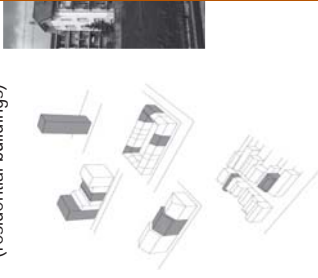


//// Research Methodology

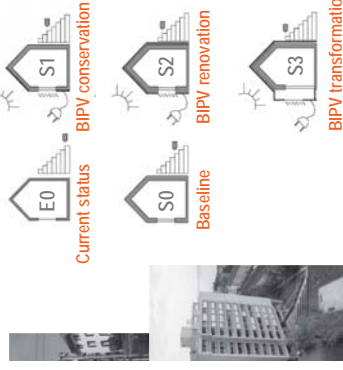
Phase 1

Identification of archetypes (residential buildings)



Phase 2

Selection of design strategies with BIPV solutions



Phase 3

Multi-criteria assessment



//// active interfaces

Project 02 - Design
Architectural design strategies for renovation projects with BIPV optimizing self-consumption and self-sufficiency

Sergi Aguacil | Laboratory of Architecture and Sustainable Technologies (EPFL)
2nd PHD Seminar | ACTIVE INTERFACES | Lausanne | 29.03.2017

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//// Agenda

- Research methodology
 - Presentation of the case studies - archetype 1 and 4
 - Design scenarios implementation - case studies
- Multi-criteria assessment
 - Indicators
 - Net energy balance
 - Annual irradiation threshold study
 - Optimization process
 - Results comparison
- Next step
 - Integration a PV battery storage system

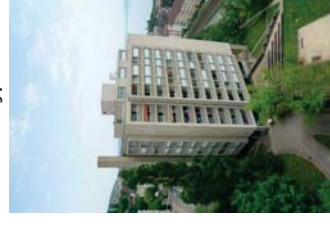
//// Phase 2 | Case studies

Archetype 1



Level of protection: II
Heating system: gas

Archetype 4



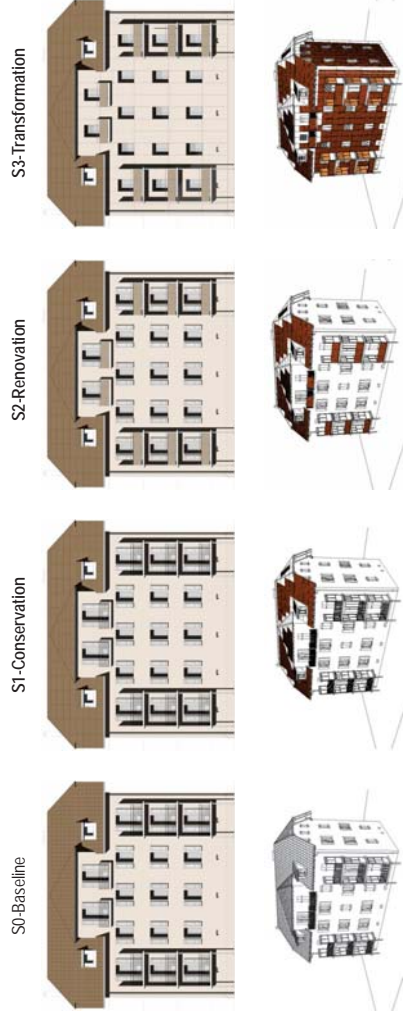
- Built in 1972
- 11 stories
- 52 apartments
- 5,263 m² floor area

1909
35
apartments
5,263 m² floor area

Oil boiler

//// Residential buildings

//// Phase 3 | Design scenarios implementation | Potentially active surfaces



Archetype 1 | 1909

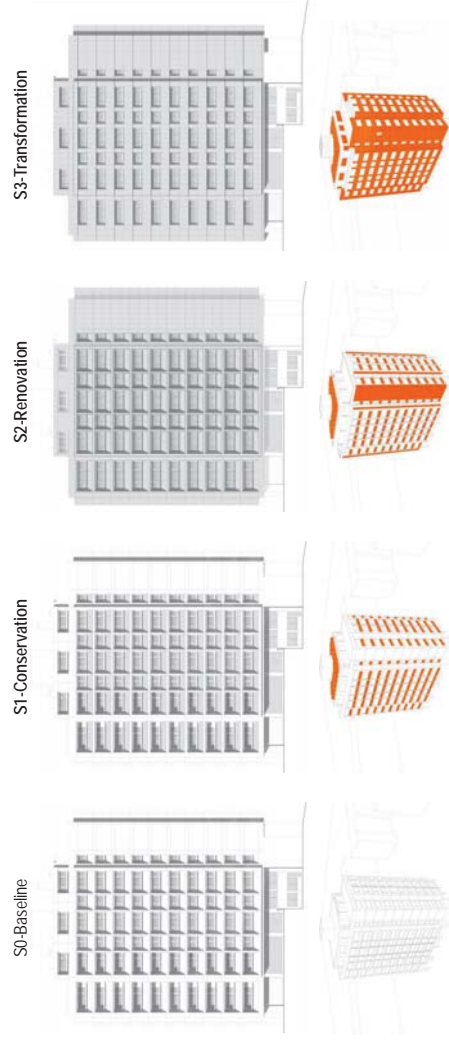
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//// Phase 4 | Multi-criteria assessment | Indicators

Assessment indicator	Unit	Method / tool used	3D modelling LoD
1. Energy and emissions			
- Primary energy consumption	kWh _{PE} /m ² .year	Energy Plus	LOD3
- Equivalent GHG emissions	CO _{2,eq} /m ² .year	Energy Plus	LOD3
2. Photovoltaic installation			
- PV Generation	kWh _{PE} /m ² .year	Energy Plus	LOD3
- Self-consumption	%	-	-
- Self-sufficiency	%	-	-
3. LCA - Life Cycle Analysis			
- Embodied energy balance	MJ/m ² .year	ecoinvent + KBOB	-
- Global warming potential	kgCO ₂ /m ² .year	ecoinvent + KBOB	-
4. Indoor comfort			
- Spatial Daylight autonomy (300lux)	% of surface	Radiance / Daysim	LOD4
5. LCC - Life Cycle Cost			
- Accumulated cost	CHF	-	-
- Payback period	years	-	-

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//// Phase 3 | Design scenarios implementation | Potentially active surfaces



Archetype 4 | 1972

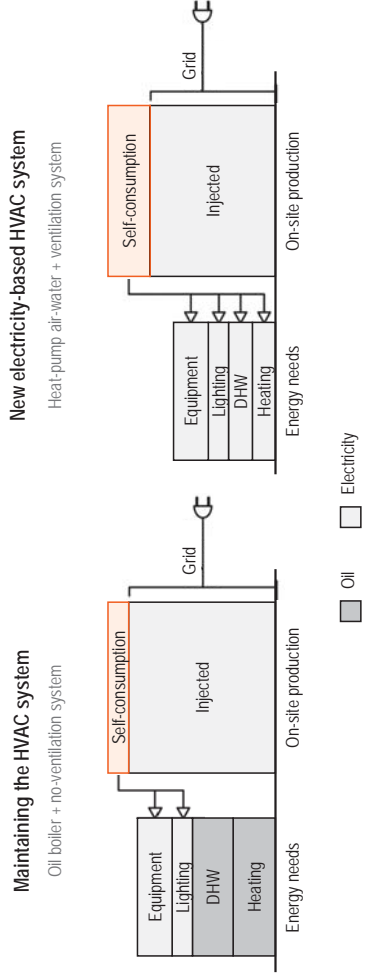
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//// Phase 4 | Multi-criteria assessment | Indicators

Assessment indicator	Unit	Method / tool used	3D modelling LoD
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- PV Generation	kWh _{PE} /m ² .year	Energy Plus	LOD3
- Self-consumption	%	-	-
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- Embodied energy balance	MJ/m ² .year	ecoinvent + KBOB	-
- Global warming potential	kgCO ₂ /m ² .year	ecoinvent + KBOB	-
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5. LCC - Life Cycle Cost			
- Accumulated cost	CHF	-	-
- Payback period	years	-	-

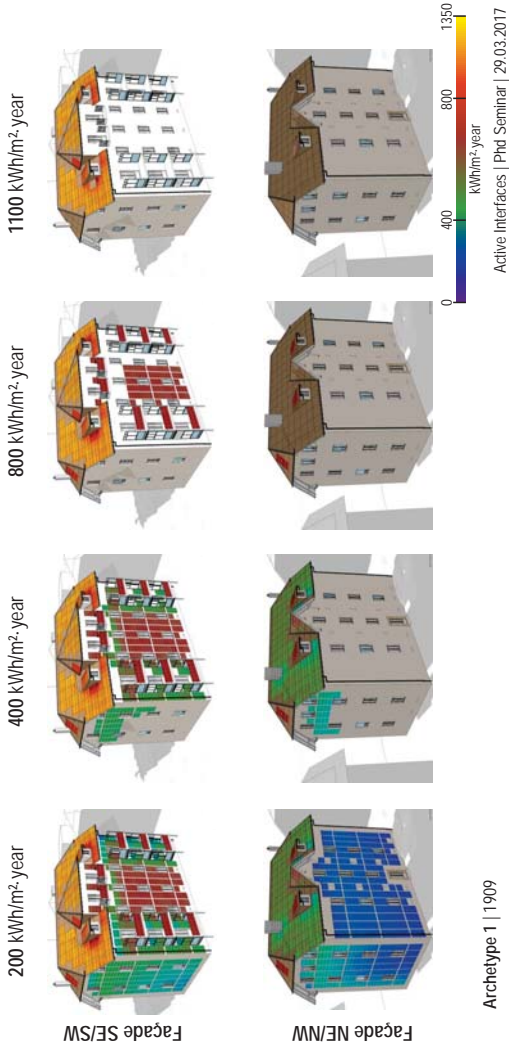
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Phase 4 | Multi-criteria assessment | Net energy balance



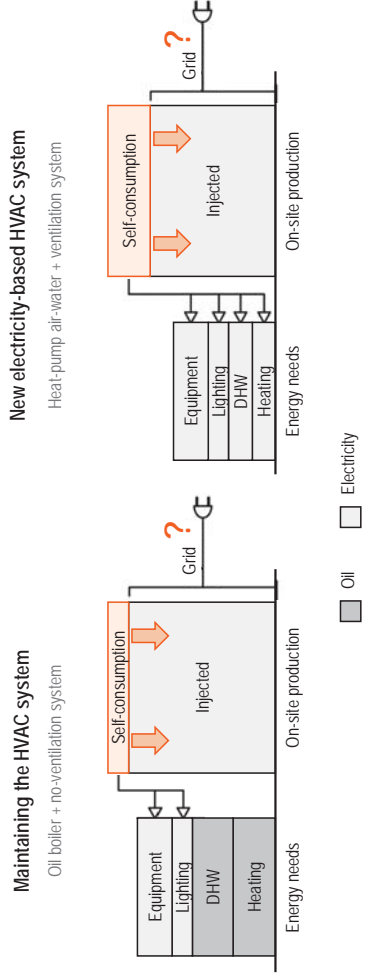
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Phase 4 | Annual Irradiation threshold study | S3 - Transformation



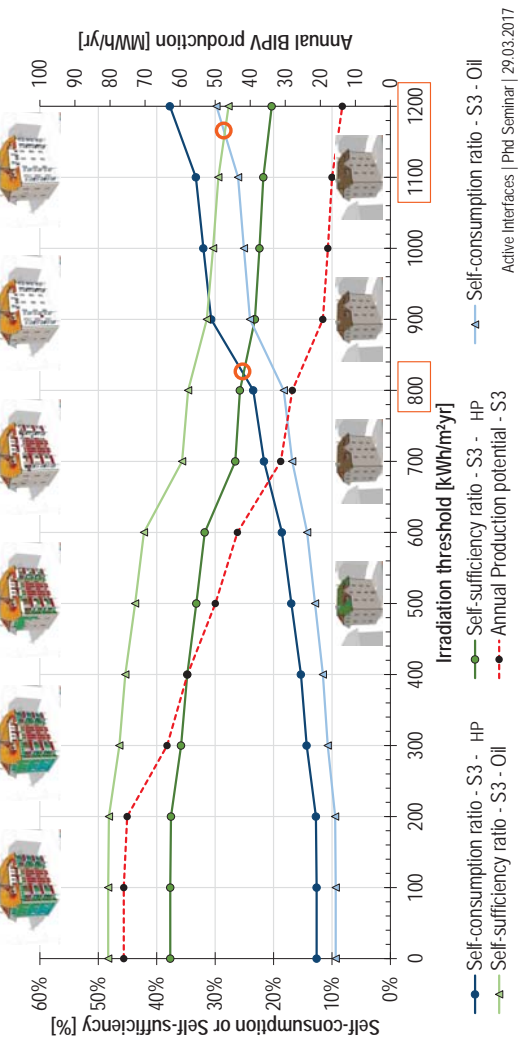
Archetype 1 | 1909

Phase 4 | Multi-criteria assessment | Net energy balance

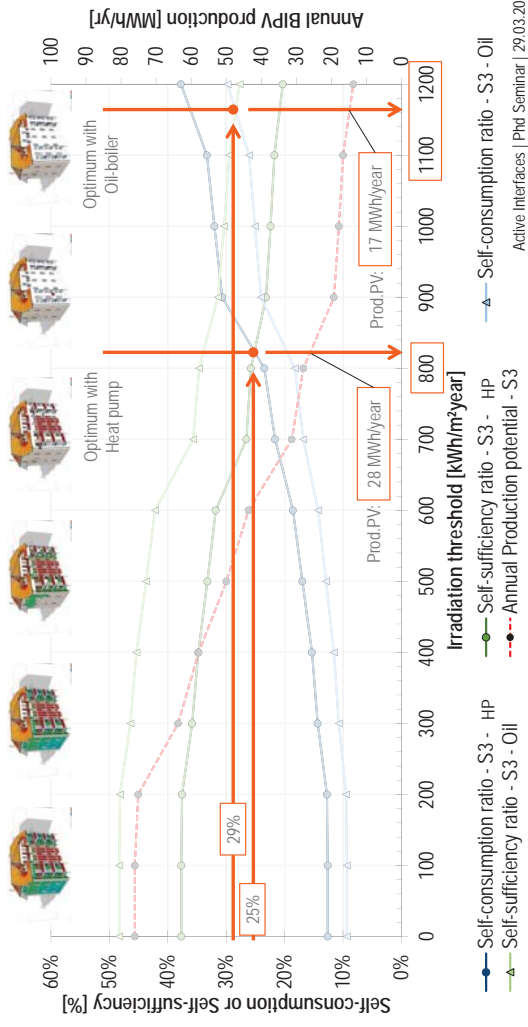


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Phase 4 | Optimization | S3 - Transformation

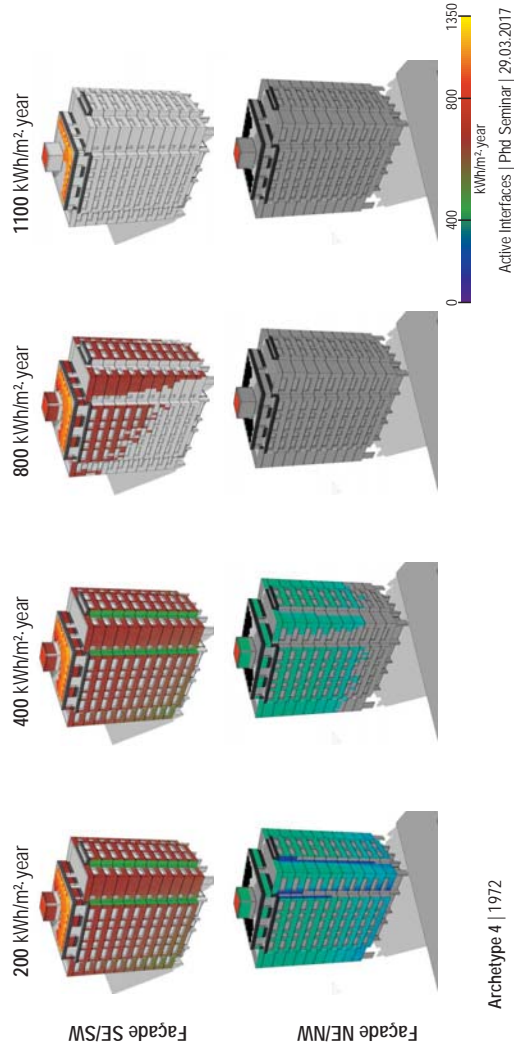


Phase 4 | Optimization | S3 - Transformation

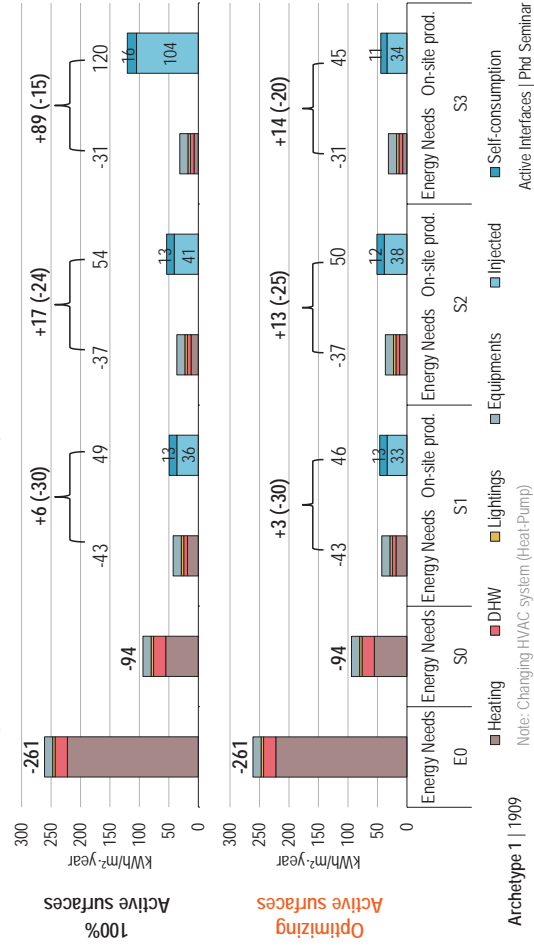


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Phase 4 | Annual Irradiation threshold study | S3 - Transformation



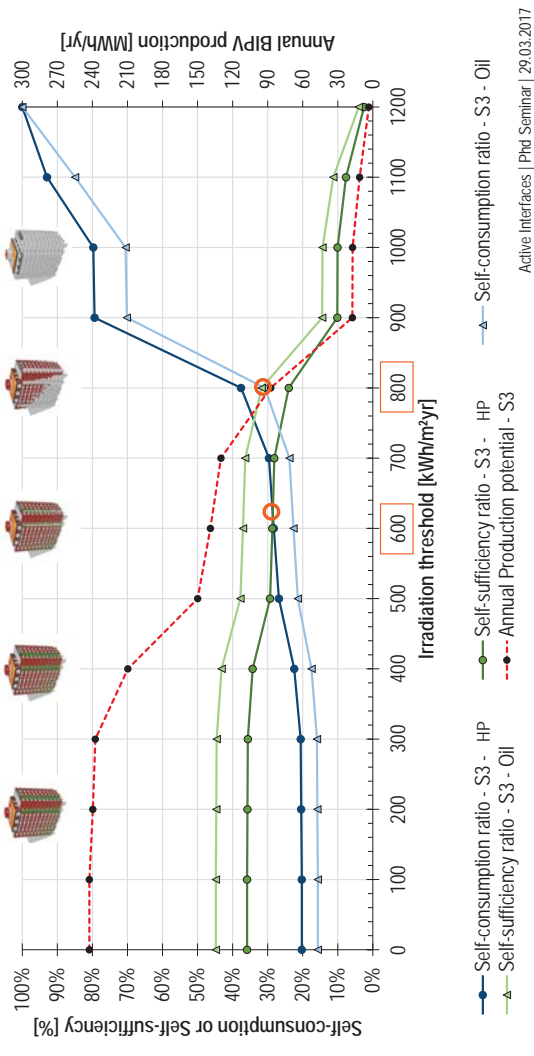
Phase 4 | Multi-criteria assessment | Net energy balance



Archetype 1 | 1909

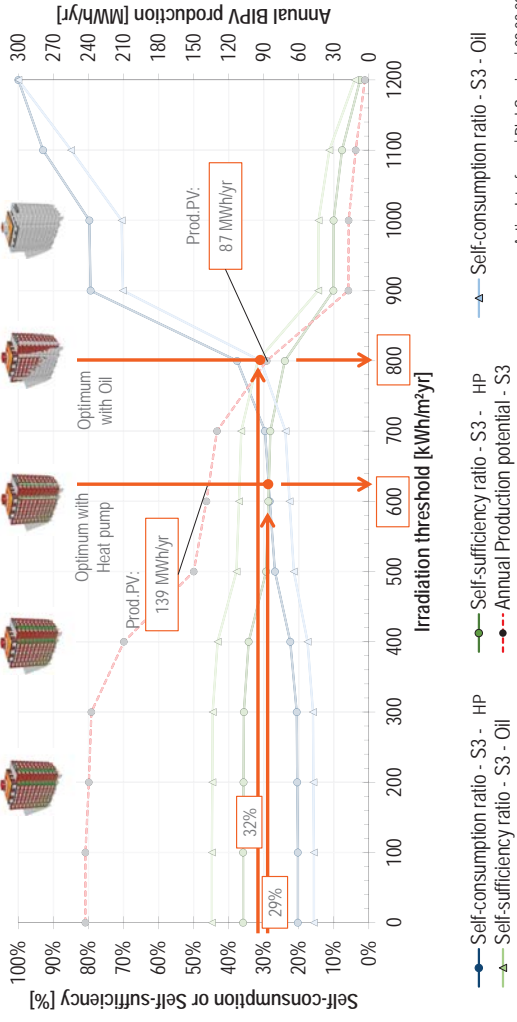
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Phase 4 | Optimization | S3 - Transformation



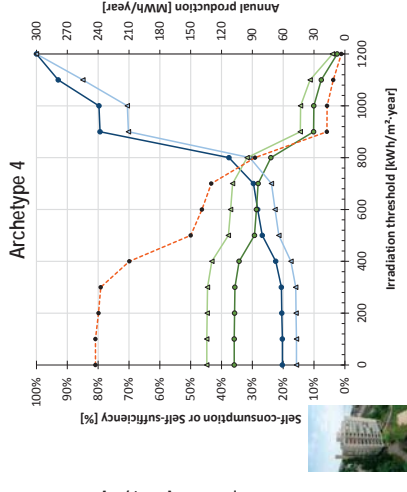
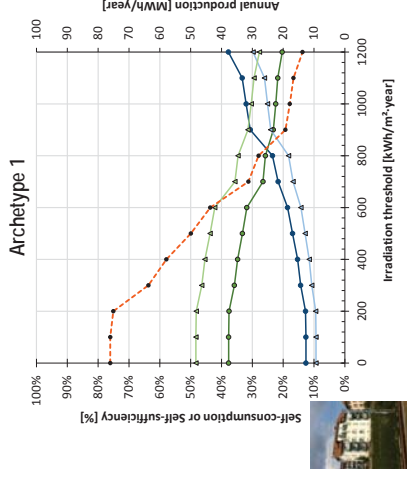
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Phase 4 | Optimization | S3 - Transformation



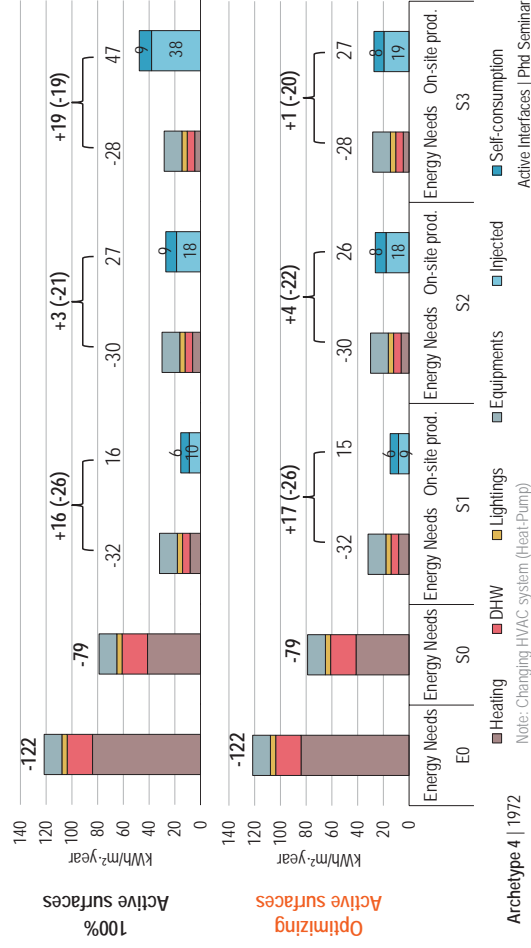
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Phase 4 | Optimization | S3 - Transformation



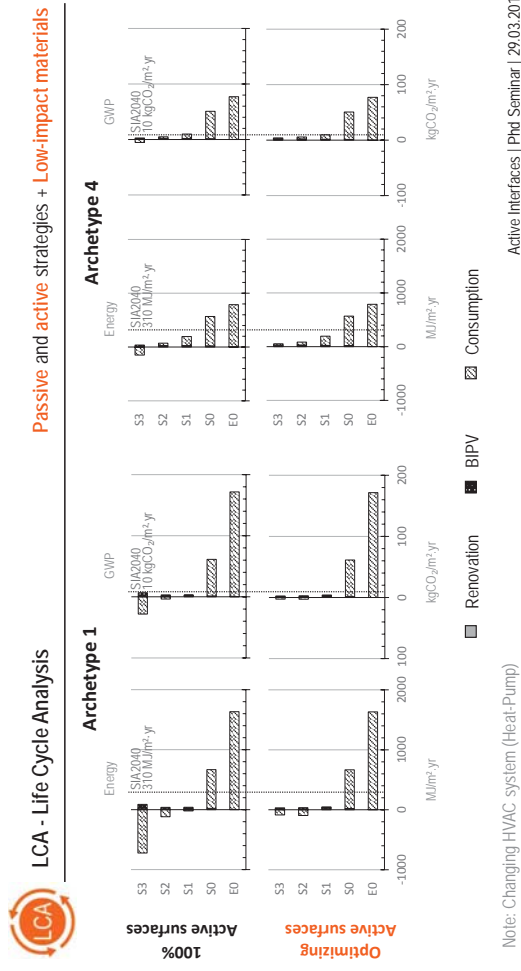
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Phase 4 | Multi-criteria assessment | Net energy balance



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Phase 4 | Multi-criteria assessment

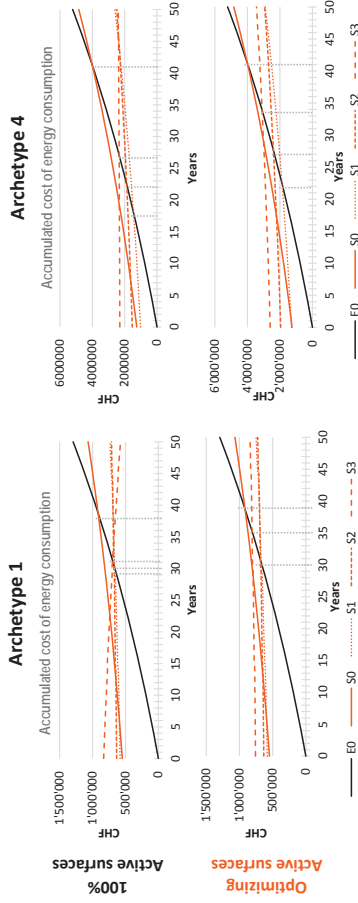


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Phase 4 | Multi-criteria assessment



LCC - Life-cycle cost



Note: Changing HVAC system (Heat-Pump)

Next step | Integration a PV battery storage system

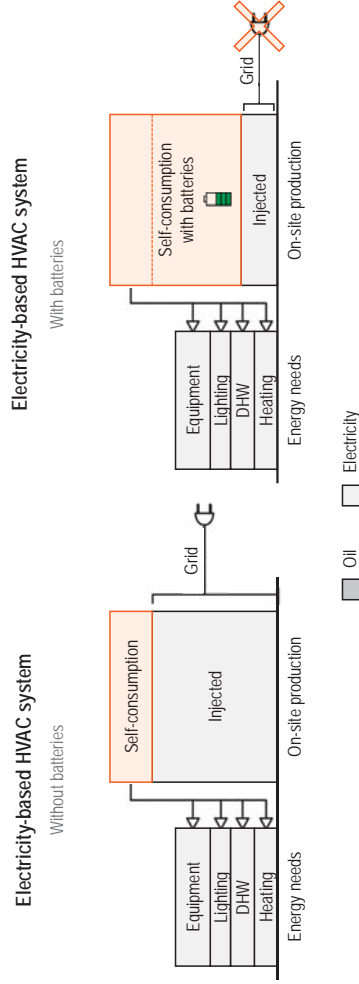
Annual results

Batteries capacity	Without batteries	With batteries
Average daily demand	→ 83 kWh	→ 57%
Needed capacity	→ 172 kWh	→ 53%
Number of batteries*	→ 15	→ 3 214 CHF/year
	→ 5 216 CHF/year	→ 3 214 CHF/year
Batteries payback	--	5 years

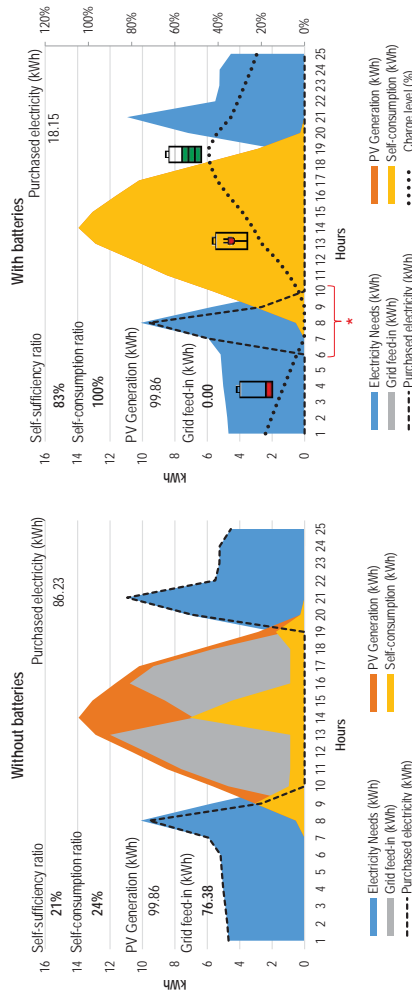


* Battery example: ROLLS 24V S480 480Ah C100

Next step | Integration a PV battery storage system



Next step | Integration a PV battery storage system





//// active
interfaces

Project 02 - Design

Architectural design strategies for renovation projects with BIPV optimizing self-consumption and self-sufficiency

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