active interfaces

Sustainable buildings with photovoltaic systems
Perspectives and obstacles for architects

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70 NRP
Energy Turnaround
National Research Programme
CONTEXT | Issues and challenges

- Importance of photovoltaics (PV) to energy turnaround (quantitative issues) might require > 30% coverage of Swiss roofs/façade
- Importance of urban renewal for the evolution of built environment towards sustainability (National Research Programme 54)
- PV integrated into the building (BIPV) : higher acceptance, required for massive penetration of PV in CH with potential lower costs (substitution effects)

But not many good examples of BIPV in the current practice and many obstacles prevent a qualitative and quantitative development of PV

ACTIVE INTERFACES = NRP 70 interdisciplinary research project aiming at crossing over these obstacles
CURRENT PRACTICE | Technological barriers

Strong cost difference between standard and custom-made products (SEAT Manufacture in Martorell | Solar Decathlon House of Cardenal Herrera University)
CURRENT PRACTICE | Design barriers

Esthetic and economical efficiency problems of building renovations without real integration of PV elements
Representative of the urban areas in the Swiss plateau, strong interest for energy issues, development of a new masterplan
RESEARCH | Main phases of the methodology

1. IDENTIFICATION OF RESIDENTIAL ARCHETYPES
2. DETAILED ANALYSIS OF THE CASE STUDIES
3. DESIGN SCENARIOS WITH BIPV SOLUTIONS
4. MULTI-CRITERIA ASSESSMENT

Methodology for the development of renewal scenarios
RESEARCH | Phase 1: Identification of residential archetypes

1. Before 1919
2. 1919-1945
3. 1946-1970
4. 1971-1985
5. 1986-1995
6. 1996-2005

REGBL ➔ 2070 buildings
REGBL + REGFonc + Patrimoine ➔ 1234 buildings

Typology based on construction period and constructive features (complete data for 2772 buildings)

Ref.: Office fédéral de la statistique (OFS), 2014
RESEARCH | Phase 1: Identification of residential archetypes

A - Construction period

|--------|-------------|------------|------------|------------|------------|------------|

B - Urban context

- **Adjacent building**
- **Isolated building**

C - Roof potential

- **Sloped roof**
- **Flat roof**

D - Façade potential

- **1-4 floors**
- **>7 floors**
- **5-7 floors**

E - Architectural quality

- **Common**
- **Common / Unattractive**

Level of protection

- **II / III**

F - Type of owner

- **Small owner (<3 proprieties)**
- **Large owner (≥3 proprieties)**
- **Co-ownership (PPE)**
- **Large owner (≥3 proprieties)**

Architectures:

- **Arch. 1**
- **Arch. 2**
- **Arch. 3**
- **Arch. 4**
- **Arch. 5**
- **Arch. 6**
### RESEARCH | Phase 1: Identification of residential archetypes

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- 1919-1945
- 1946-1970
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![Architectural representations](images)
First case study: Rue Troncs 12 (Residential archetype 4, Period of construction: 1972-1973)
RESEARCH | Phase 3 : Design scenarios with BIPV solutions

Current status

Baseline: Compliance with current legal requirements

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

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

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)

Definition of the design scenarios
RESEARCH | Phase 3: Design scenarios with BIPV solutions

**Evolutive**: Products directly issued from mainstream PV, but which naturally fits better for BIPV (e.g. "smart wire" modules, Metallization-Wrap-Through – MWT – modules).

**Transformative**: Products based on low-cost “standard” technology products, but which integrate low-cost modifications, such as texture or colour variation with “adaptation” foils.

**Disruptive**: Products including customized-size products or on-site shaping of PV elements.

(a) Polycrystalline silicon PV module (55% of the market) with a black backsheet (SIGNATURE™ BLACK) - http://us.sunpower.com/

(b) White c-Si based PV modules (shiny & matt) as developed by CSEM and now commercialized by Solaxess.

(c) Customized-size PV modules by Meyer Burguer AG - www.meyerburger.ch
RESEARCH | Phase 3 : Design scenarios | E0 – Current status
RESEARCH | Phase 3 : Design scenarios | S0 – Baseline
RESEARCH | Phase 3 : Design scenarios | S1 – Conservation
RESEARCH | Phase 3 : Design scenarios | S2 – Renovation
RESEARCH | Phase 3: Design scenarios | S3 – Transformation
SIA 2040: La voie SIA vers l’efficacité énergétique (objective «2000W society»)
RESEARCH | Phase 4: Assessment | Indoor comfort

Daylight Autonomy | 300 lux | Occupation 8 am – 10 pm | Time ratio with more than 300-Lux

S1 | Conservation

S3 | Transformation
RESEARCH | Phase 4: Assessment | Global cost-effectiveness

Accumulated cost due to energy consumption (CHF)

- Scenario_E0: Current Status
- Scenario_S0: Baseline
- Scenario_S1: Conservation
- Scenario_S2: Renovation
- Scenario_S3: Transformation

Renovation cost vs Years

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RESEARCH | Phase 4 : Assessment | Global cost-effectiveness

Mean rent level in Neuchatel: **220 CHF/m2 per year**
**RESEARCH | Phase 4 : Assessment | Photovoltaic installation**

**Daily analysis**

<table>
<thead>
<tr>
<th>Energy balance</th>
<th>Purchased electricity (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-sufficiency ratio</td>
<td>22%</td>
</tr>
<tr>
<td>Self-consumption ratio</td>
<td>52%</td>
</tr>
<tr>
<td>PV Generation (kWh)</td>
<td>202.12</td>
</tr>
<tr>
<td>Grid feed-in (kWh)</td>
<td>97.61</td>
</tr>
<tr>
<td>Electricity needs: Equipment + Light + HVAC (Electric heat pump) - Simulation day: March 21th</td>
<td></td>
</tr>
</tbody>
</table>

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COMMUNICATION | Website www.activeinterfaces.ch

Homepage of the Active Interfaces website
TEAM | 10 Research groups | 9 Post-doc | 5 PhD students