stories and a total of 8 apartments and 630 m² of living floor area.

Research methodology

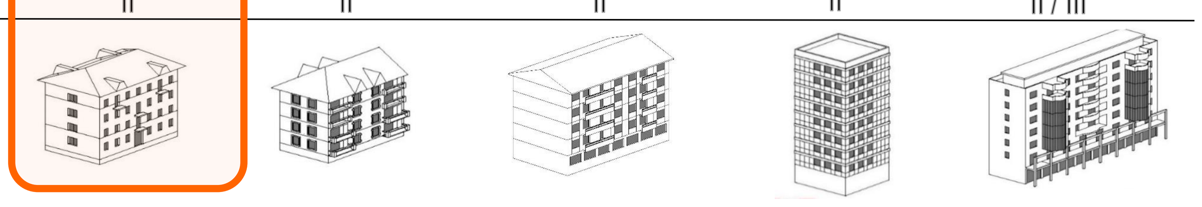
Phase 1 Identification of archetypes (residential buildings) > **Phase 2** Detailed analysis of the case study > **Phase 3** Design strategies with BIPV solutions > **Phase 4** Multi-criteria assessment



///// Phase 1 - 2

Identification of archetypal situations and analysis of the case studies

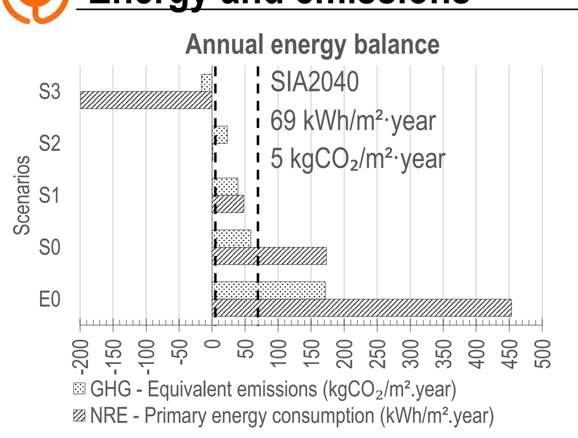
	Arch. 1	Arch. 2	Arch. 3	Arch. 4	Arch. 5
A - Construction period	before 1919	1919-1945	1946-1970	1971-1985	1986-2005
B - Urban context	Isol / Adj. building	Isolated building	Isolated building	Isolated building	Isolated building
C – Roof potential	Sloped roof	Sloped roof	Sloped / Flat roof	Flat roof	Flat 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					



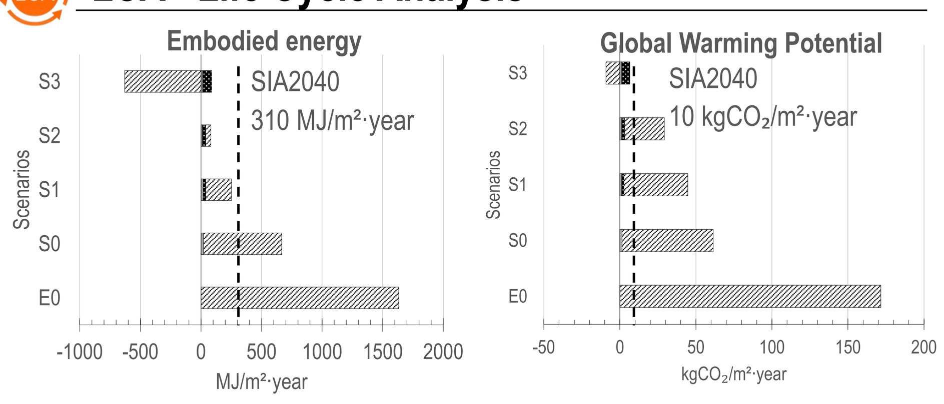
Conclusion / Outlook

Based on the results of the evaluation, it seems clear that energy renovation projects without the integration of renewable 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 demonstrate that scenarios with BIPV allow improving the cost-effectiveness of the renovation process, and that we can achieve more than 79% of total savings (only with passive strategies) and reach positive energy buildings by introducing mixed strategies (passive, active and renewable energy systems), allowing us to achieve the "2000Watts society" objectives.

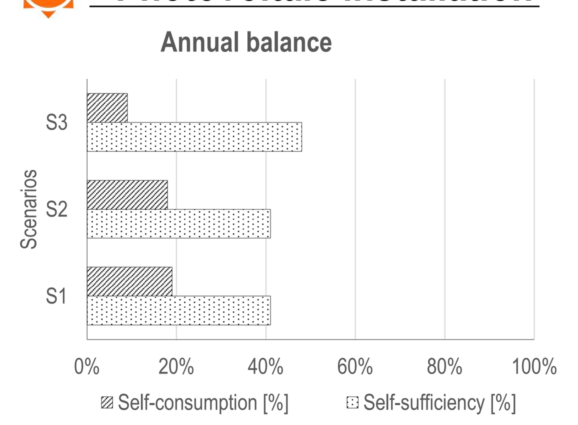
Energy and emissions



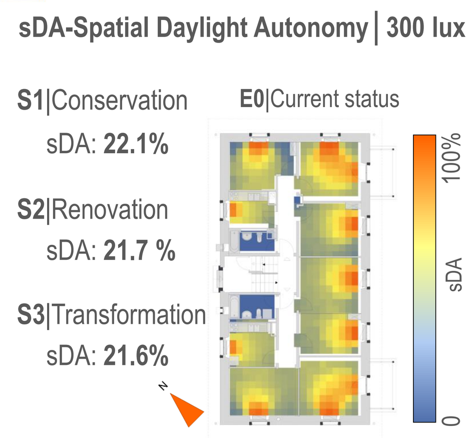
LCA - Life Cycle Analysis



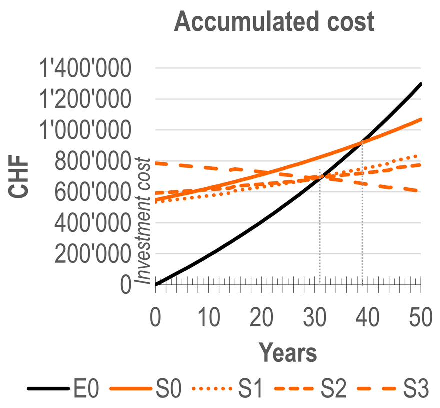
Photovoltaic installation



Indoor comfort



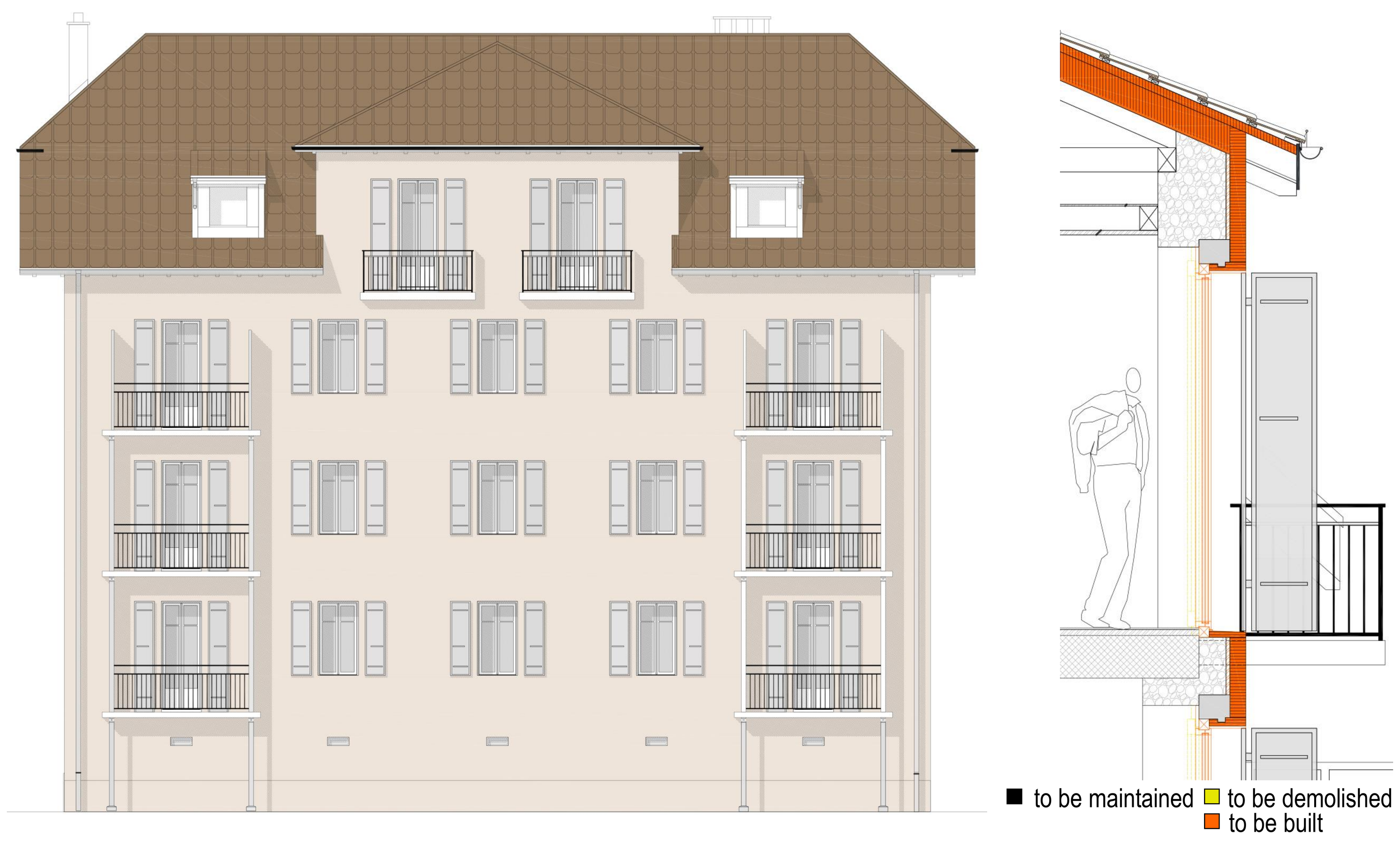
Cost-effectiveness



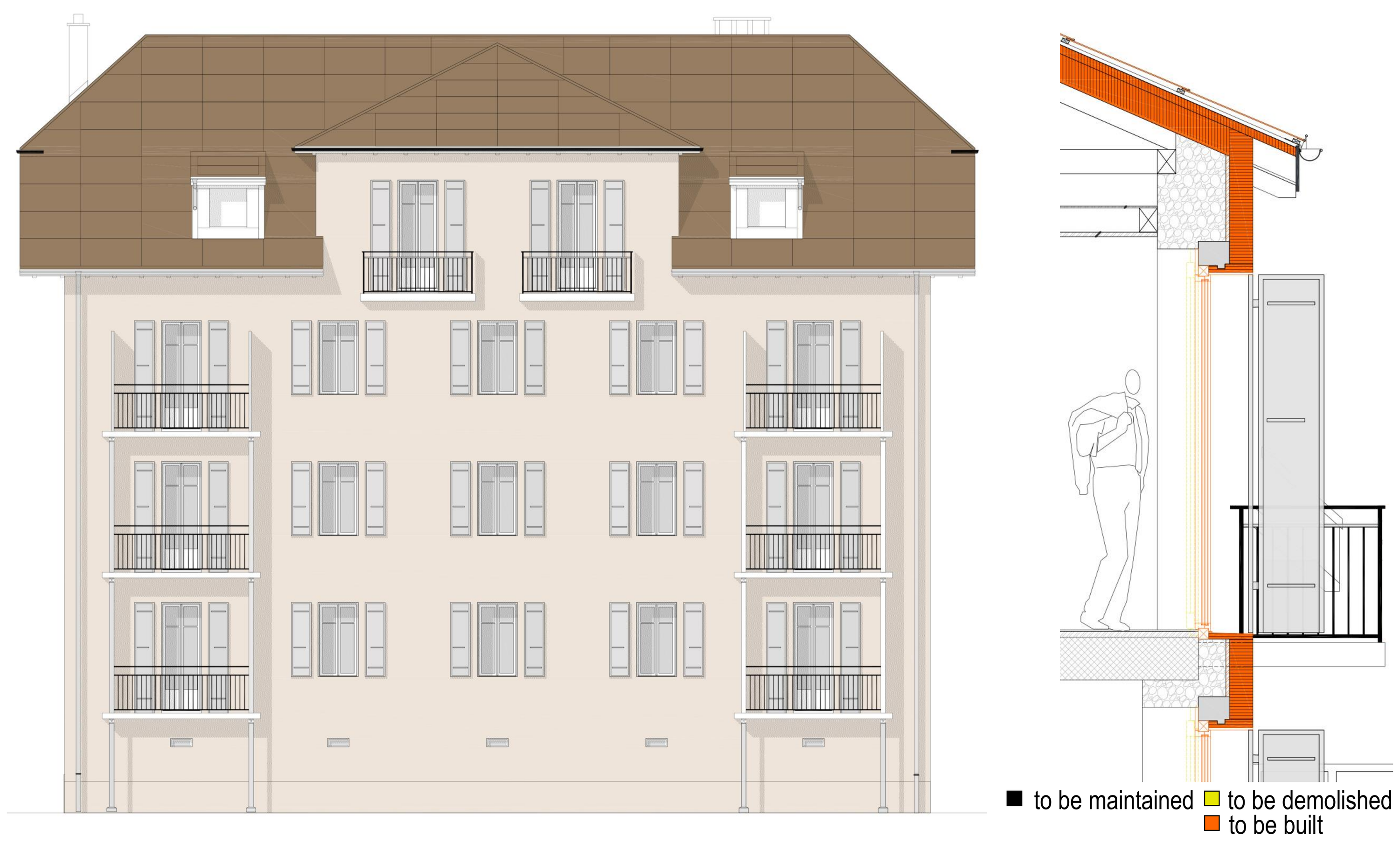
///// Phase 3

Design strategies with BIPV solutions

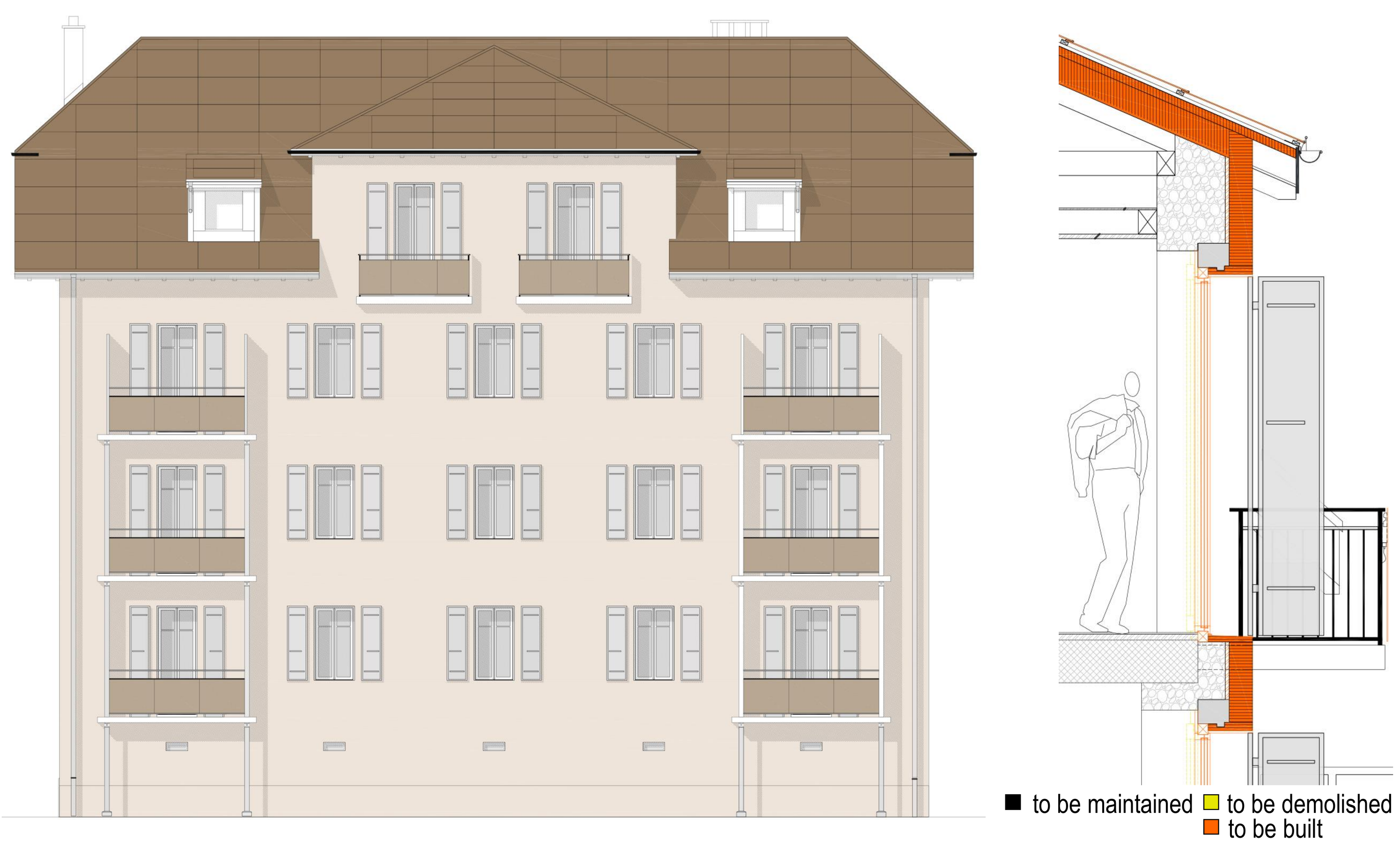
S0 - Baseline: Compliance with current legal requirements (which represents current practice)



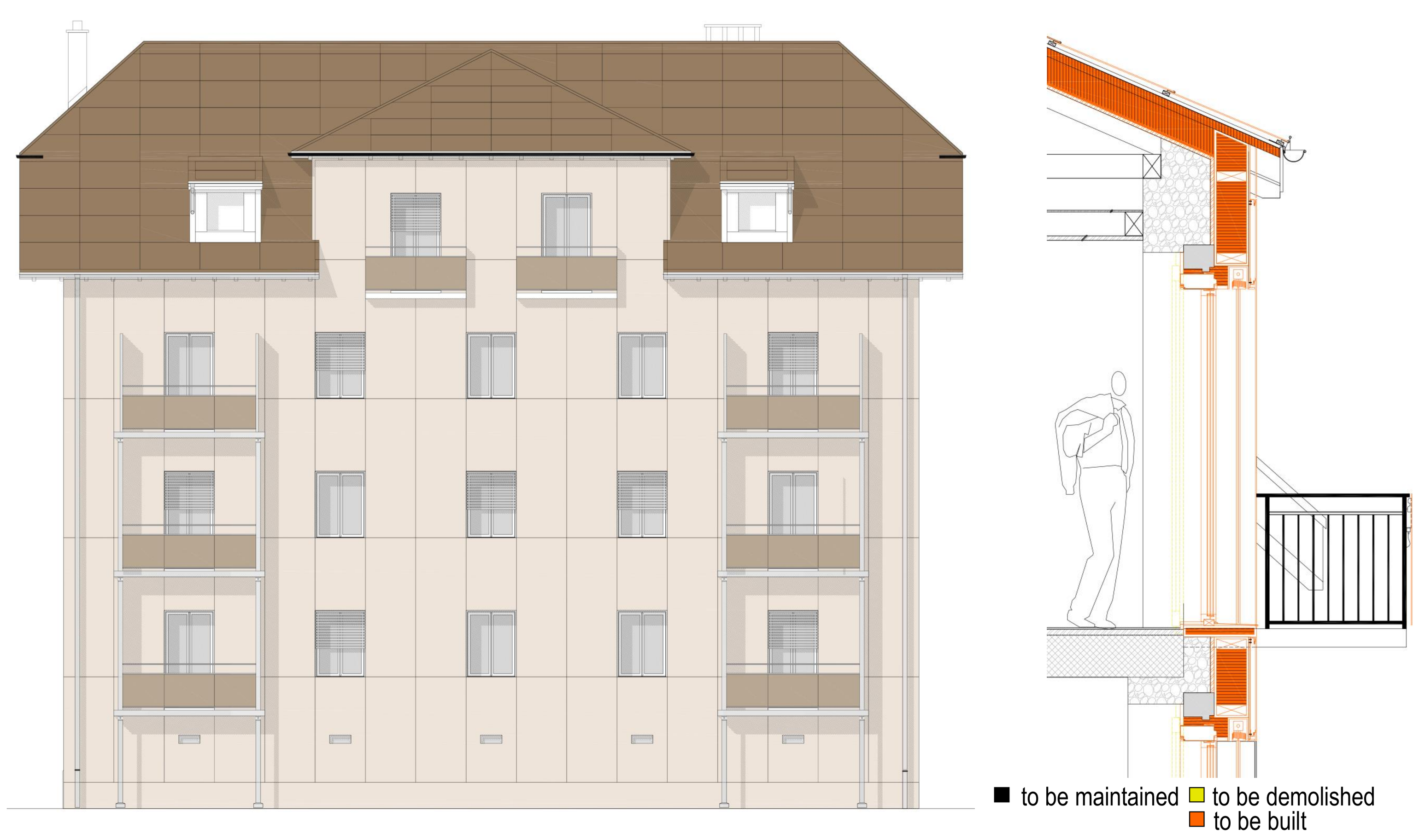
S1 - BIPV conservation: Maintaining the expression of the building while improving the energy performances of the building (at least current legal requirements)



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	S1	S2	S3
Primary energy consumption	173 kWh/m²·year	48 kWh/m²·year	1 kWh/m²·year	-199 kWh/m²·year
Global warming potential	61 kgCO₂/m²·year	45 kgCO₂/m²·year	29 kgCO₂/m²·year	-3 kgCO₂/m²·year
Onsite PV Electricity production	- MWh/year	49 MWh/year	54 MWh/year	121 MWh/year
Self-consumption	- - %	19 %	18 %	9 %
Self-sufficiency	- - %	41 %	41 %	48 %
Spatial Daylight Autonomy	22.3 %	22.1 %	21.7 %	21.6 %
Payback time estimation	39 years	31 years	31 years	31 years
Cost Final Energy per year	7'057 CHF/year	3'677 CHF/year	2'063 CHF/year	-2'864 CHF/year

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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

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

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