RESEARCH AND DEVELOPMENT

Is net zero energy possible for high-rise buildings?

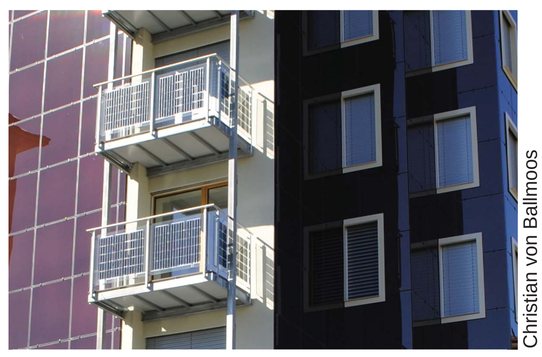
20TH INTERNATIONAL PASSIVE HOUSE CONFERENCE 2016
Darmstadt (D), 22-23 April 2016

Net-ZEB for high-rise buildings

A typical net zero energy building is a single family or small apartment building with sufficient area available on the roof for a PV-system large enough to match the annual load with its electricity yield. However, can large buildings of up to 40 levels also achieve a net zero balance for HVAC only and/or achieve net zero energy building status?

Swiss Solar Prize 2013

Refurbisment Romanshorn,
Swiss Solar Prize 2013
(Viridén + Partner AG)



Christian von Ballmoos

Refurbisment Chiasso,
Swiss Solar Prize 2014
(Gasser Gebäude AG)

Case studies

A wide range of parameters is investigated in regard to their impact on the zero energy balance (**base variant**):

- climate (**Bern**, Davos, Lugano),
- heat demand (**60%**,110% standard for new building),
- heating system (**gas system**, district heating, heat pump),
- thermal losses for storage and distribution for heating and domestic hot water (**10%/40%**, 50%/60%),
- energy load for electric devices and lighting (high, **low**),
- different distances and heights of neighboured buildings
- orientation of the building (stretched building: **S/N**, O/W),
- self-shading due to balconies (multifamily dwellings only),
- size of useful PV areas (multifamily dwellins only) and
- over all performance of the PV-system (**14%**, 22%).

The analysis presented here is based on the simulation of two multifamily dwellings and two office buildings, one each with a square and a stretched footprint.

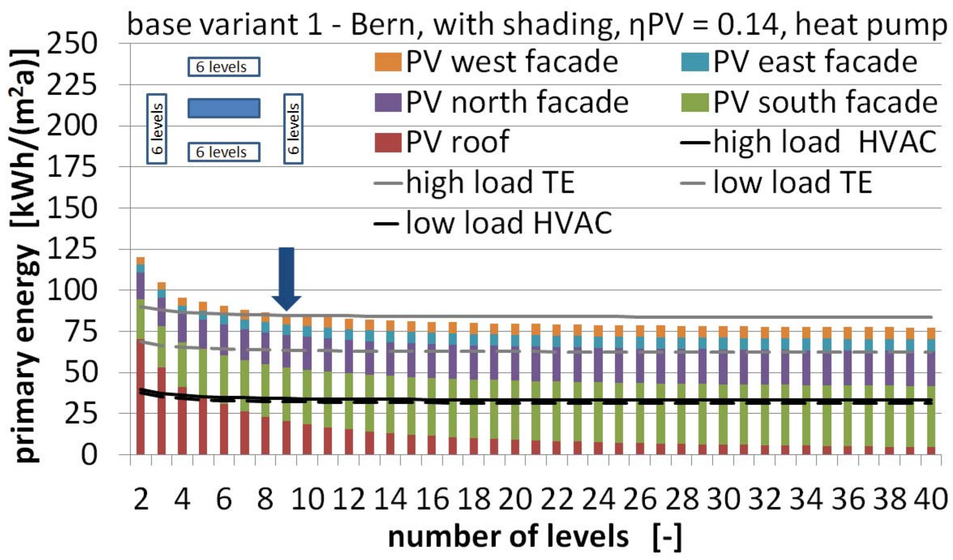
Results

The main results can be summarized as follows:

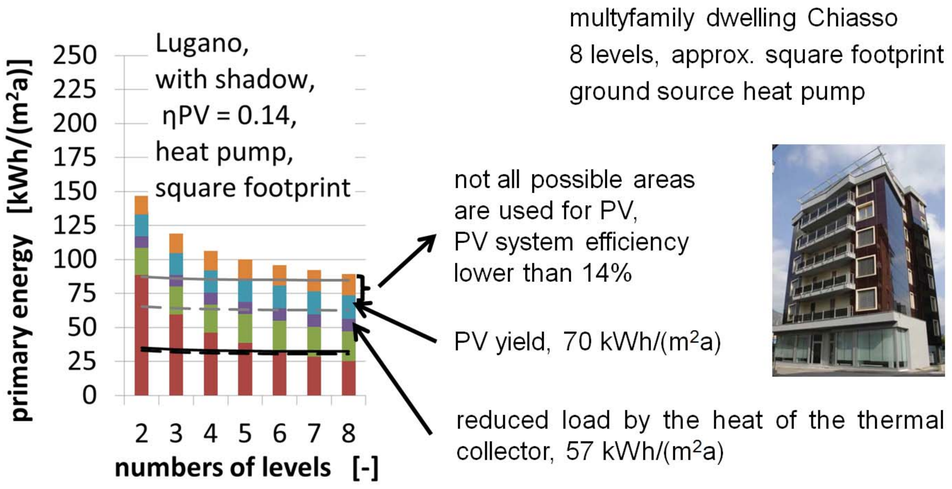
- net zero balance for HVAC only can be achieved for up to 40 levels for all variants studied but one
- The five main parameters in regard to achieving a net zero energy balance are
  - low heat demand
  - efficient electric devices and lighting,
  - the type of heating system,
  - the actually available area for PV and
  - the overall efficiency of the PV-system.
- As the number of levels increases, the fraction of the PV yield attained from the roof decreases. It follows that:
  - a small change in energy demand or PV yield have a large impact on the net zero balance
  - high-rise buildings need to be more energy efficient than low-rise buildings.

Boundary conditions

- all values are primary energy (Swiss factors: gas: 1.0, district heating: 0.6, electricity/PV yield: 2.0)
- multifamily dwellings:
  low/high load for domestic electricity: 16/25 kWh/(m²a)



Example of load and PV yield depending on the no. of levels.



Comparison of multifamily dwellings in Chiasso and basic variant multifamily dwellings with square footprint, climate Lugano and ground source heat pump.

Passive House Classification

Renewable primary energy demand and classification for a multifamily dwelling with a stretched footprint, 40 levels, 16 kWh/(m²a) domestic electricity and different heating systems (climate Bern).

Renewable primary energy demand and classification.

	renew. primary energy demand		classification
	$kWh_{PER}/(m^2a)$	$kWh_{PER}/(m^2_{ground}a)$	
gas system	86	1550	-
district heating	66		-
ground source heat pump	41		plus

Conclusion

High-rise buildings of up to 40 levels can not only achieve Passive House status, but also a net zero balance for HVAC only and even net zero energy building status. With further improvements in the efficiency of devices, lighting and PV-systems, reaching „zero“ energy will become easier.

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The project „Möglichkeiten und Grenzen von grossen Nullenergiegebäuden (Grenznull)“ is funded by the Swiss Federal Office of Energy SFOE, www.bfe.admin.ch (SI/500950-01).