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# SEMI-AUTOMATED BUILDING PERFORMANCE EVALUATION

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## Highly energy efficient

Space heating demand/living area

new build      15 kWh/(m<sup>2</sup>a)

retrofit        25 kWh/(m<sup>2</sup>a)

Detailed monthly energy balance model

Quality assurance design to completion

# Energy balance model PHPP



## Design & Verification tool

Based on monthly method in EN 13790 / ISO 53016

Heating/cooling/dehumidification

Lighting and all electrical energy use

Occupancy

Building certification: Third party design review

Airtightness test

Site supervision

**Verify building performance in the field**

**Inform systematic commissioning**

**Optimise performance as standard procedure**

**Exploit energy model**

**update with measured boundary conditions**

- **Weather vs. climate**
- **Actual indoor conditions**
- **Actual occupancy and internal heat gains**

Temporary

Inexpensive

Non-intrusive

Easy to use for non-experts (e.g. Architects)

Acceptable measuring uncertainty

temperatures  $< 0.3$  K



## Room conditions



Elsys.se *ERS CO<sub>2</sub> lite*

Ca 80 x 80 mm<sup>2</sup>

Temperature  $\pm 0.2$  K

Rel. Humidity  $\pm 2$  %

CO<sub>2</sub>  $\pm 50$  ppm  $\pm 3$ %

## Pulse counters for meters



Elsys.se *ELT 2*



BelSenso FM432e

## Weather



Specs:

0.2 °C typ

1.5 % RH

1.5 hPa

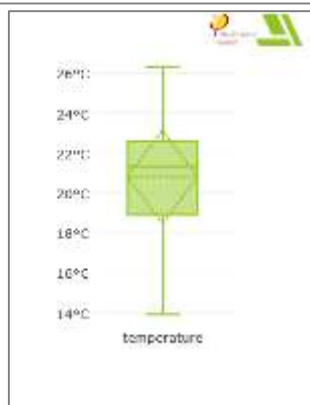
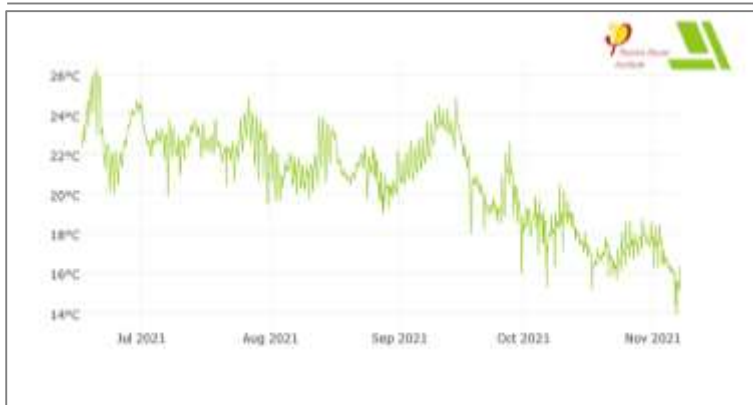
5% daily total Irradiation

^^^ not ideal

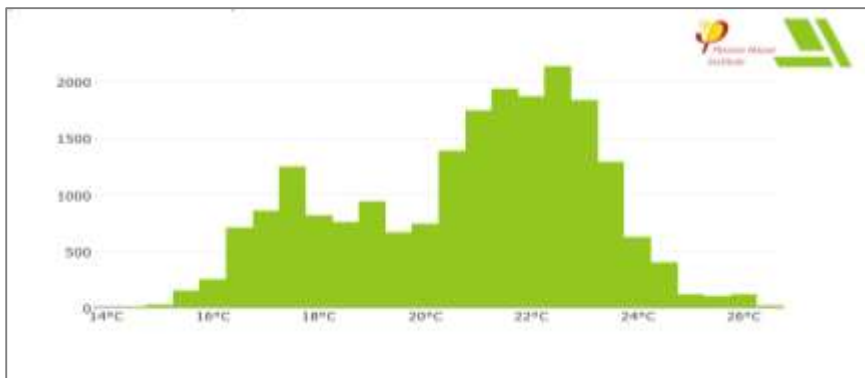
<https://www.baranidesign.com/meteohelix-pro-weather-station>



# Visualisation and Preprocessing on-line



Threshold	Hours
<15	3
<16	36
<17	268
<18	603
<19	866
<20	1111
>25	46
>26	6
>27	0
>28	0
>29	0
>30	0



**Building**

**Zone (e.g. flat)**

**Room**

**Sensor**

**Area weighted averaging**

# Updating the energy model

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Monthly weather data

Monthly mean indoor conditions

Monthly mean internal heat gains, occupancy, ...

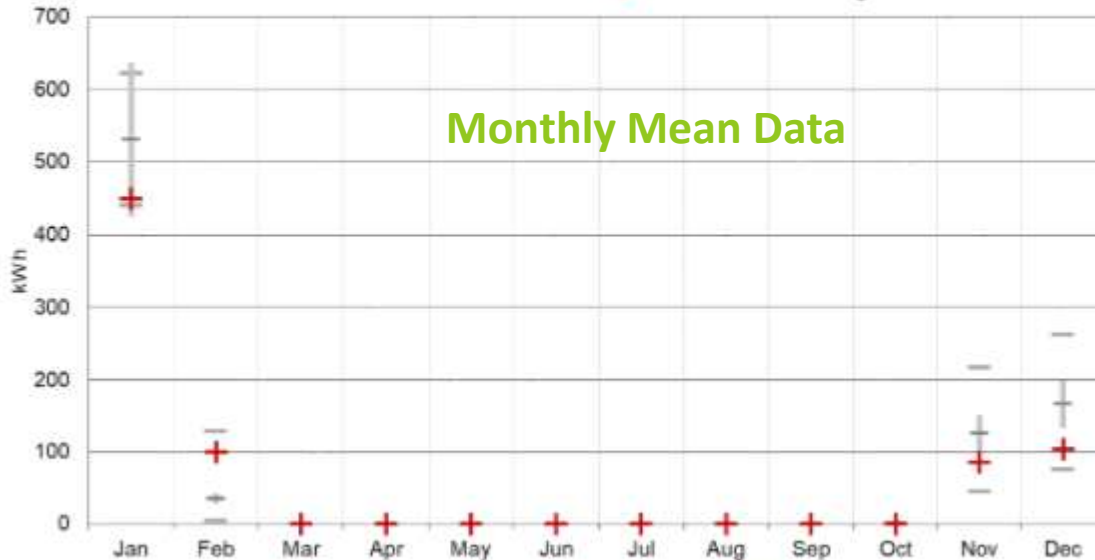
Automatically transferred into energy balance

Expected performance figures

# Results Space Heating

## Heating: Comparison of measured value and PHPP calculation

- PHPP: Plausibility boundaries
- PHPP calculation: expected amount (+ error indicator)
- + Measured values for heating



End-of-terrace Passive House 156 m<sup>2</sup> treated floor area, Germany



Passive House with PHPP Version 10.3



<http://tribblegryntiles.com/road/free-cardboard-tin-can-packaging-mockup-psd/>

# Thanks for your attention



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