Lucerne University of
Applied Sciences and Arts

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Technik & Architektur

PLUSQUA: Potential of the neighbourhood to reduce thermal and electrical peak loads

Forschung & Entwicklung
Zentrum für Integrale Gebäudetechnik
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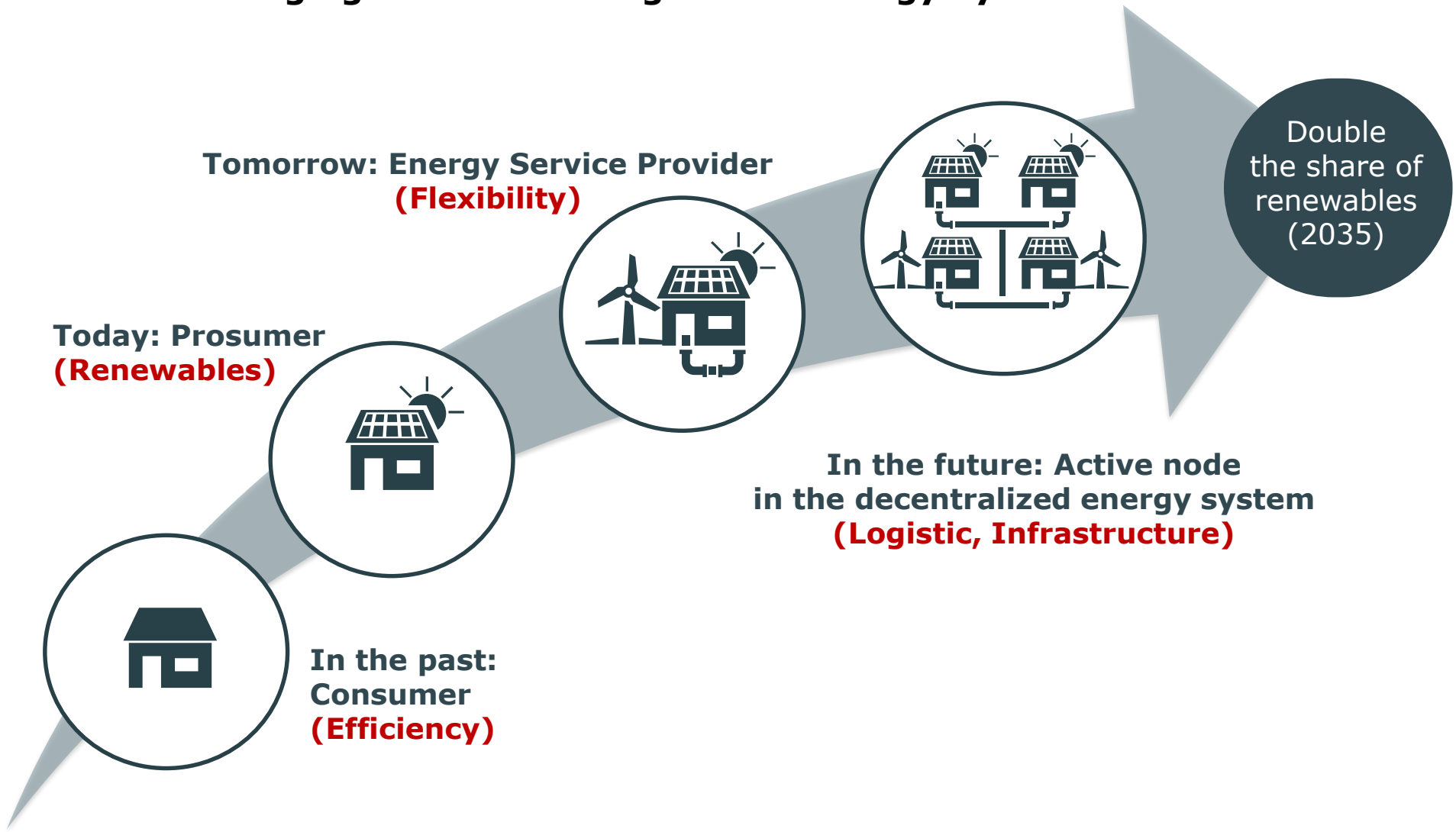
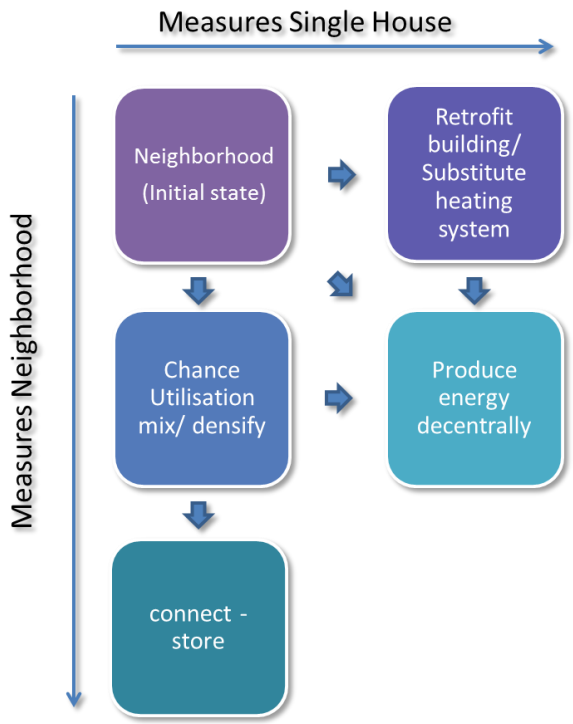
The Emerging Role of Buildings in the Energy System



Research question

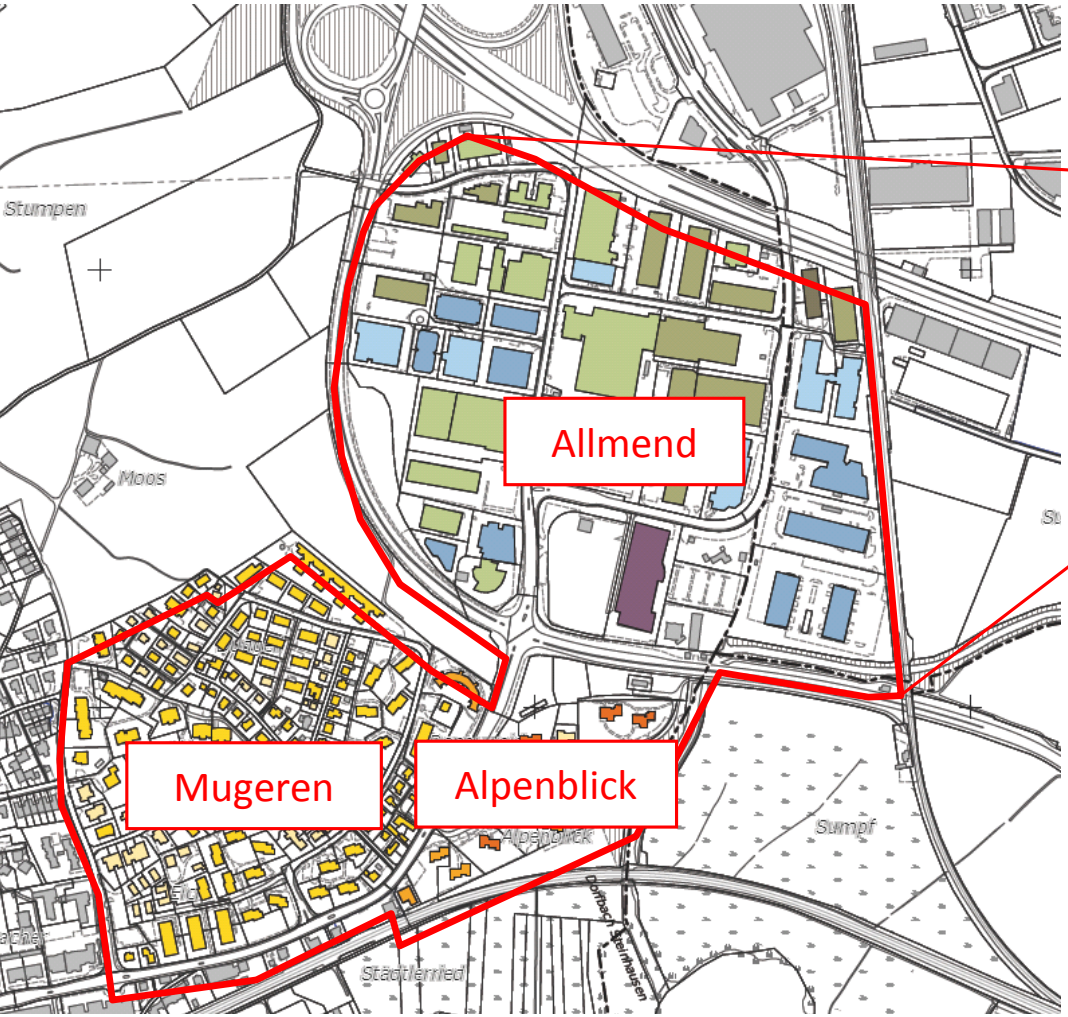
- ***To which extent is it possible to reduce the thermal and electrical peak loads at the neighbourhood's scale through technical and architectural measures?***

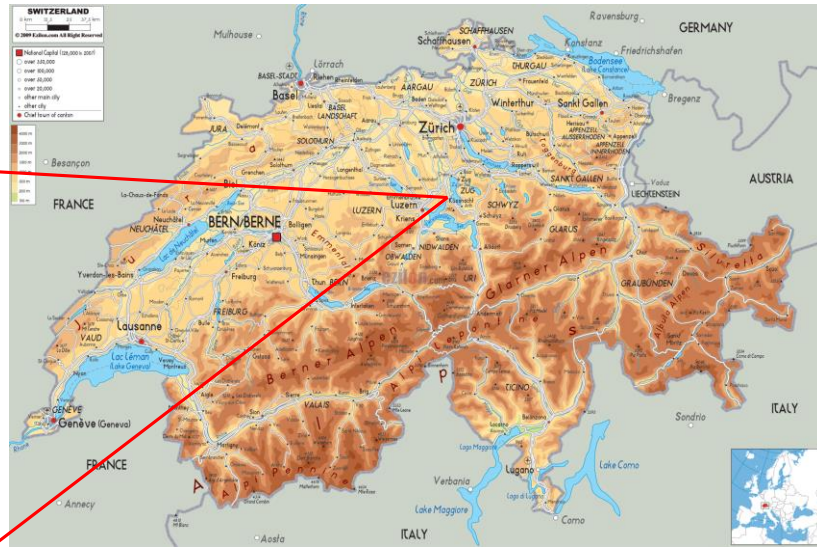


Scenarios

- **Utilisation mix**
- **Densification**
- **Efficiency (retrofit)**
- **Decentralized energy production**
- **Storage**

Pilot: Neighbourhood Cham «Ost»





Utilisation	Floors
Offices	1-2
Offices	3-4
Offices	>5
Residential	1-2
Residential	3-4
Residential	5-9
Residential	>10
Sales	1-2
Sales	>3
Industry	1-2
Industry	3-4
Industry	>5

Utilisation mix «Cham Ost»

Allmend

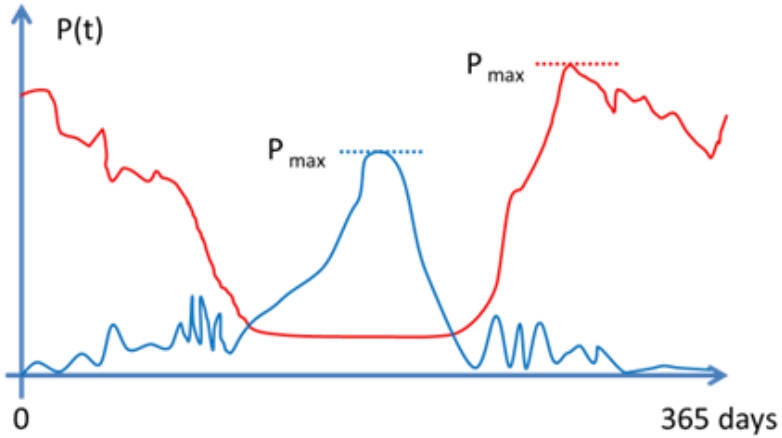
Mugeren

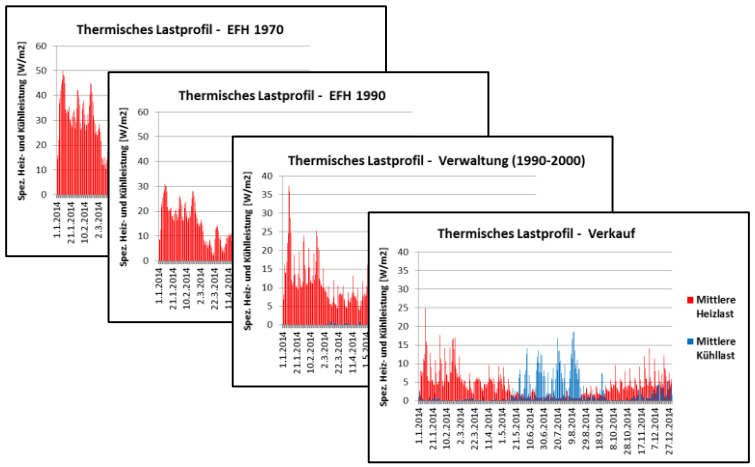
Alpenblick

Neighborhood	Category	Sum surface (ERA)	Share	Roof surface [m^2]
Allmend	Industry	131‘669 m^2	30%	53‘484 m^2
	Administration from 2000	42‘757 m^2	10%	7‘751 m^2
	Administration from 1990-2000	99‘616 m^2	23%	21‘038 m^2
	Commercial	19‘800 m^2	5%	10‘020 m^2
Mugeren	Residential from 2000	1‘225 m^2	0.3%	350 m^2
	Residential from 1990-2000	69‘483 m^2	16%	17‘947 m^2
	Residential until 1990	39‘858 m^2	9%	13‘505 m^2
Alpenblick	Residential until 1990	31‘470 m^2	7%	3‘652 m^2
Total = Cham «Ost»		**435‘877 m^2**	**100%**	**127‘747 m^2**

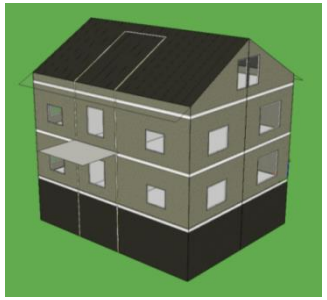
Simulation: Thermal loads

- IDA-ICE

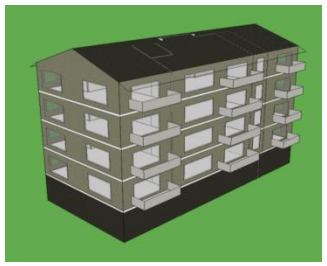




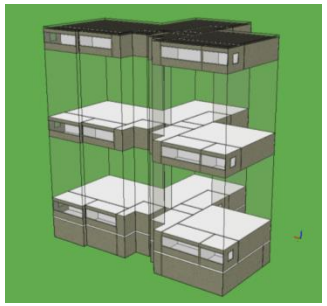
Single FH



Multi FH



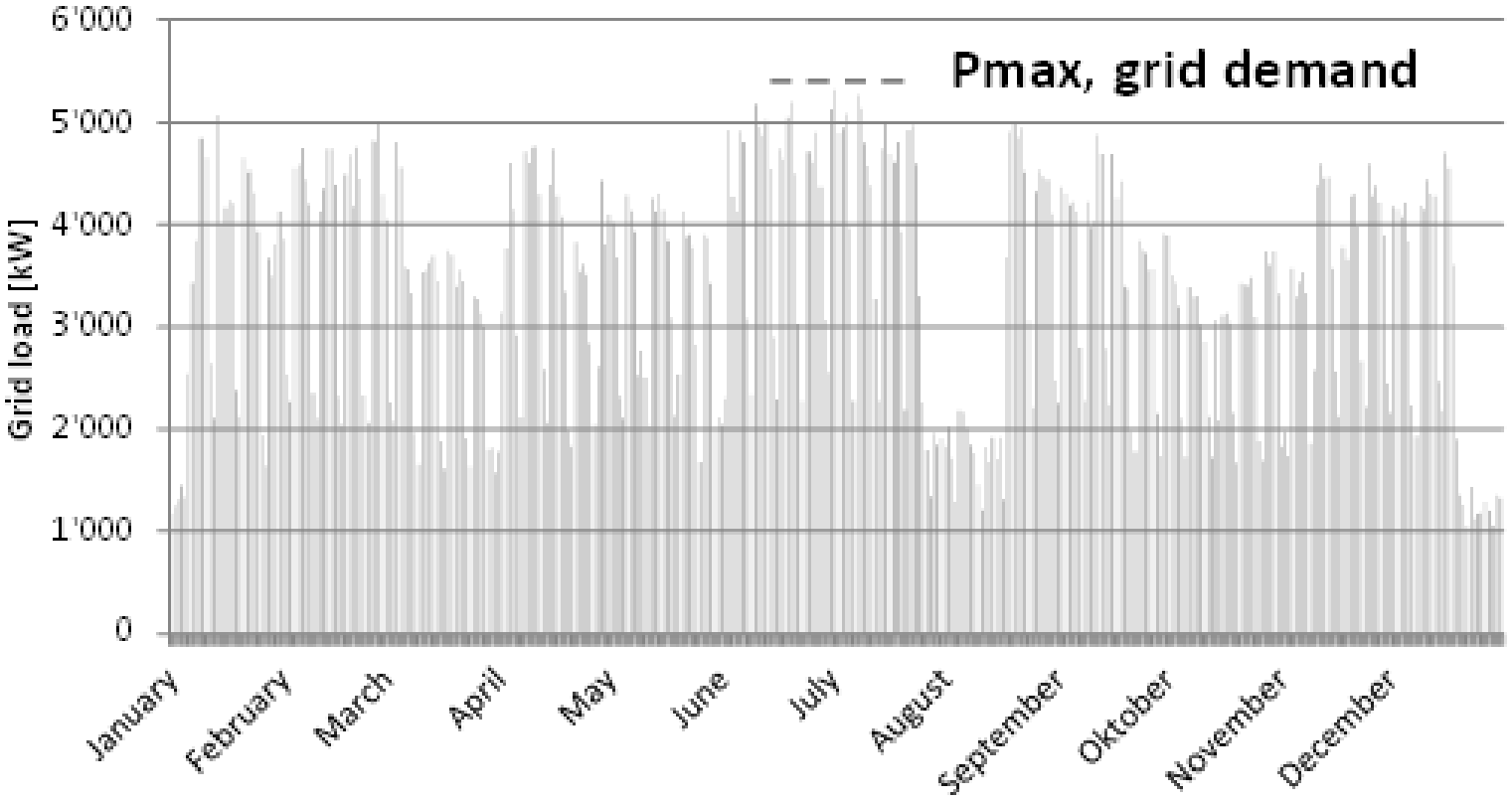
High-Rises



Industry

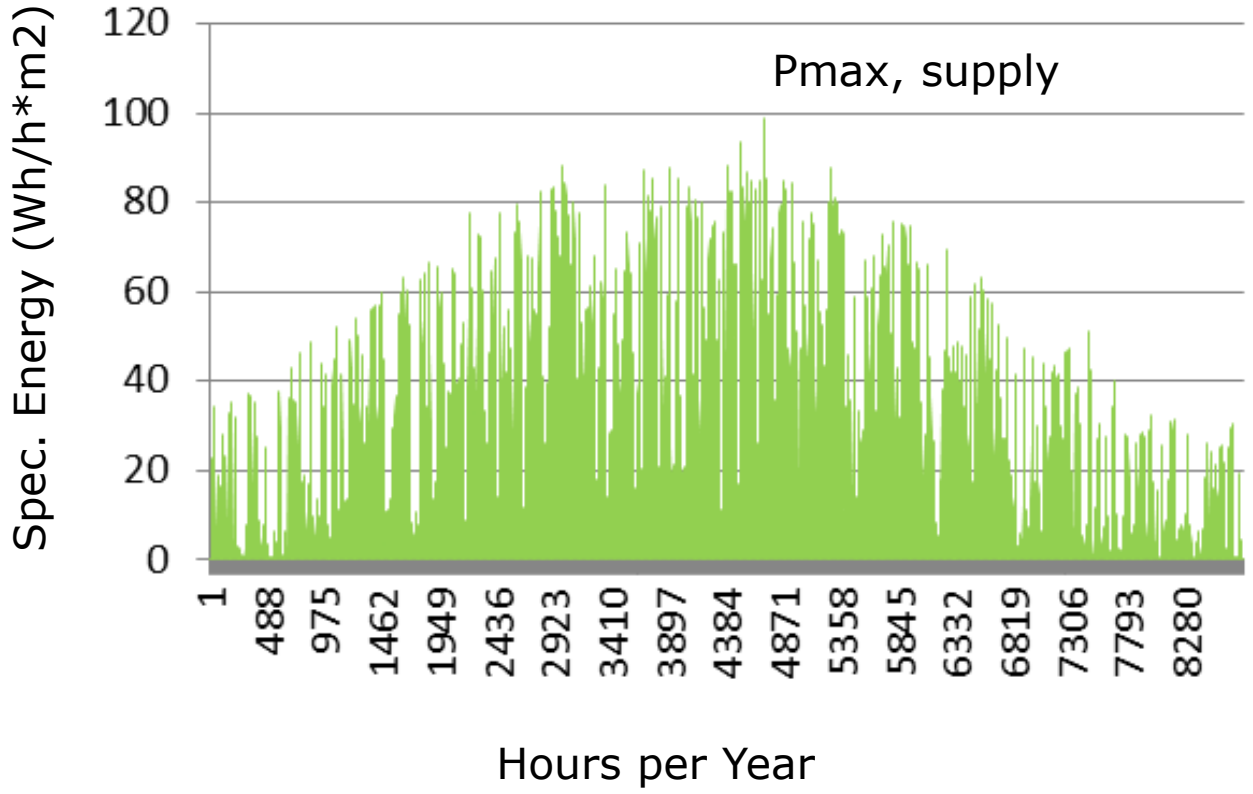
Simulation: Electrical loads

- Electrical demand loads from real measurements → Standardisation

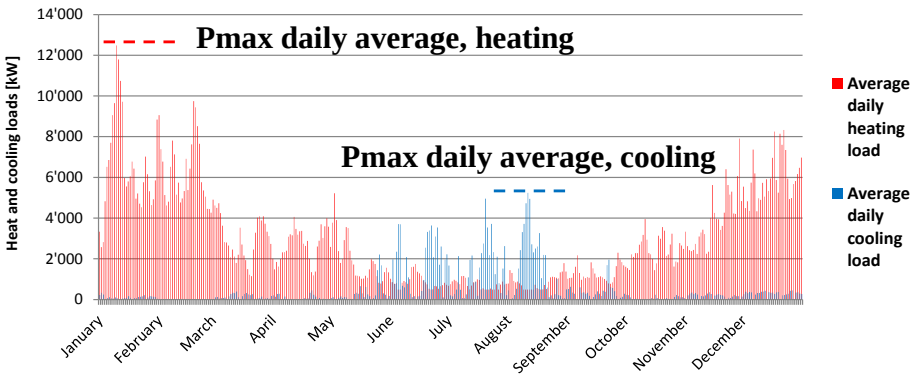


Simulation: Electrical loads

- Electrical supply loads from Polysun



Base Case: Thermal & electrical loads Pilot «Cham Ost»



Pmax, heating

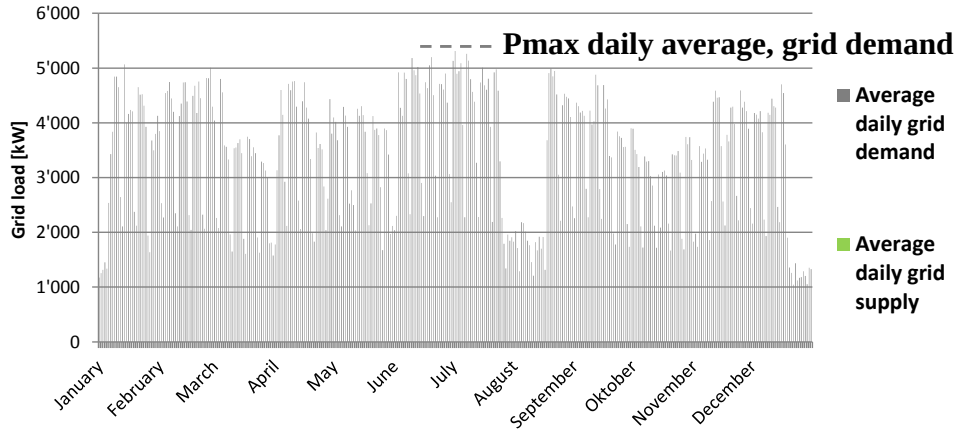
12.5 MW

Pmax, cooling

5.2 MW

Heating / Cooling demand

25.8 / 3.5 GWh



Pmax, grid demand

5.3 MW

Pmax, grid supply

0 MW

Grid demand / supply

27.7 / 0 GWh

- Cooling load about 40% of heating load.
- Cooling energy demand about 10% of the heating demand
- Summer break (Industry holiday)

Optimisation: Scenarios

- **Utilisation mix:**
  50% ERA offices => Residential of the same construction period

- **Densification:**
  +50% ERA utilisation mix => standard of new buildings

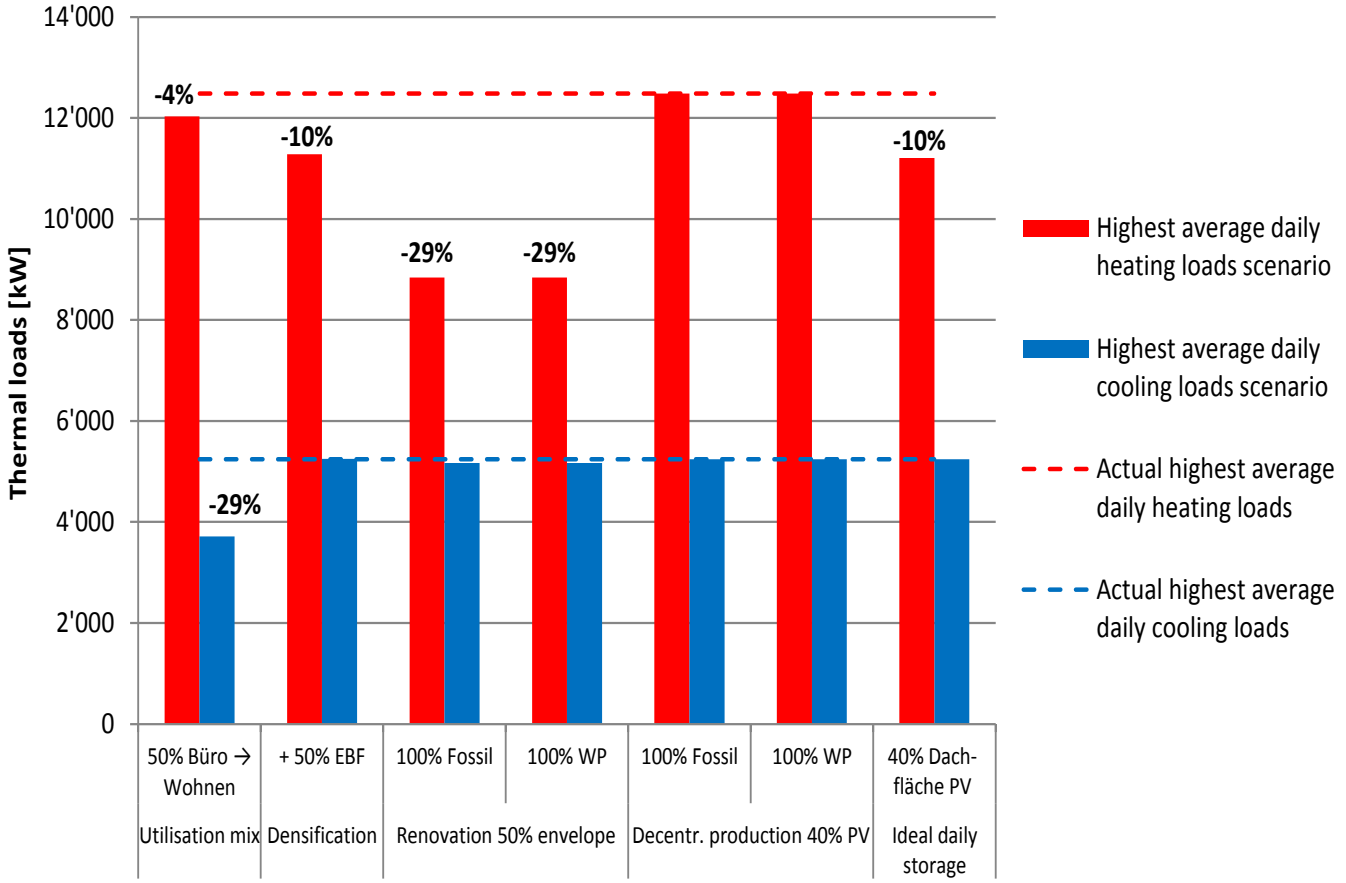
- **Efficiency (retrofit):**
  50% ERA old buildings (1970) => new buildings (2010)
  - once with 100% fossile energy carriers
  - once with 100% heat pumps

- **Dezentralized electricity production:**
  40% roof surface with PV plant
  - once with 100% fossile energy carriers
  - once with 100% heat pumps

- **Storage:**
  Ideal thermal and electrical storage systems

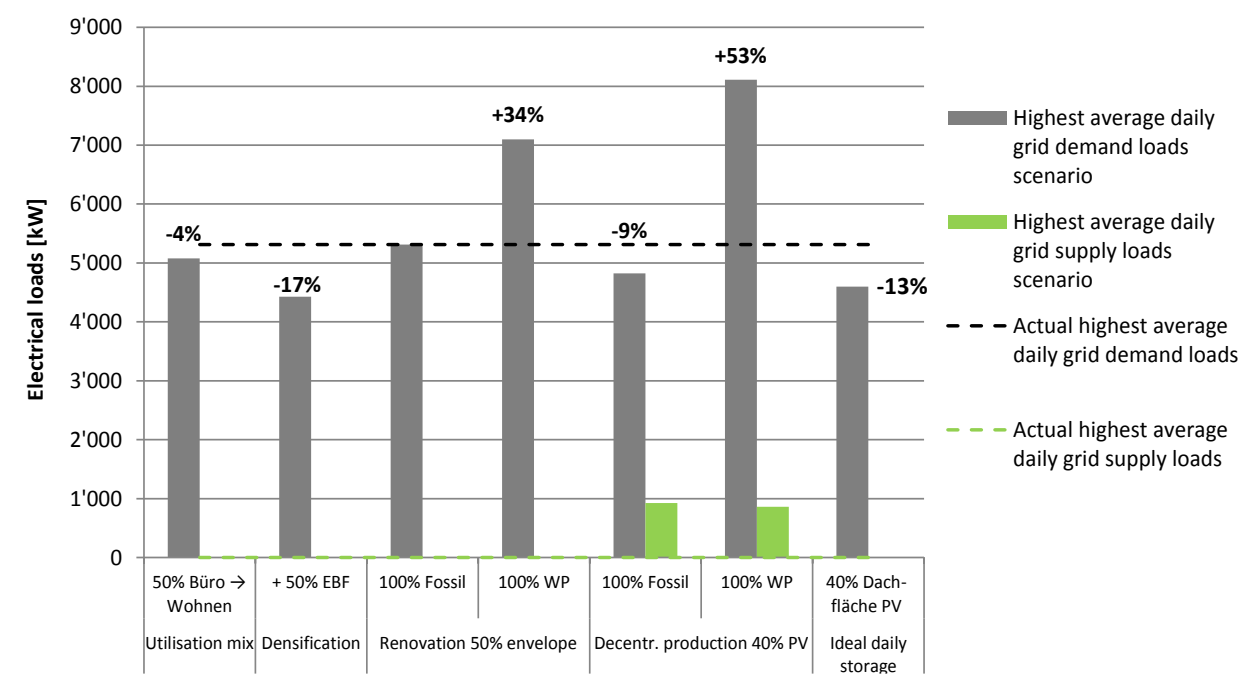
Results (thermal loads)

- Spatial planing measures can reduce the thermal load up to 10%.
- Retrofit has the highest potential to reduce heating loads.



Results (electrical loads)

- Densification in the neighbourhood brings a reduction of the specific electrical loads of 17% (because of industry).
- The use of heat pumps increases the electrical loads up to 53%, despite the decentralized production of electricity through PV.
- Use of PV plants without load management reduces loads from grid up to 9%
- Daily storage only -4% reduction



Conclusion

- The renovation of the buildings has the greatest effect on the reduction of heating loads (-30%), but ... the retrofit rates are low and the costs for refurbishments are high.

- In the future, the use of heat pumps can increase the current load by a factor of 1.5. Without load management and long-term storage for PV power, the highest loads per year can not be substantially reduced.

- A great load reduction can be achieved with regard to spatial planning measures:

  Through densification & changing utilization mix
  → reduction of thermal loads up to 10%
  → electrical loads up to 17%.