



# Annex 49

## Design and integration of heat pumps for nZEB

**Heat pumps can become the standard building technology for nearly Zero Energy Buildings (nZEB). Due to the high performance of heat pumps, nZEB can be achieved cost-effectively. Furtheron, heat pumps can increase on-site electricity self-consumption and unlock flexibility potentials by smart controls. In this way heat pumps become the backbone of a future sustainable and renewable built environment and energy system.**

### Key Findings

Heat pumps will become the key technology for nZEB due to following results of Annex 49

- 1 Heat pumps reach high performance in nZEB. More than 15 partly long-term monitoring projects in Annex 49 confirm high seasonal performance factors up to an SPF of 5.5 for all building services which facilitate to reach the nearly Zero Energy Building requirements.
- 2 A focus of Annex 49 monitoring projects was on larger buildings where the nZE balance is more challenging due to restrictions for on-site energy production. Heat pumps can enable to achieve nZEB also for larger buildings. nZE requirements in turn will be a market driver for heat pumps.
- 3 Simulation studies on heat pump and storage integration in Annex 49 yield the result that self-consumption and energy flexibility for connected grids can be notably increased by smart control

both with rule-based or more advanced model predictive control strategies.

- 4 Heat pumps can cover all loads in nZEB with one generator. Developed prototypes in Annex 49 were dedicated to highly compact integration of all building services of space heating and cooling, DHW and dehumidification driven by on-site renewable energy production.

By the high building performance of nZEB with heat pumps and the integration with renewable on-site production, nZEB can be realised energy-efficiently and cost-effectively. Thereby, built environment will become a resilient and sustainable backbone for the energy system, which can supply itself with renewable energy and offer services to connected thermal and electric grids. Heat pumps are the key technology to connect the electrical and thermal load and production and unlock flexibility potentials.



Figure 1: Five-storey multi-family plus energy building monitored in Annex 49



Figure 2: Results of storage integration variants concerning PV self-consumption and grid support

## Background

Buildings make up about 40% of the primary energy consumption and CO<sub>2</sub>-emission in many countries. Therefore, buildings are a key potential to fulfil climate protection targets. By Jan 1, 2021, all new buildings in the EU have to comply with nearly Zero Energy requirements. Other countries worldwide will introduce nZEB as future building standard until 2030. Therefore, building technologies for nZEB are of high importance. Due to their unique features, heat pumps are a well-suited technology for nZEB, and can establish as standard systems for nZEB, offering a huge market potential. Integration and design of heat pumps for nZEB were investigated and developed in Annex 49 to promote heat pumps for nZEB application.

## Objectives

The objectives of the Annex 49 were to

- » Characterise the state-of-the-art of nZEB introduction and heat pump application in nZEB in the participating countries
- » Analyse and develop integration options of the heat pump and other building technologies, in particular regarding integrated operation to cover all nZEB loads with the heat pump.

- » Gather experience with real heat pump operation in nZEB, in particular of larger buildings for residential and non-residential application to approve the balance, characterise heat pump performance and identify typical optimisation potentials to improve heat pump operation.

- » Investigate design and control of heat pumps for nZEB application, especially regarding renewable energy and storage design and control for enhanced self-consumption, demand response and grid support by the heat pump and building operation.

- » Further develop and test highly integrated heat pump prototypes as core component in HVAC systems for nZEB.

## Further information

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- Participating countries: Austria, Belgium, Germany, Norway, Sweden, Switzerland, United Kingdom, United States of America
- Publications: Final reports of Annex 49 and Executive Summary of Annex 49, available at <https://heatpumpingtechnologies.org/publications/>
- Internet: [Link to Annex 49](#)