NEW TOWN HALL IN FREIBURG

Concept, performance and energy balance after one year of monitoring of a large net plus-energy building

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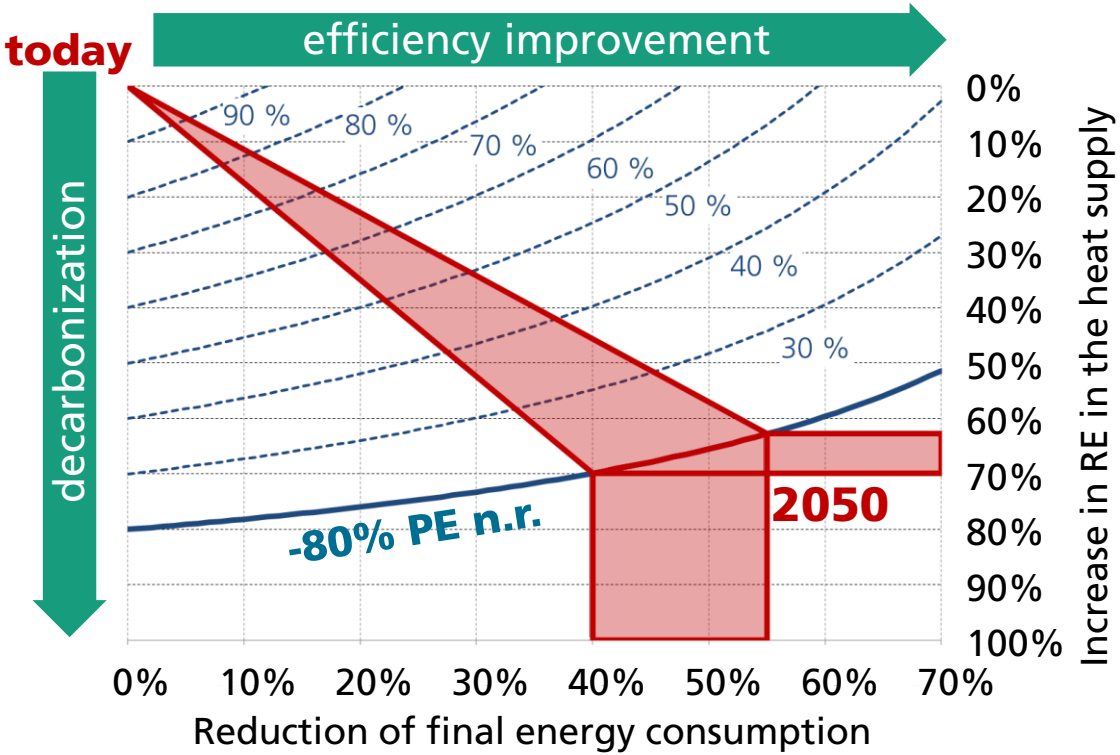
AGENDA

- Backgrounds and challenges
- New town hall in Freiburg
- Monitoring results
  - Overall performance
  - BIPV performance
  - HVACs performance
- Lessons learned and outlook

Backgrounds and challenges

Target: climate-neutral building stock 2050



- Goal of the government: "Climate-neutral building stock" by 2050
- Interaction of demand reduction and increase in RE share
- 300.000 of the approx. 1.7 million non-residential buildings in Germany are municipal property

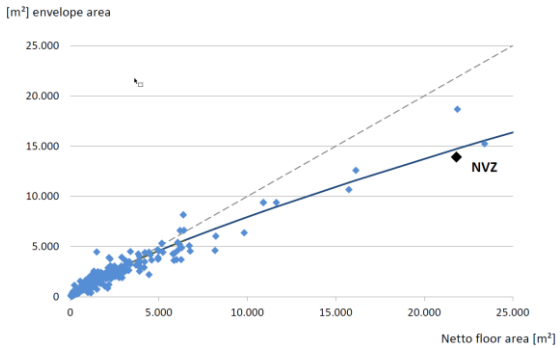
Backgrounds and challenges

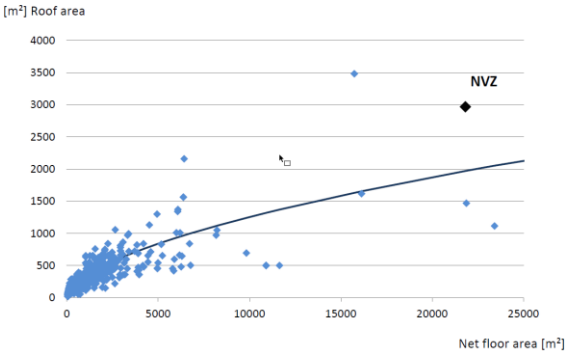
Plus energy balance is challenging for big buildings

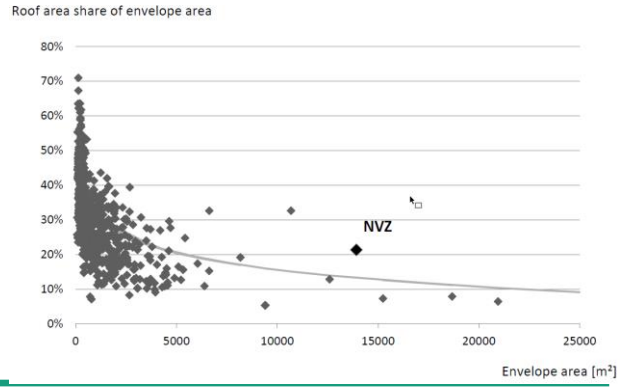
- **PE compensation** over installed PV on the building **limited by available envelope (facade + roof)**

➢ **Low specific PV-gains** (kWh/m²$_{ngf}$.a) despite of solarization of facade and roof

➢ **Need for a very efficient heat supply and demand reduction**





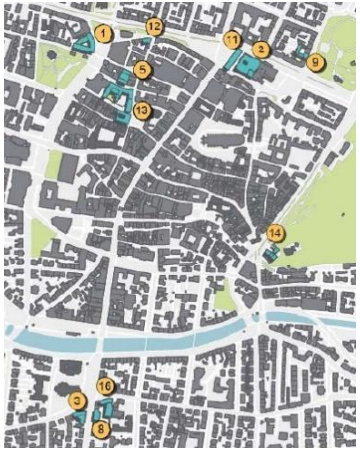


Data source: tabula building typology

New town hall Freiburg

Motivation

- The city of Freiburg is striving to reach **climate neutrality by 2050**
- Initial situation: **distributed locations** of 16 different offices
- Tender as competition in 2013 for a building with **net-plus primary energy balance** for the **energy demand of technical systems (EnEV)**
- **2014** start of construction of the first three construction phases and handover in **Nov 2017**



Pictures: Stadt Freiburg, A. Schmidt
Model: ingenhoven architects,

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Building physics and services

- Netto ground floor area: 22.650 m²
- U_{opaq}= 0,1 W/m²K; U_{transp}= 0,8 W/m²K, H_T'=0,45 W/m²K
- PV: **440 kWp** roof; **220 kWp** facade
- Heating and Cooling: **heat pumps**, PV-T, gas boiler for peak load, **borehole heat exchanger for cooling, TACS** + heating/cooling ceiling
- Primary energy demand (EnEV): **61.1** kWh/m²a

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The building

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©ingenhoven architects H.G. Esch

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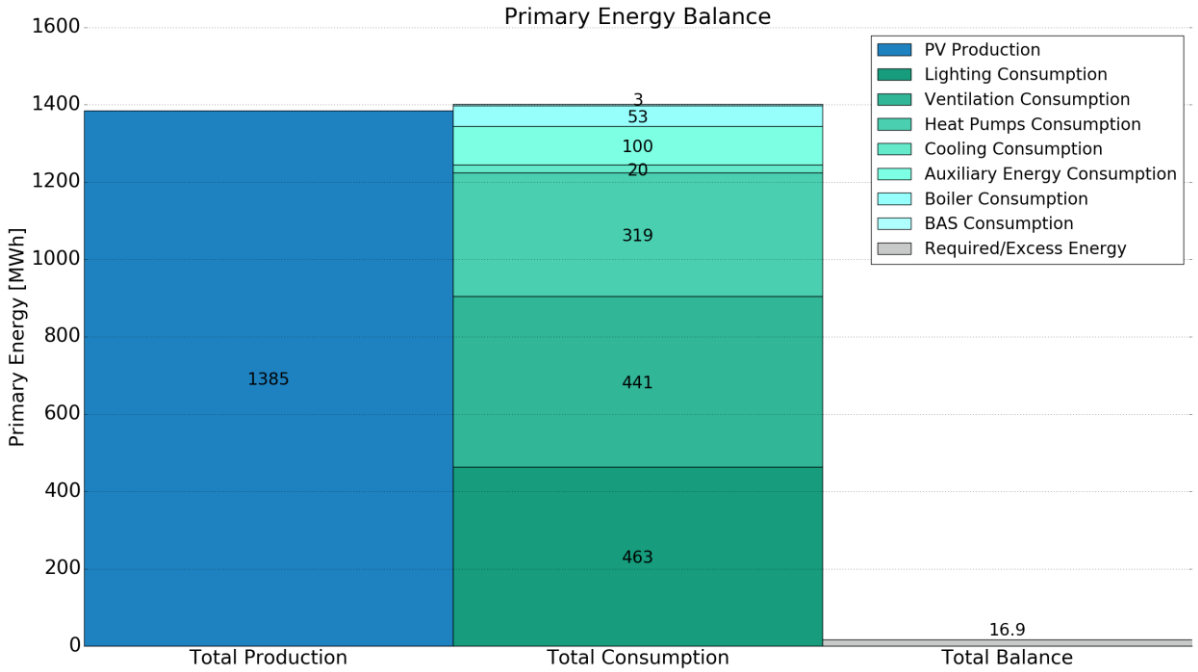
Primary energy balance 2018



- Consumers:
  - Lighting 33% (constant value)
  - AHUs: 32%
  - Heating: 23%
  - Cooling: 2%
- **Slightly negative balance** (+ 16.7 MWh)
- Concept robustness need being validated in the **long term**

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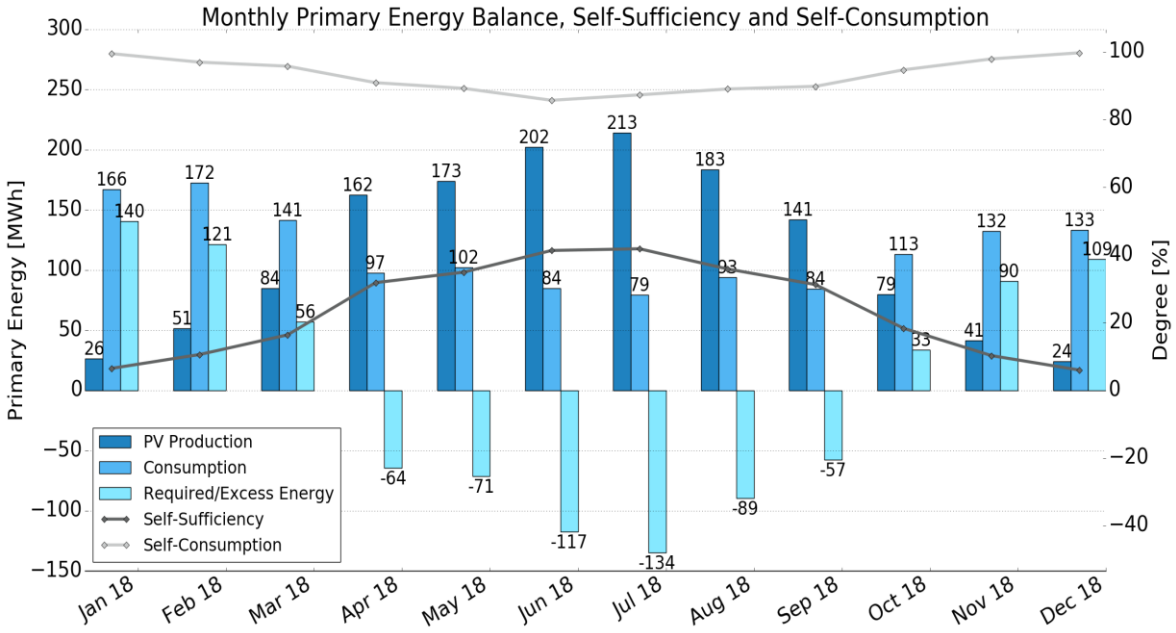
Primary energy balance 2018 – monthly basis



- Surplus from Apr. to Sept.
- Deficit from Oct. to Mar.
- For the whole building:
  - Self-consumption: 92.2 %
  - Self-sufficiency: 23.7 %

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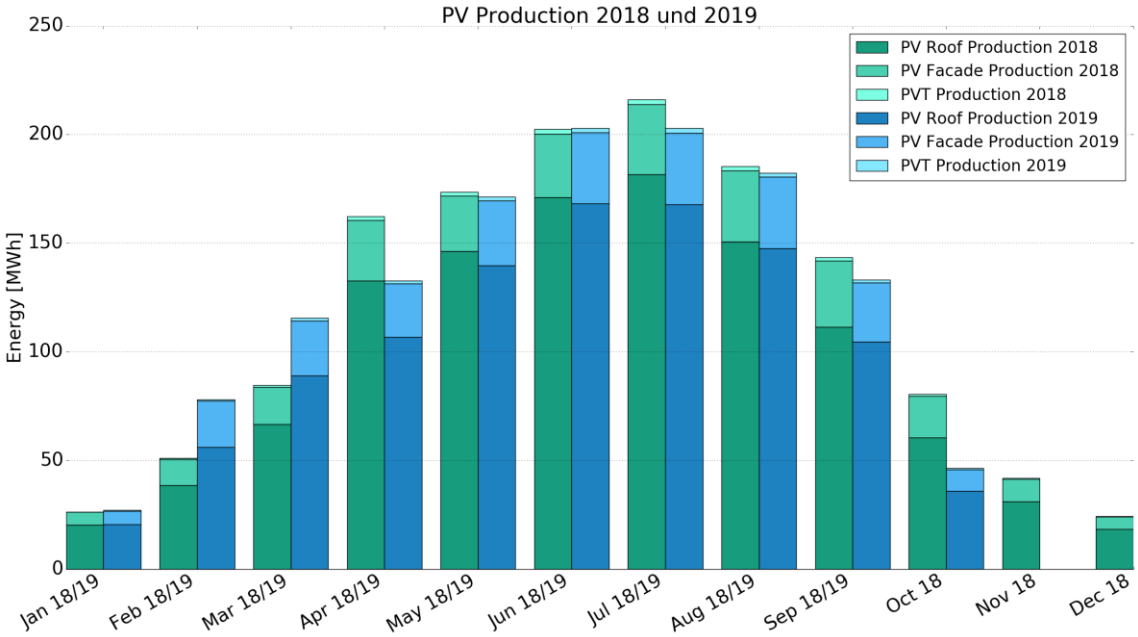
Monitoring – photovoltaic plant



- PV production 2018:
  - 554.1 MWh (final energy)
  - 25.4 kWh/$m^2_{NFAEnEV}$
  - Roof: 81 %, 982 kWh/kW_p
  - Facade: 18%, 448 kWh/kW_p
  - PV-T: 1%, 869 kWh/kW_p
- Production loss of ~ 5..10 MWh due to inverter failure

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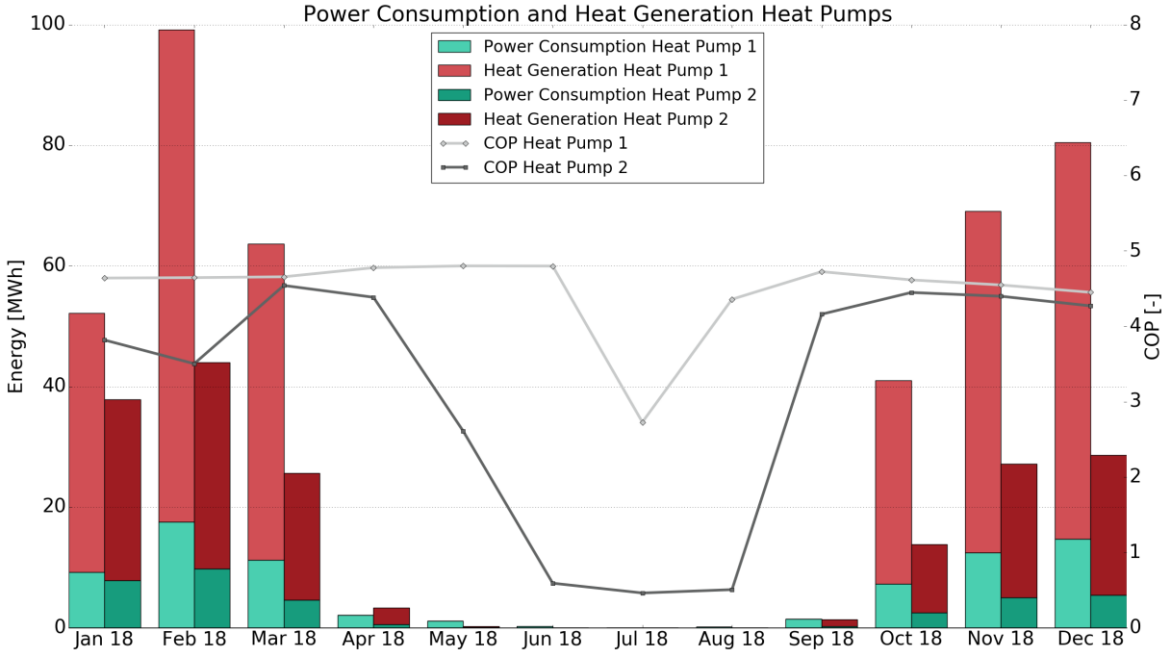
Monitoring – HVACs



- Heat generation:
  - Heat pumps: 87%
  - Gas boiler: 13 %
- Heat pump performance (target SPF=4.8):
  - HP1: SPF = 4.6
  - HP2: SPF = 4.0
- Cold generation:
  - SEER = 45.0

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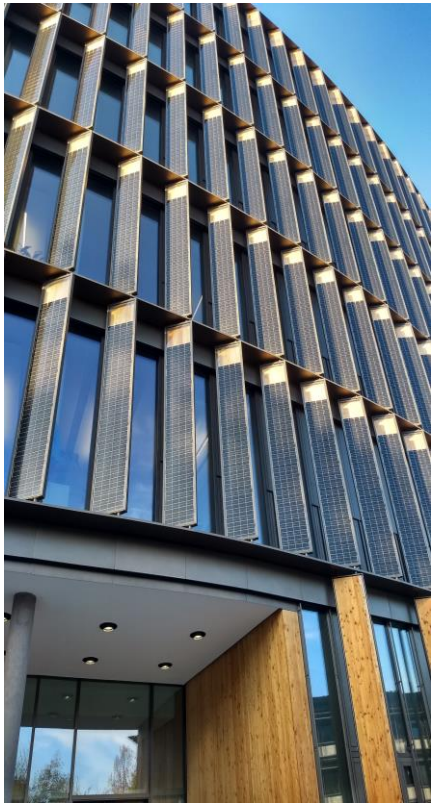
Lessons learned and outlook

- First year of monitoring showed that:
  - The **plus-energy target** has **almost** been reached,
  - The **cooling system** with water brine is **highly efficient**,
  - **Optimization potentials up to 15%** in the operation of the **heat pumps** and **air-handling units**,
  - **BIPV** systems are **indispensable** for large plus-energy buildings,
- **Design** of the **second building** rely on the current monitoring results
- **Ongoing monitoring** is required to assess the robustness of the concept in the long term → **See you at NZEB+ in 2021!**



Thank you for your attention!

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