nZEB as an active element of the energy system

First findings II .

Jeseník, February 2017

Cyril Svozil

FENIX

Office center - a building with nZEB parameters
A fully electrified building as an active element of the grid

Construction commenced –10/2015
Construction completed – 05/2016

Cooperation between a 7.2 kWh rooftop PV system with a 26kWh home battery and the energy supply network

Expected yearly energy consumption UCEEB – approx. 27 000 kWh
Usage of energy from building's own PV system – 100% used PV – 7 200 kWh
Coverage of total energy consumption from own production PV - approx. 26 %
Charging of battery from the PV system and from the network in a controlled way for a maximum period of 4 hours/24 hours
Expected period of controlled autonomous operation - 4 – 7 hours/day
Expected period of reduced stable consumption (2kW) - 6 – 9 hours/day
Checking of the option to use the building to control the ¼ hour maximum.
A working group was set up – technical supervision – UCEEB – Czech Technical University, as well as the Ministry of Industry and Trade, the Ministry of the Environment, the Energy Regulatory Office and ČEZ-ESCO

Current situation:

- It appears so far that the total yearly electricity consumption will be lower than expected despite the fact that this year´s winter has been significantly subnormal as far as temperatures are concerned.

- Small alterations to system settings are still being carried out, though it is already clear from the results obtained to date that the intention to separate the real course of the building's consumption from the course of its consumption from the grid is completely realistic.

- Operation of the building has proved that the presented concept ensures that 100% of the energy produced by the PV system is used within the building itself.

- It is clear from the results obtained so far that the system eliminates overflows into the network even in individual phases.

- It was proven during the summer period that it is excessive to use air conditioning under the given climatic conditions. If needed, controlled ventilation for intensive night airing is sufficient.

- On the other hand, in the winter months, the high flexibility of the radiant heating systems used can be seen. They react swiftly and efficiently to the current situation in each area of the building and make full use of heat gains (equipment, people, sunlight).

- The radiant heating system, together with controlled ventilation, provided suitable microclimatic conditions for all monitored parameters for the whole period.

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Three surprises from the construction process

Surprise No. 1

The total investment costs for construction

Building volume (m3)	**1 750 m3**
Total costs (not including PV system and batteries) -	**13 642 000 CZK**
Costs per m3	**7 795 CZK/m3**
Total costs (including PV system and batteries) -	**14 959 000 CZK**
Costs per m3	**8 547 CZK/m3**

Current standard costs for standard buildings (based on the ÚRS pricing system)

7 700 - 8 300 CZK/m3

It is evident that with proper pre-project and design preparation, prices comparable with standard buildings (2015) can be achieved even in the case of above-standard, equipment-filled buildings like this one.

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Heating system – return on investment

(comparison of an electric radiant heating system and a heat pump) :

Radiant heating system (floor heating – radiant panels – central regulation with the possibility of managing each area individually via remote control) - 174 000 CZK

Multi-split air conditioning + warm water system - 193 000 CZK

flexible, exact and targeted heat and cool air supply to individual areas; both selected systems react immediately to heat gains

Heat pump and warm water system - 661 000 CZK

System suffers from high inertia, low flexibility and low ability to react to heat gains in individual areas

Difference - 294 000 CZK

Total energy consumption for heating, warm water - 9 335 kWh/year

Installed wattage of heating 9kW

- Maximum possible savings when heat pump is used - 4 700 kWh /year
- Return on investment at today's electricity prices - 28 years

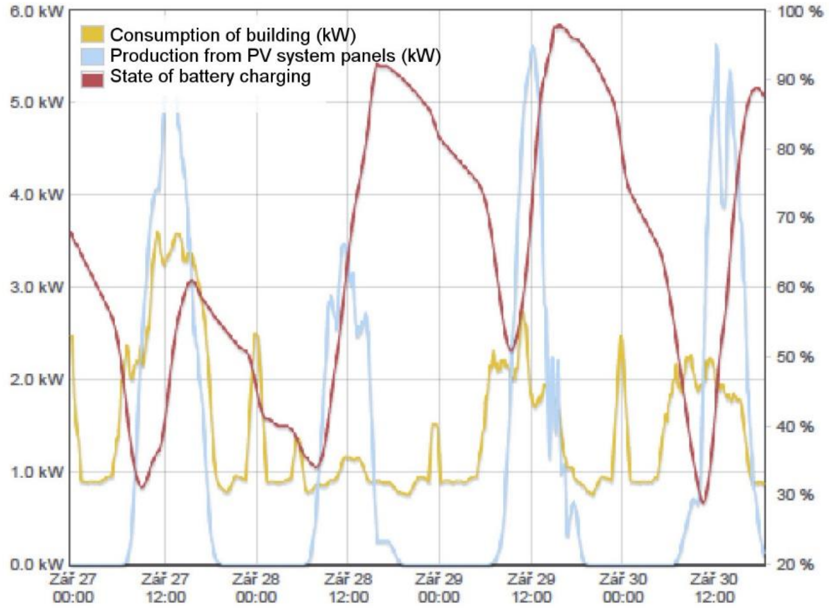
Surprise No. 2

Even though a heat pump is an excellent piece of equipment, particularly in cases when energy consumption is high, there is no return on investment for the given concept until long after the service life of the device ends. The installation of heat pumps in highly energy-efficient structures like this one just doesn´t make economic sense!

Surprise No.3

Lifespan of the battery in the given mode to 30.9. - 31 years!
to 15.2. - 28 years!

30. 9. 2016 FENIX



Outdoor LED panel

Outdoor temperature	15.9 °C
Consumption of the building	29.20 kWh
Consumption from the grid	7.20 kWh
Self-sufficiency	75 %
PV system production	28.05 kWh
Supply from BAT	-6.05 kWh
State of BAT charging	87 %

Yearly production and consumption

Yearly consumption	5 094 kWh
Yearly PV system production	2 157 kWh
Self-sufficiency during the year	42 %

Battery cycles

Number of cycles 30 days	13.8
Number of cycles in total	54.5
Battery lifespan	5000.0
Cycles per day 30 days	0.459
Cycles per day in total	0.435

Sun exposure 0°: 0 W/m2
Sun exposure 35°. 0 W/m2
Output of PF system: 0,00 kW

http://data.uceeb.cz/fenix/index.php 1/2

The aim was to balance the lifespan of the battery with the expected service life of the PV system - this has been achieved so far, and there are batteries commonly available on the market today with double the lifespan!

Awards :

1) The concept of the house as an active element of the energy system received a special award at Prague Castle on 16. 6. 2016 within the framework of the CZECH TOP 100 awards.
Special award: Environmental deed of the year in energetics

2) The concept of the house impressed the organizers of the INFOTHERMA 2017 exhibition to such a degree that they turned it into the central exhibit and motto of the whole exhibition.
A specialized thematic conference also took place there at which some of the members of the specialized working group took part.

We consider the fact that this project will be presented at the Czech Republic's display as one of10 official exhibits at the world exhibition in Astana (06/17-10/17) to be the highest award.
The motto of the exhibition is energy savings and energy efficiency.

EXPO2017
ASTANA
CZECH
REPUBLIC

Zakázka:	Dodavatel souborného díla účasti ČR na Mezinárodní specializované výstavě Astana EXPO 2017
Zadavatel:	Česká agentura na podporu obchodu/CzechTrade
Podávající:	ARTEO CZ, s.r.o. Tržní 818, 336 01 Blovice
	ARTEO

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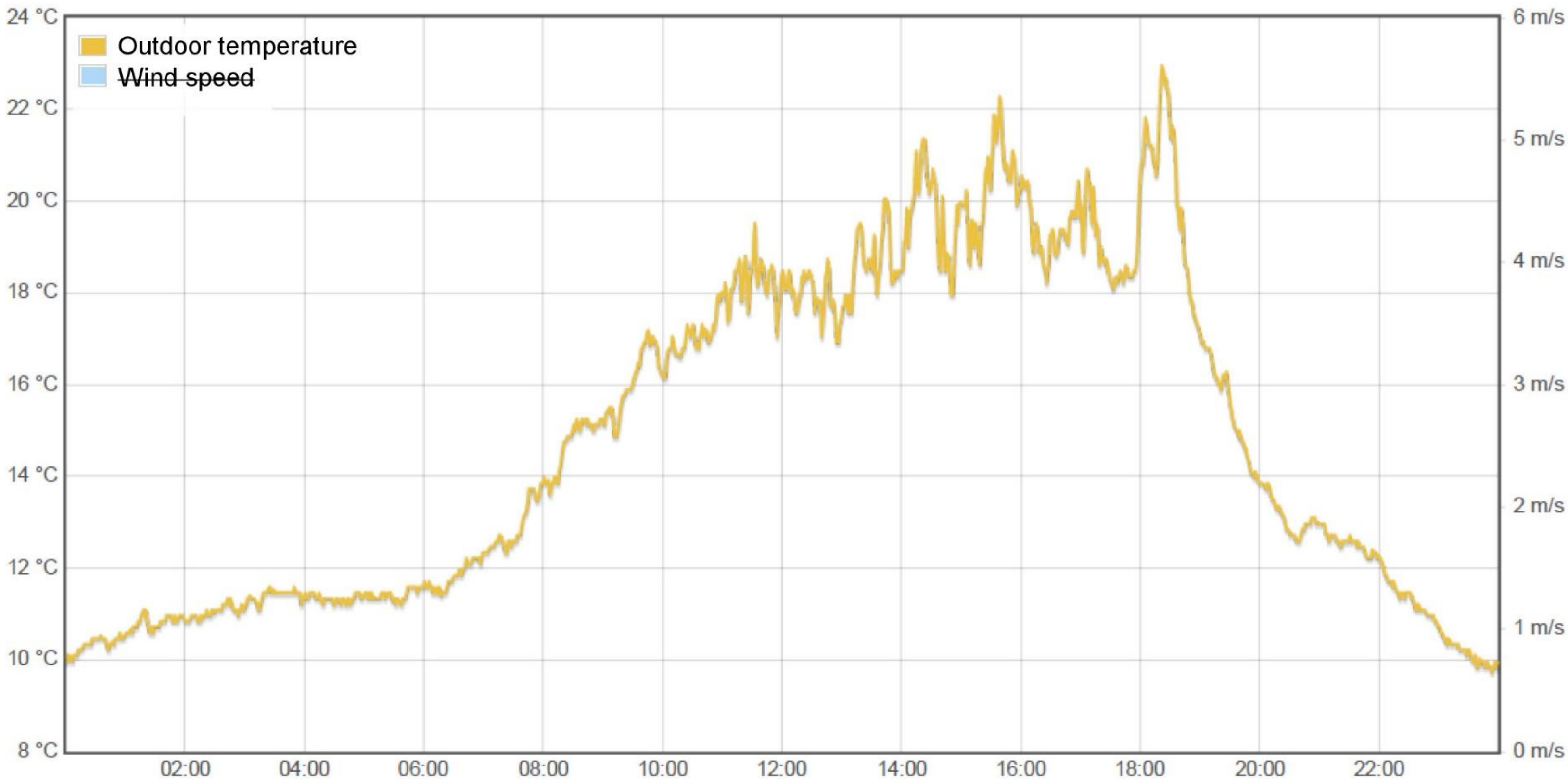
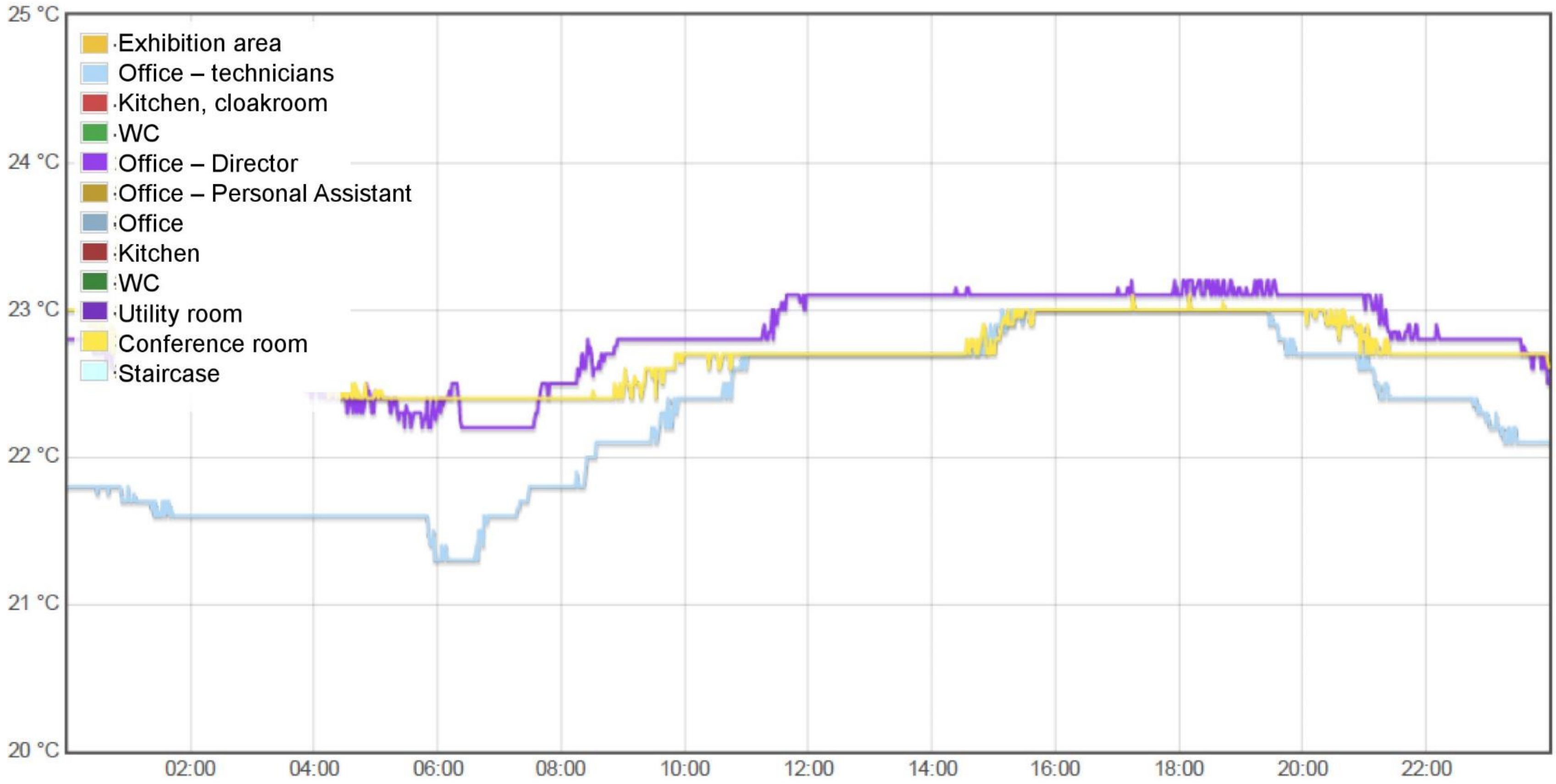
A typical summer day – cloudy weather (22.8.2016)

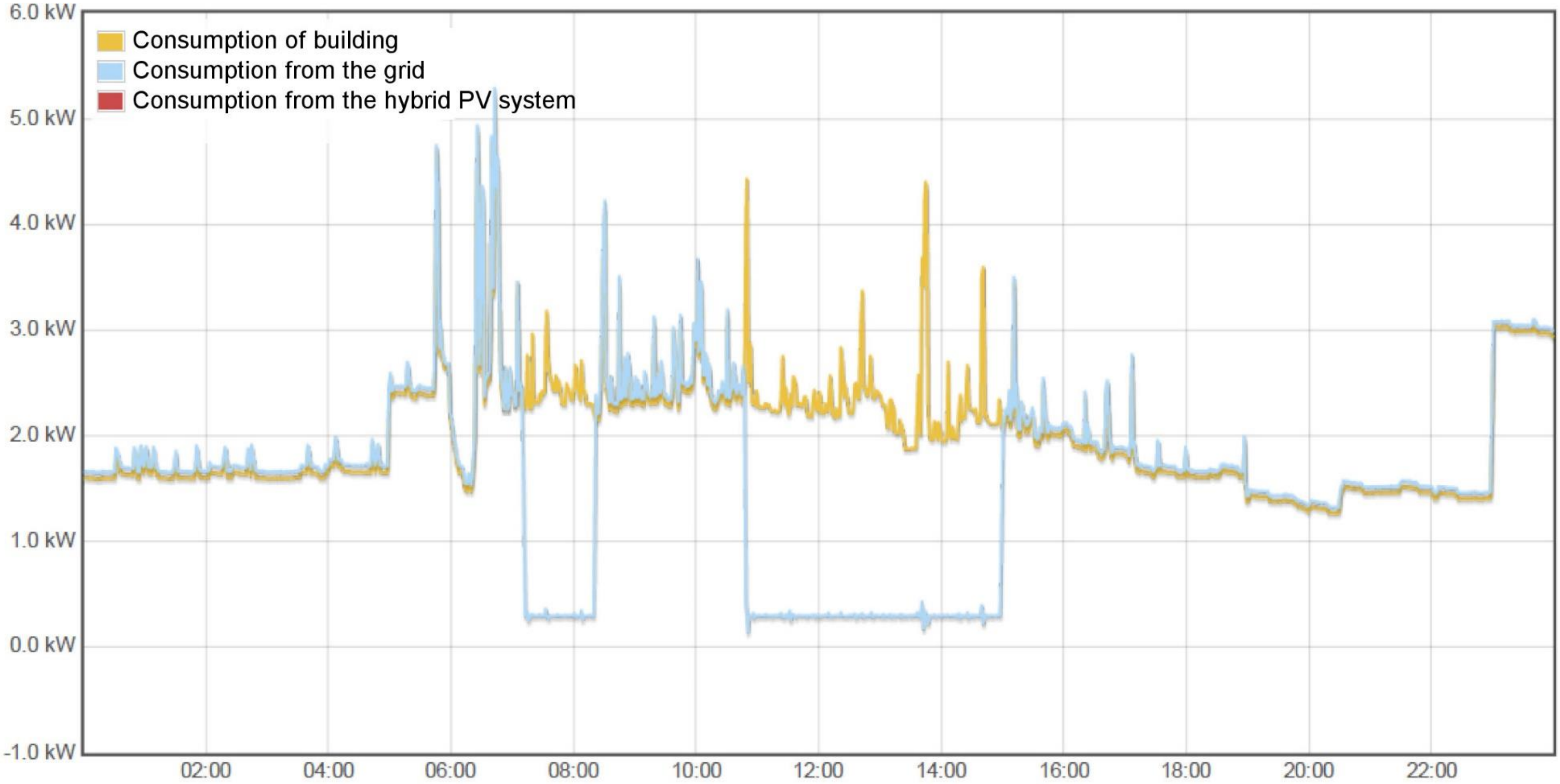
Outdoor environment



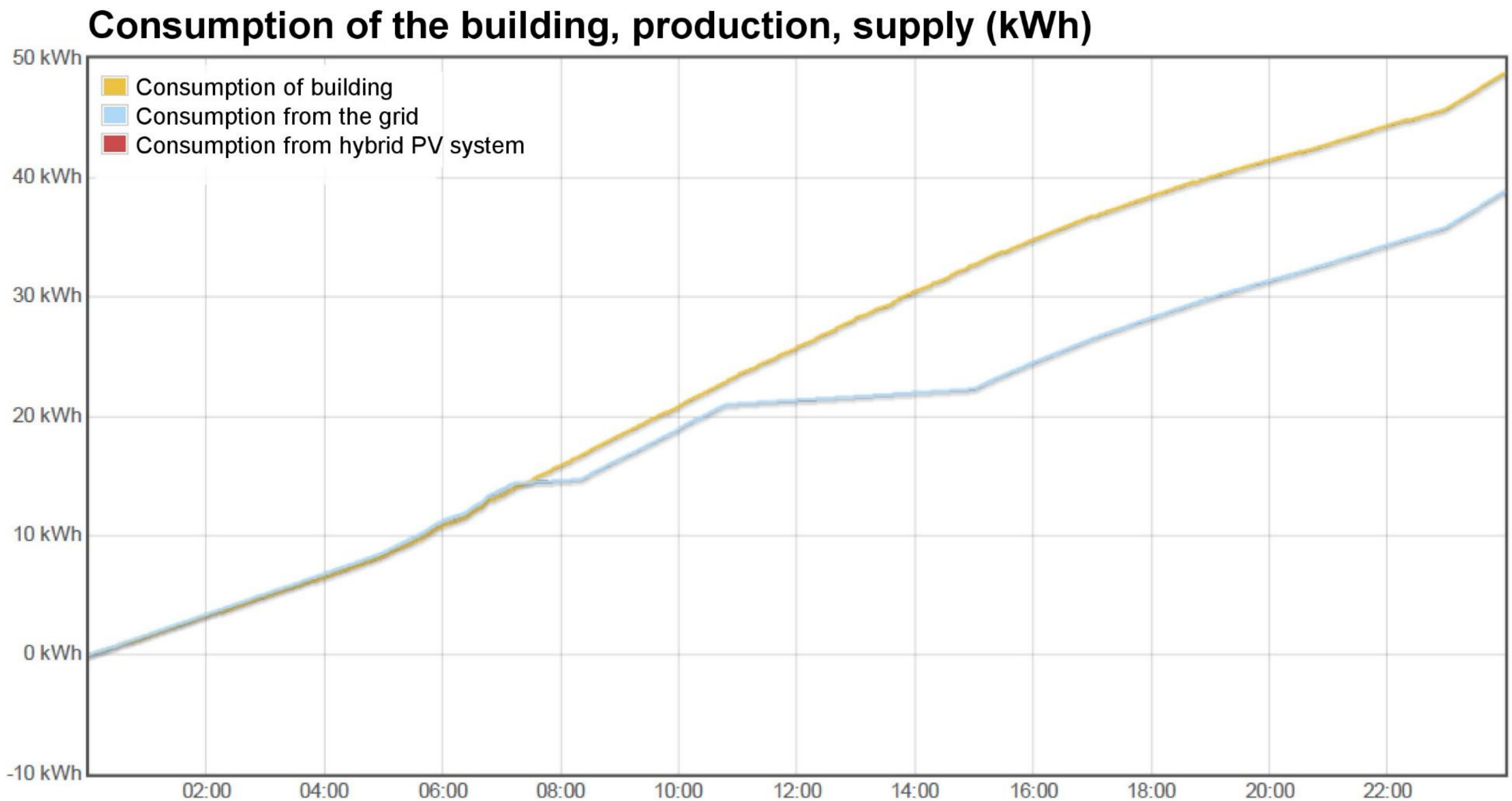
Indoor temperature (°C)



Consumption of the building, production, supply (kW)

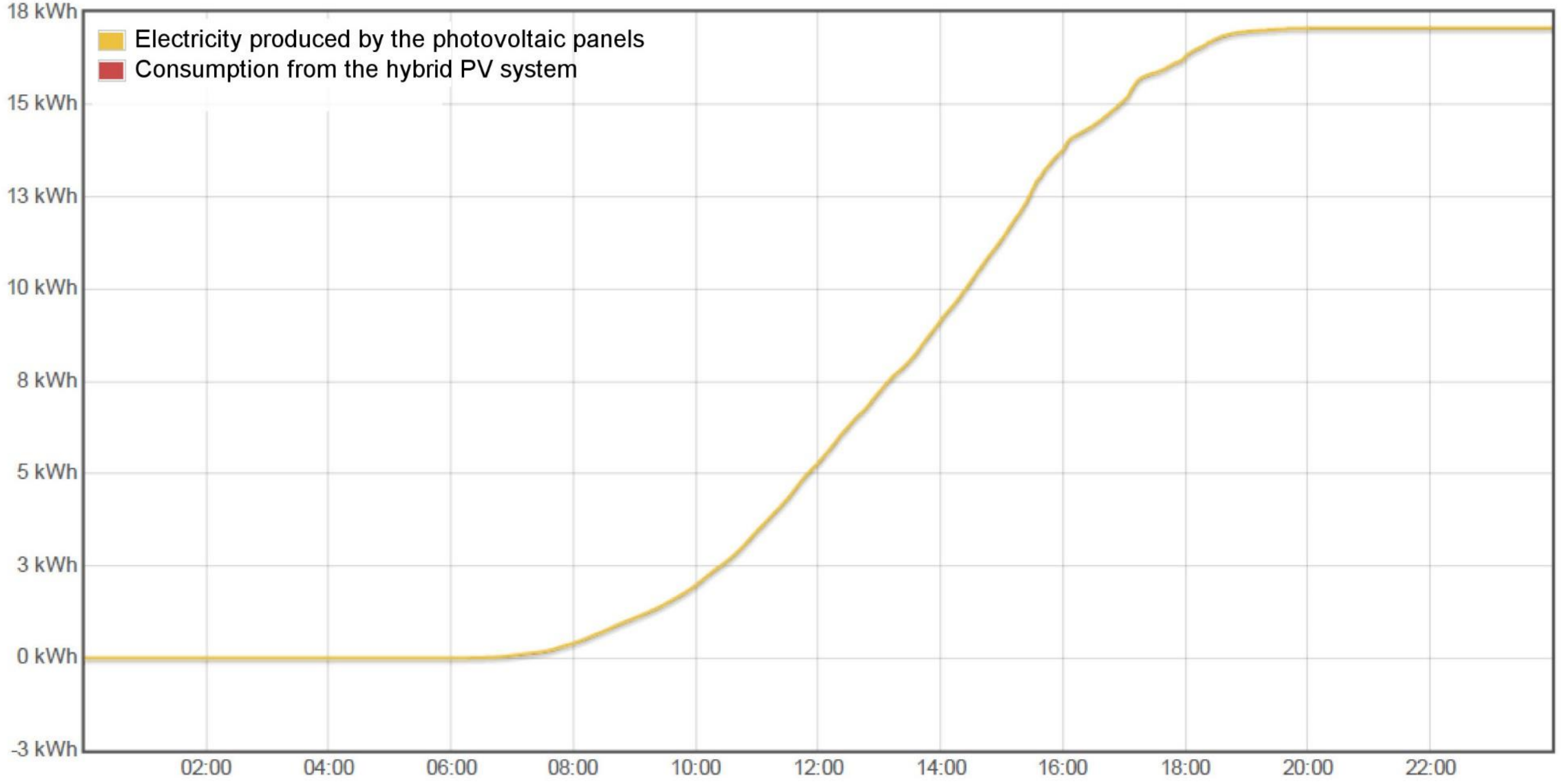


The building was in the mode where zero consumption takes place from the network for a period of 5 hours!



Total consumption of the building was 48 kWh, supply from the network – 35 kWh

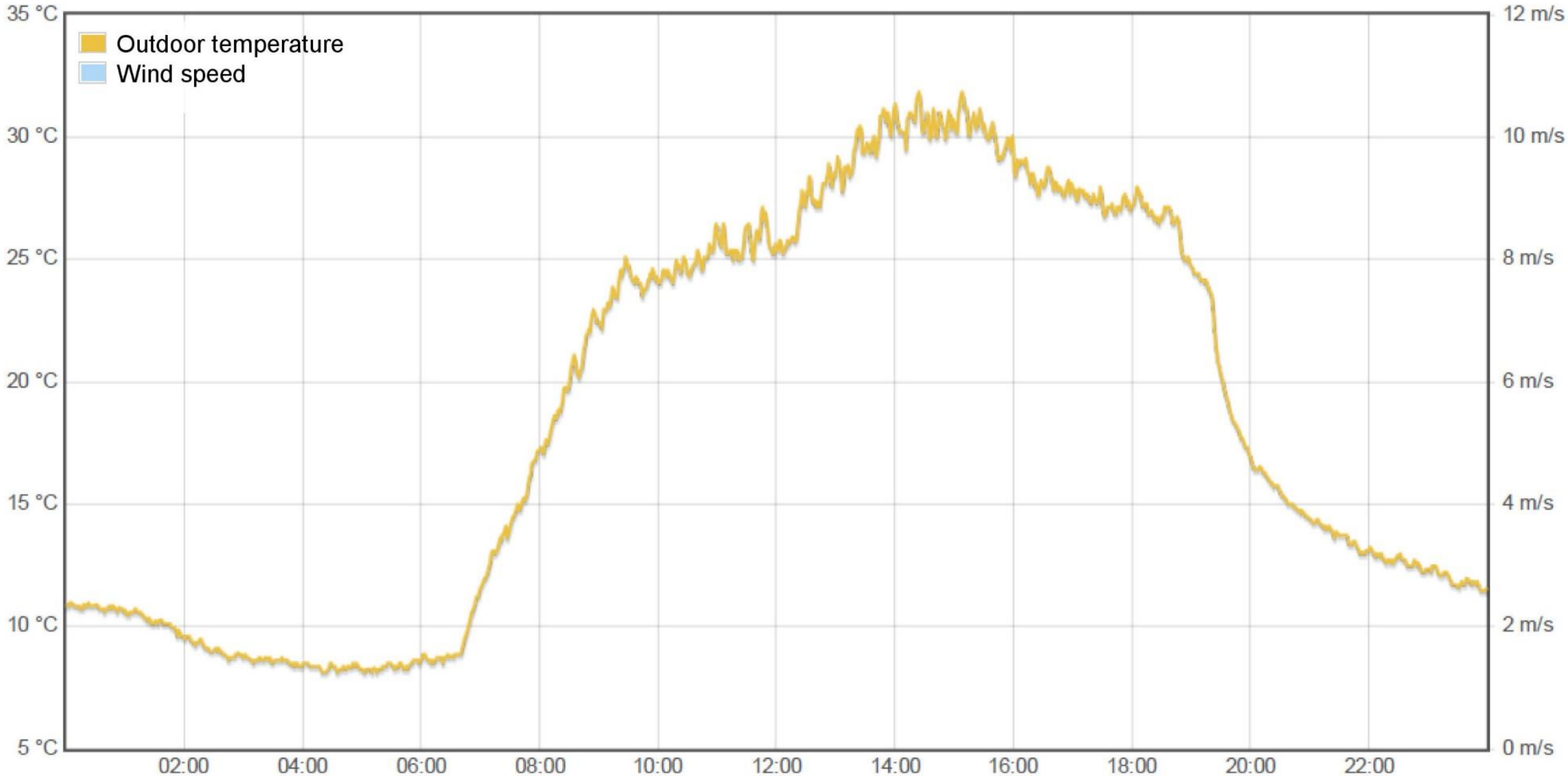
Electricity produced by the hybrid PV system (kWh)

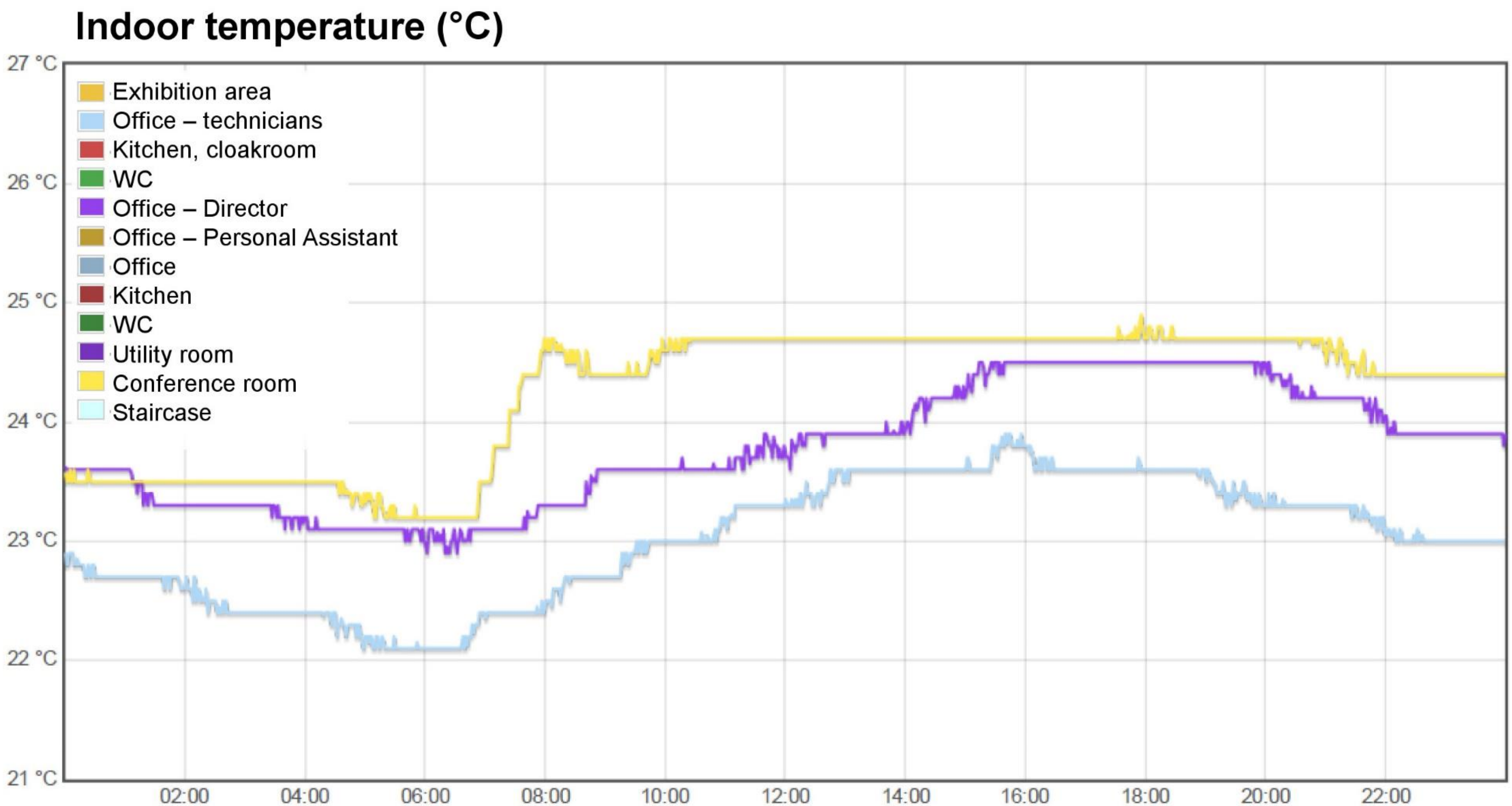


The PV system produced 17 kWh on its own, 100% of which was used in the building.

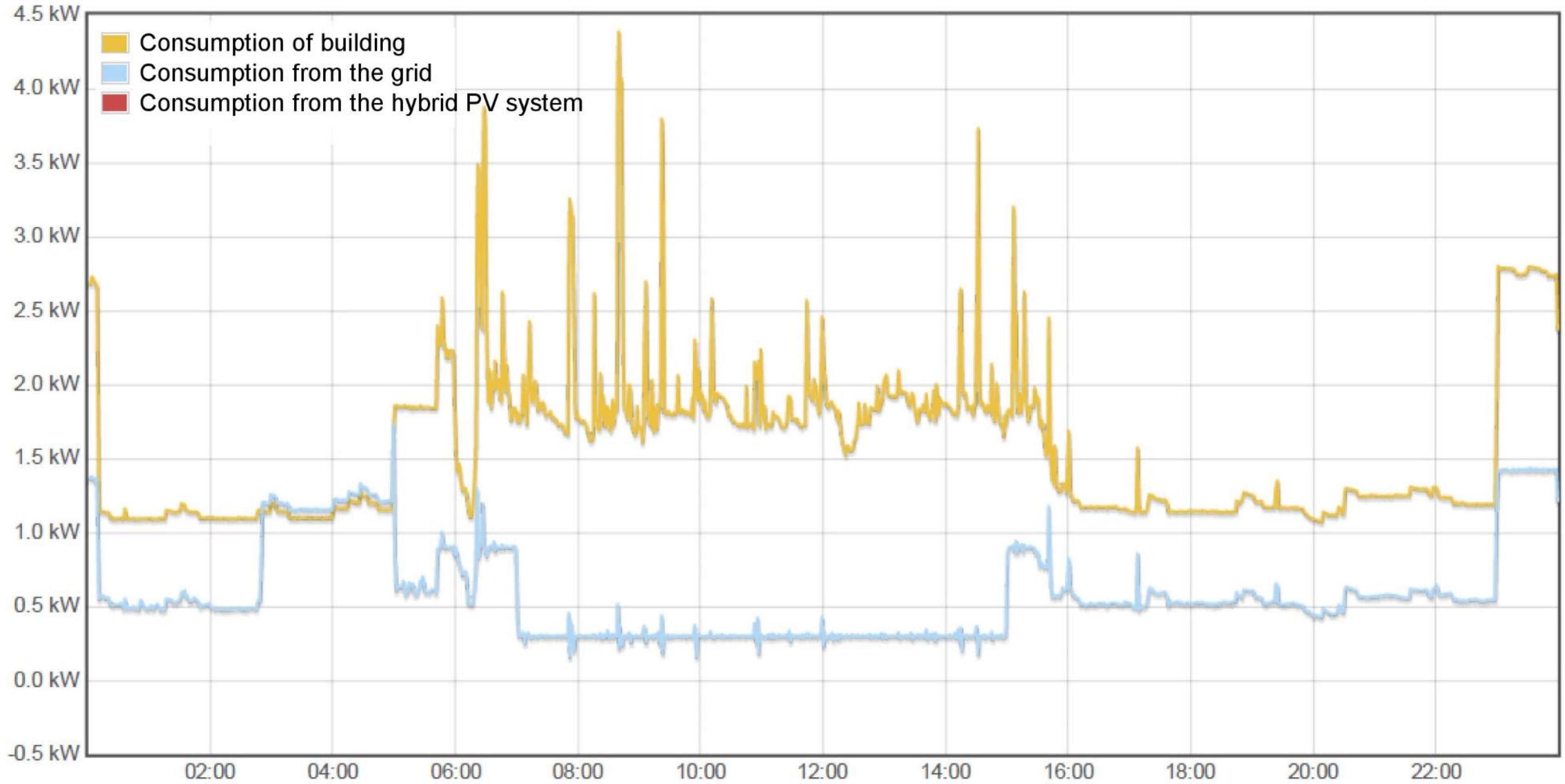
A typical summer day – sunny weather (26.8.2016)

Outdoor environment

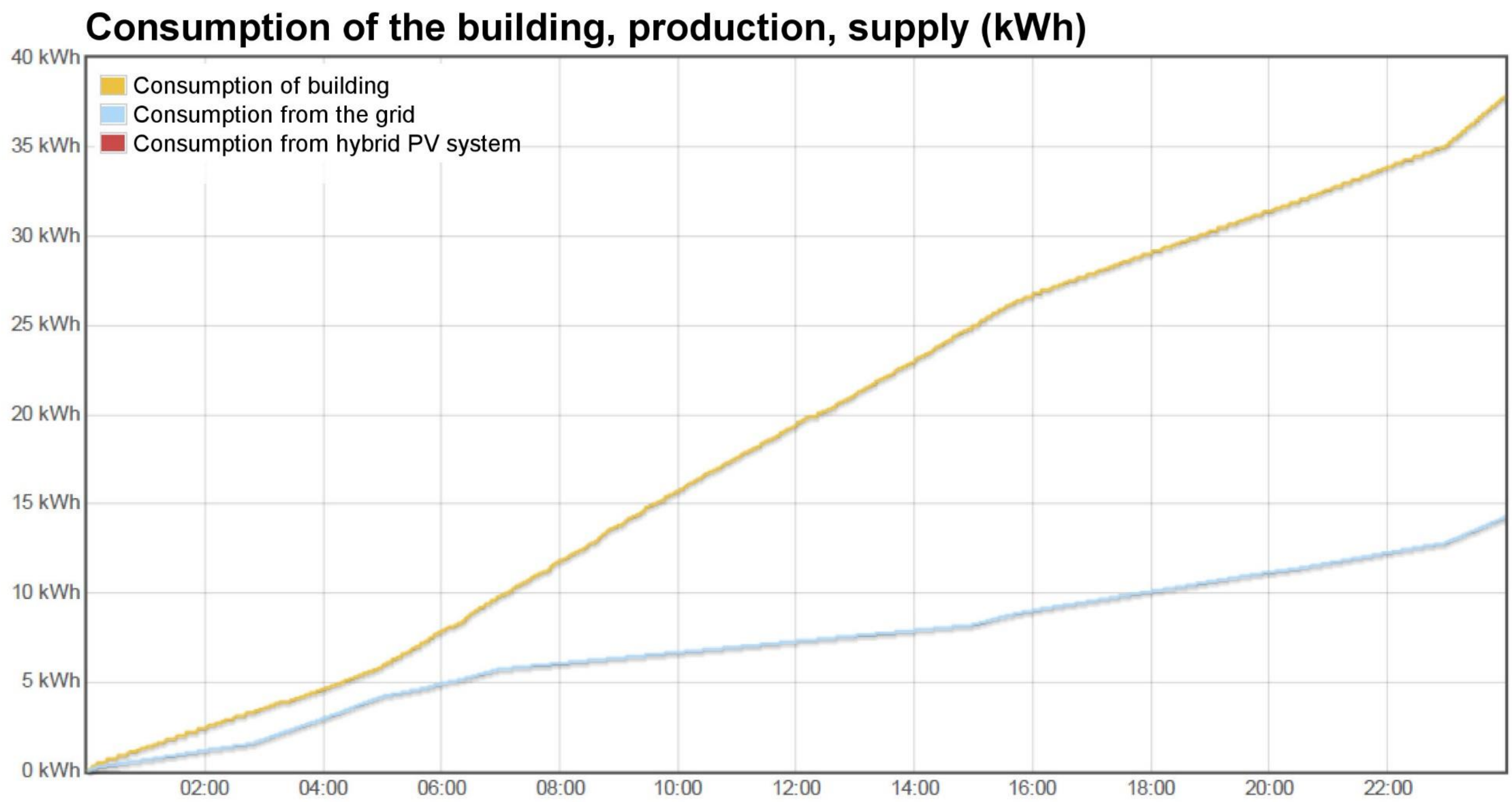



Indoor temperature (°C)
27 °C
26 °C
25 °C
24 °C
23 °C
22 °C
21 °C
Exhibition area
Office – technicians
Kitchen, cloakroom
WC
Office – Director
Office – Personal Assistant
Office
Kitchen
WC
Utility room
Conference room
Staircase
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

Consumption of the building, production, supply (kW)

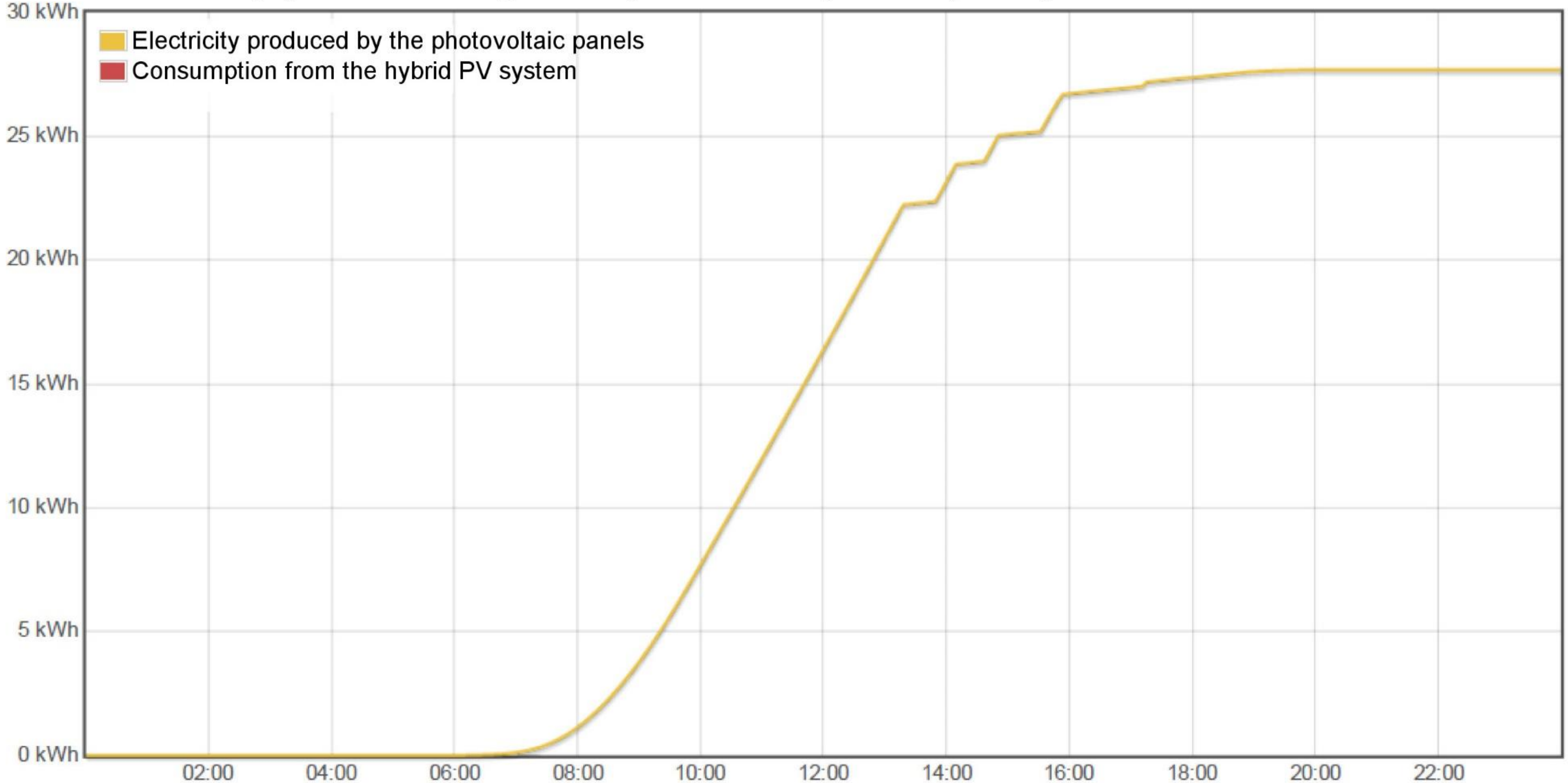


Consumption from the grid lowered from 5.00 a.m. to 11.00 p.m. – complete separation of the real course of electricity consumption of the building from its image in the energy system!



The real energy consumption in the building was 38 kWh, during which only 12 kWh was drawn from the grid.

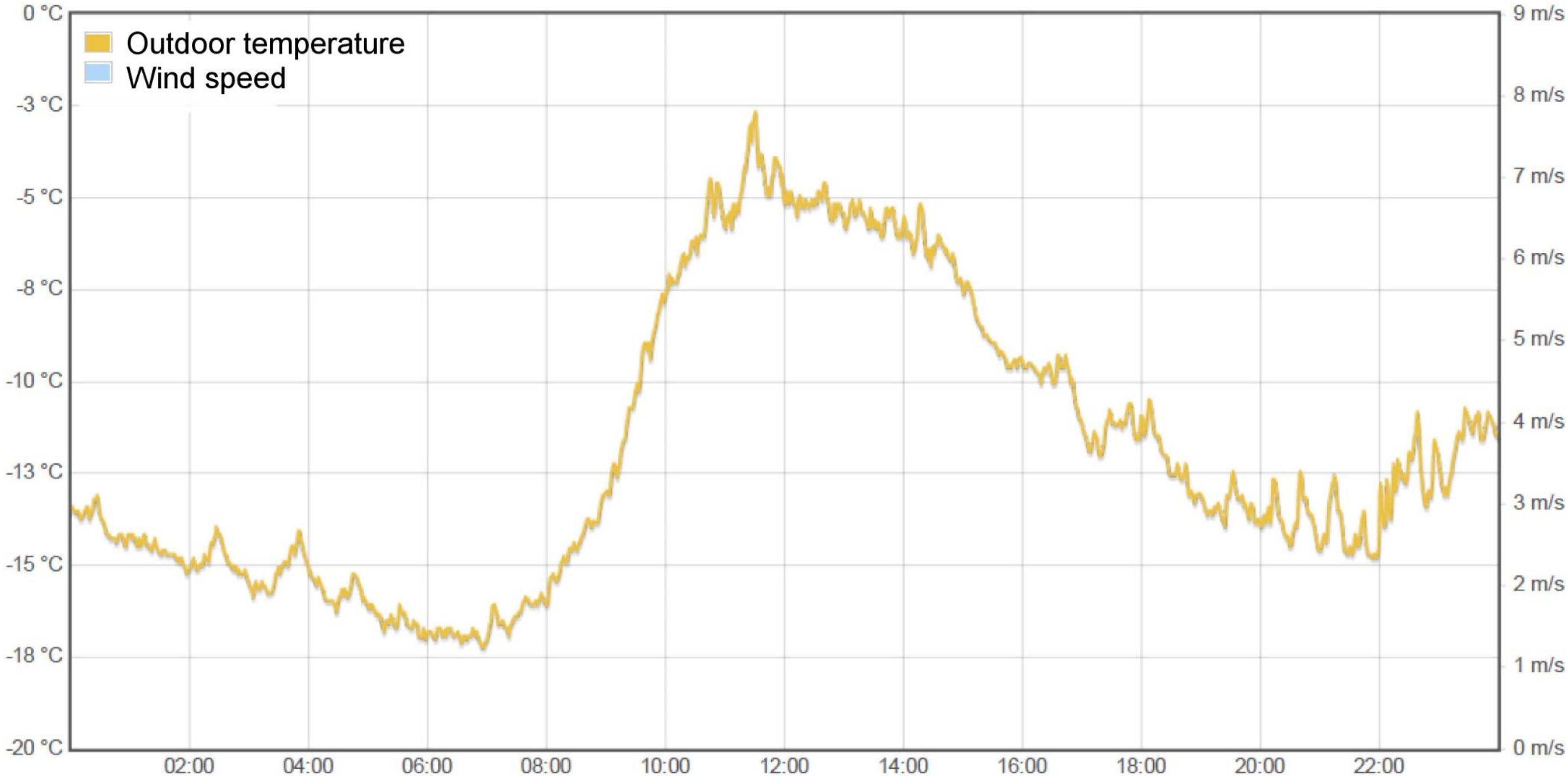
Electricity produced by the hybrid PV system (kWh)

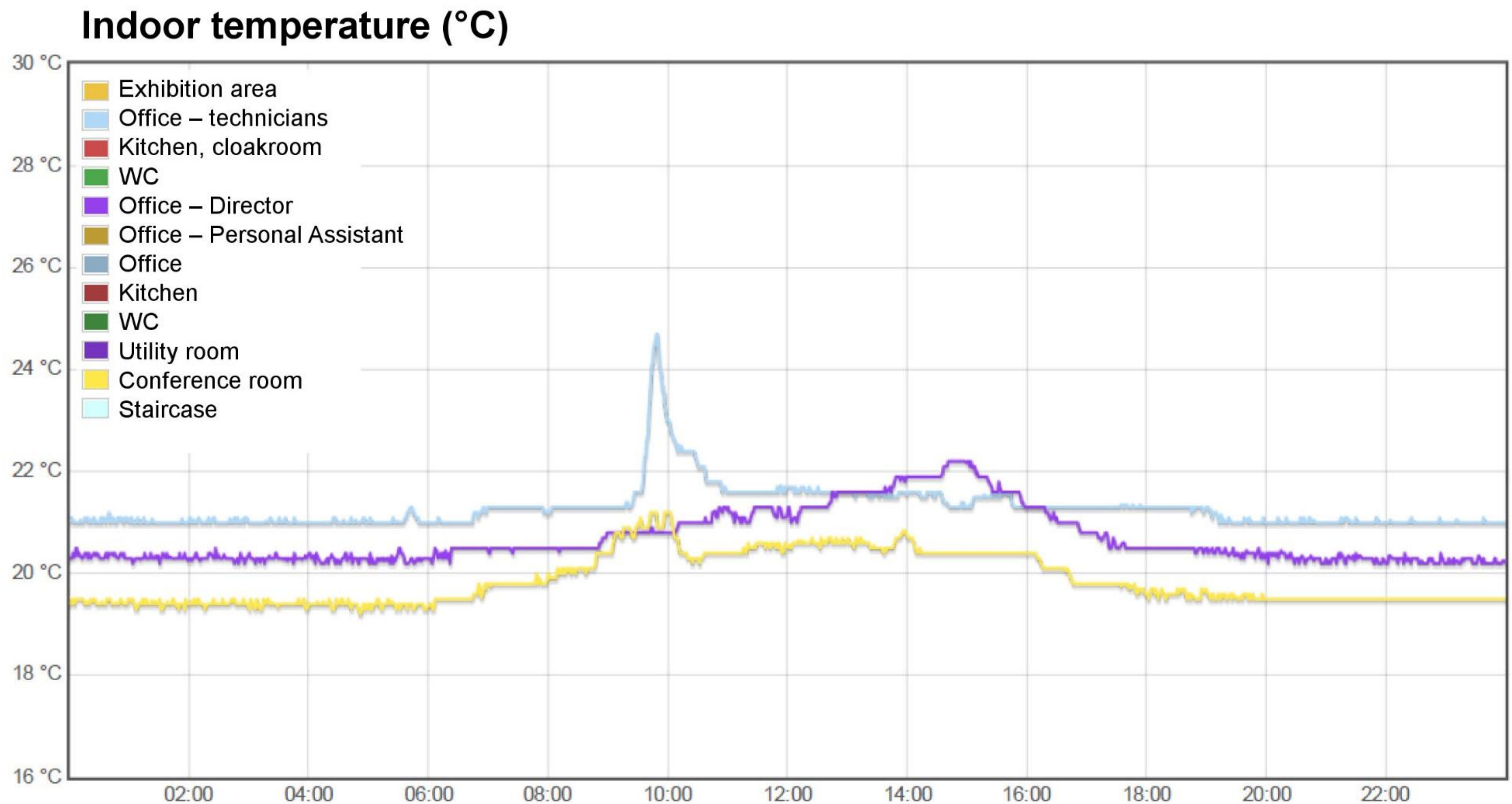


The PV system produced 26 kWh of electricity, of which 100% was used in the building!

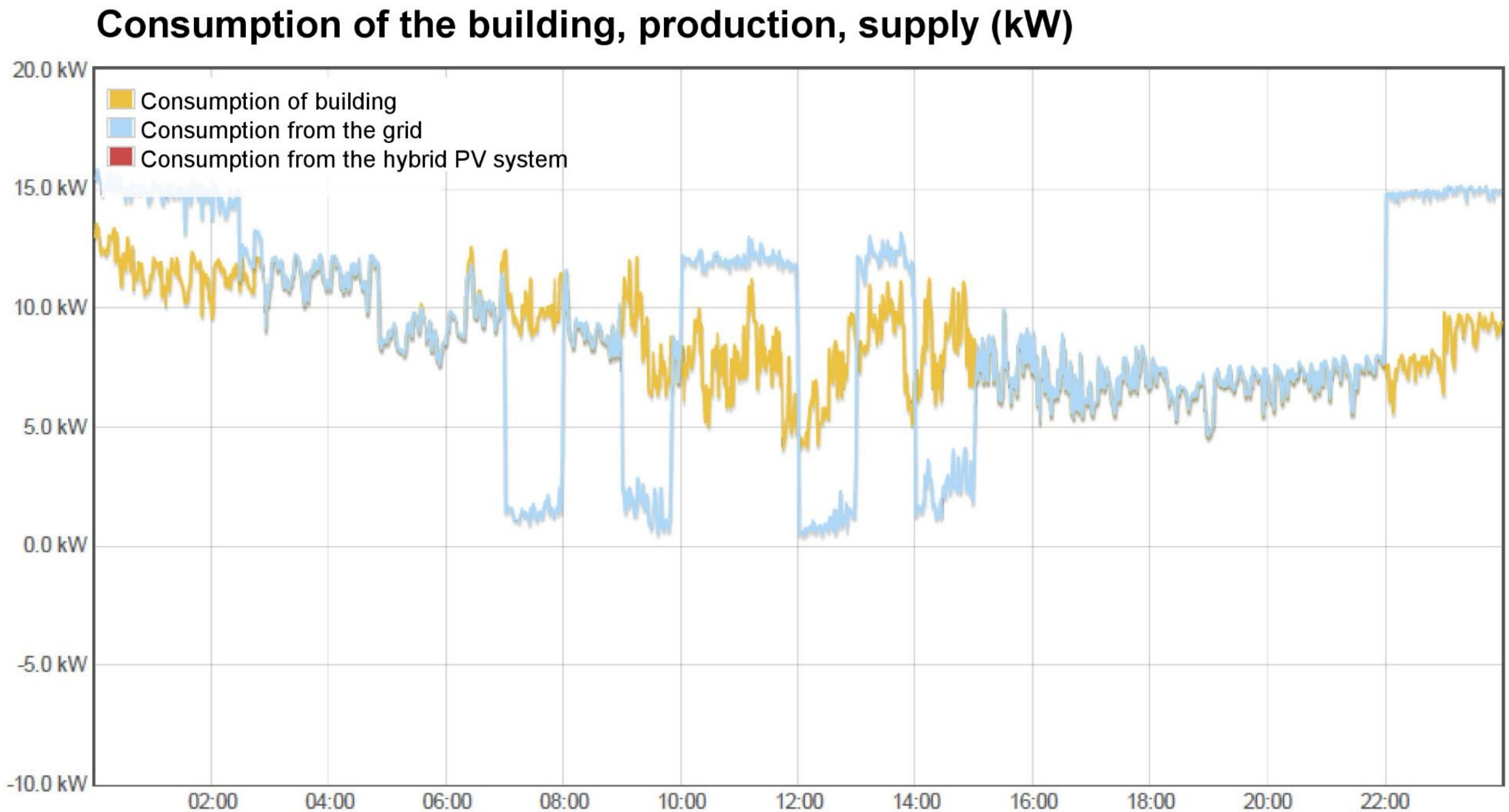
A typical winter day – overcast weather (10.1.2017)

Outdoor environment

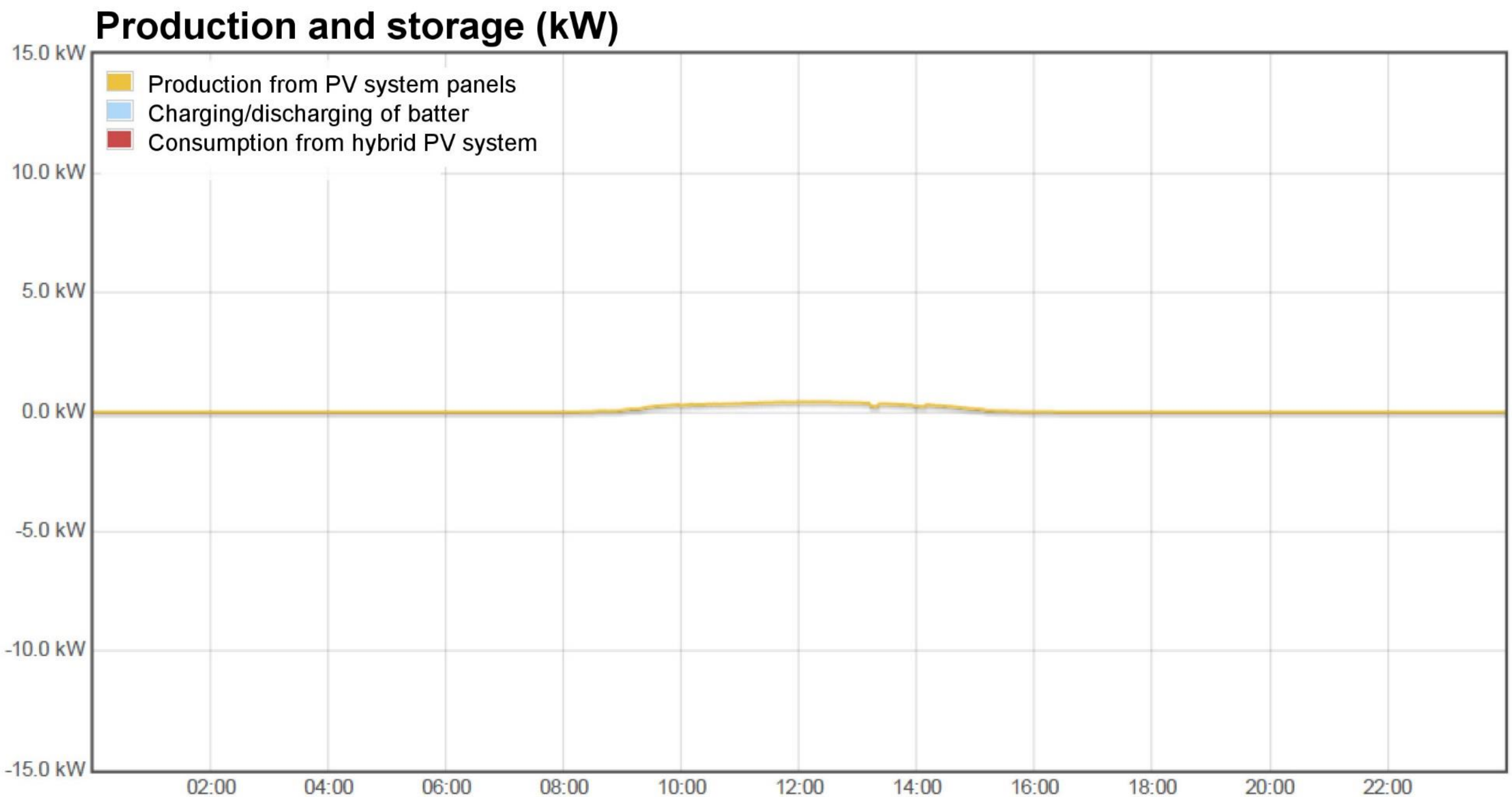




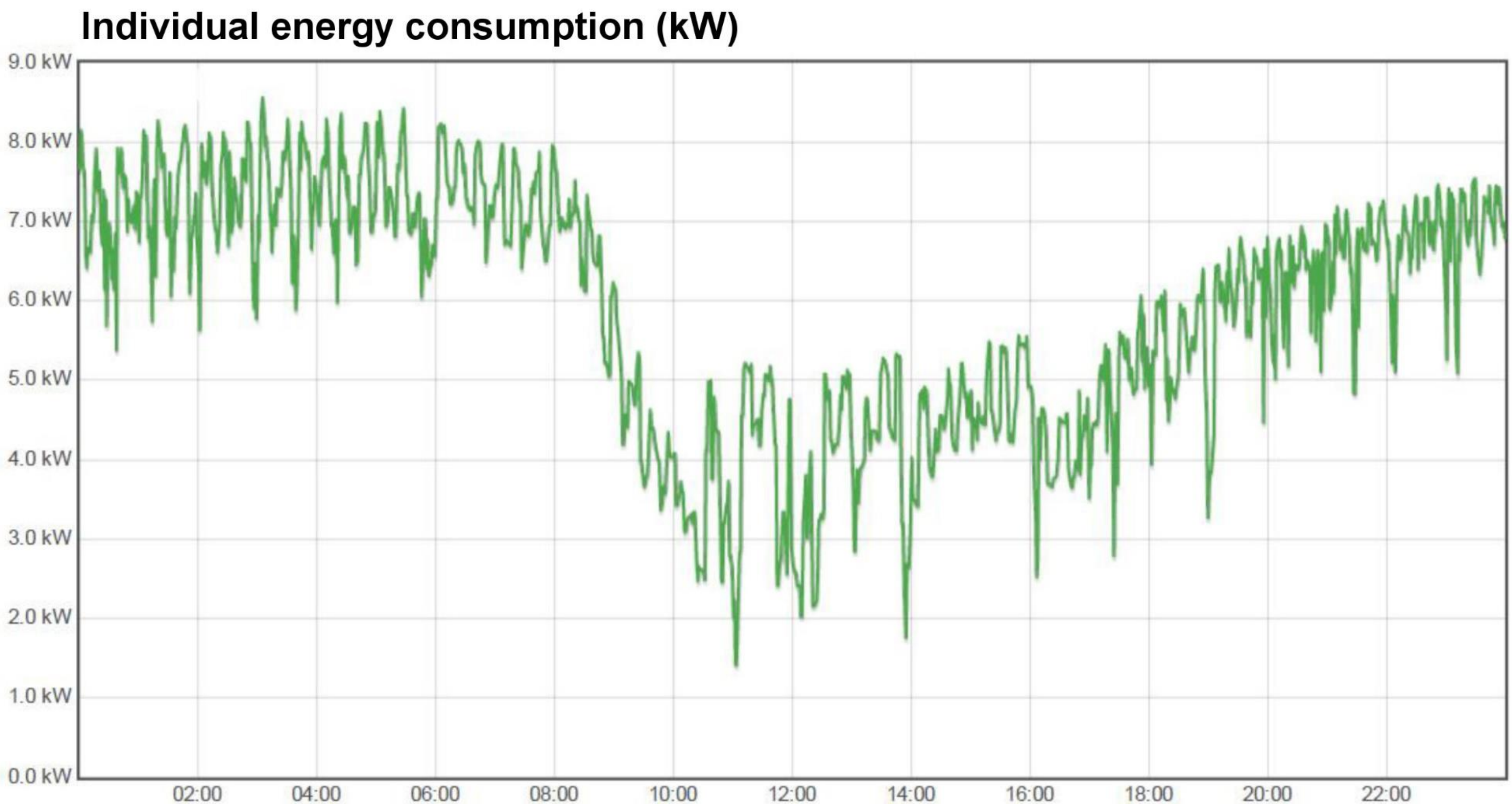
The visible sharp increase in temperature around 10 a.m. and 3 p.m. is caused by the direct exposure of sensors to sunlight (the outdoor blinds are not operational in the winter due to the use of heat gains from sunlight). This phenomenon has now been prevented via the installation of indoor scattering blinds.



It is clear from the graph that with regard to the technical parameters of the building, the consumption of energy over the 24 hour cycle is very even (the main consumption is from the radiant heating). Even under these conditions, this concept ensures controlled zero consumption by the building from the grid for a period of 4 hours.



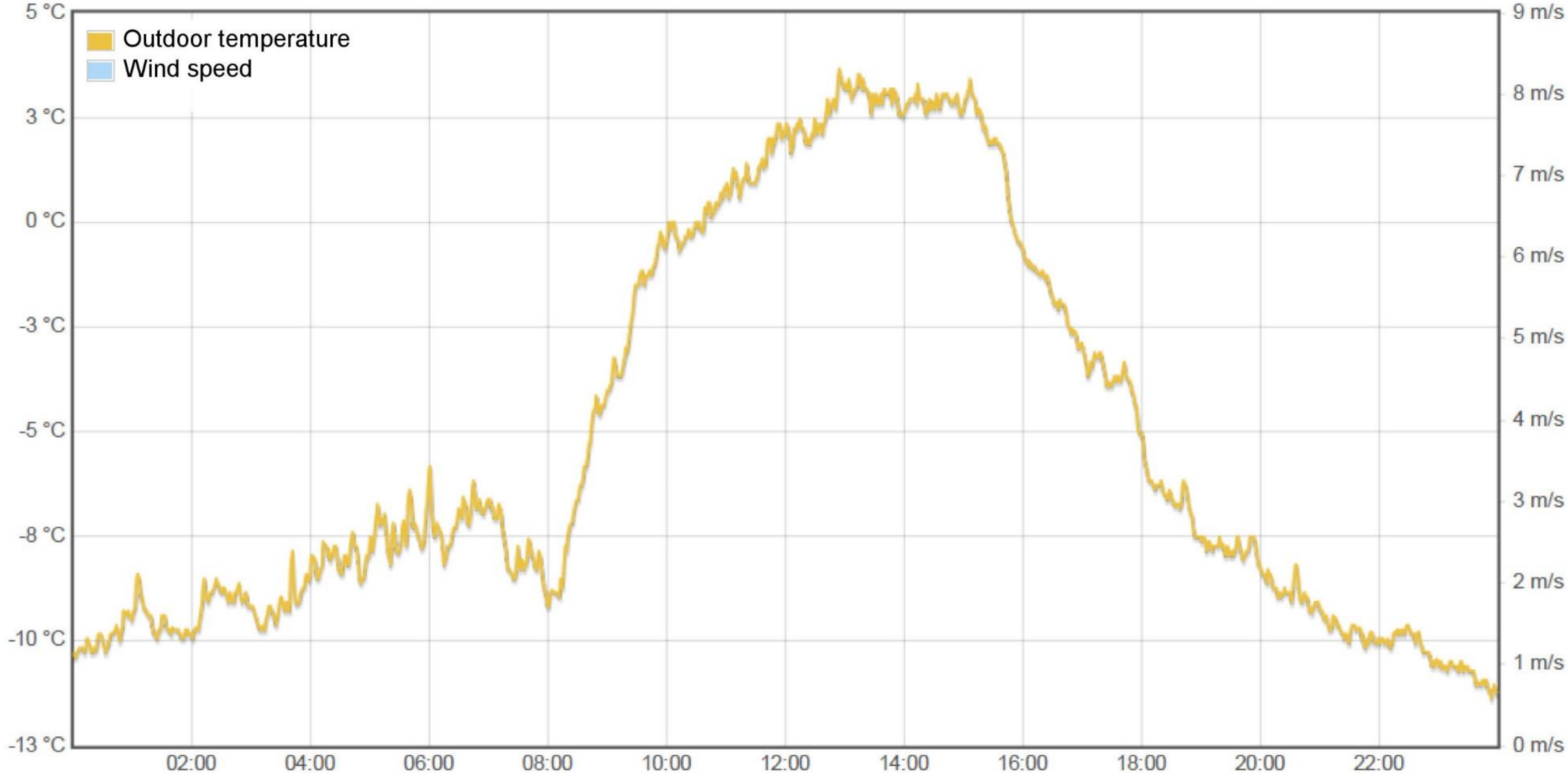
The contribution of the PV system was insignificant under these conditions!

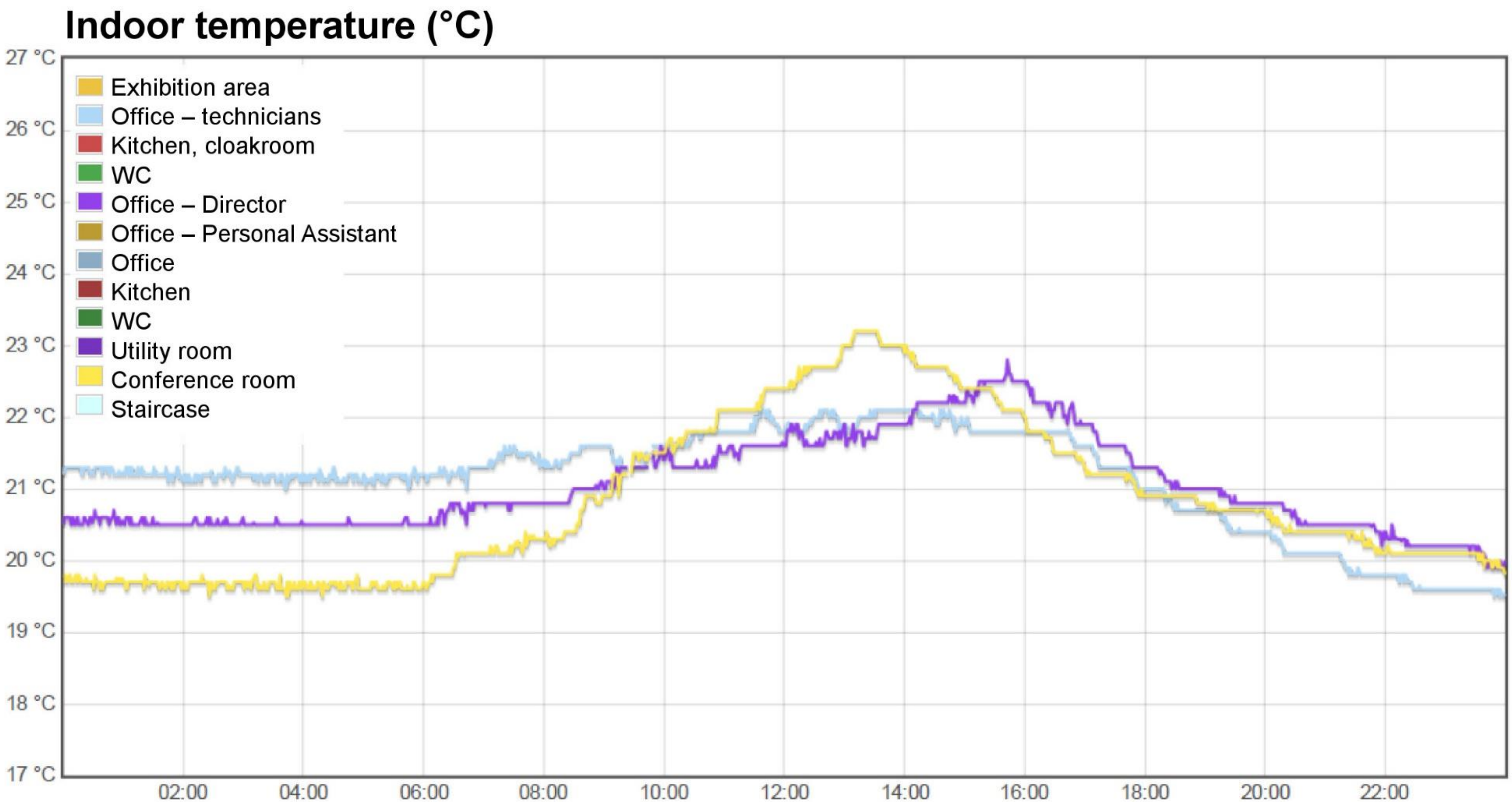


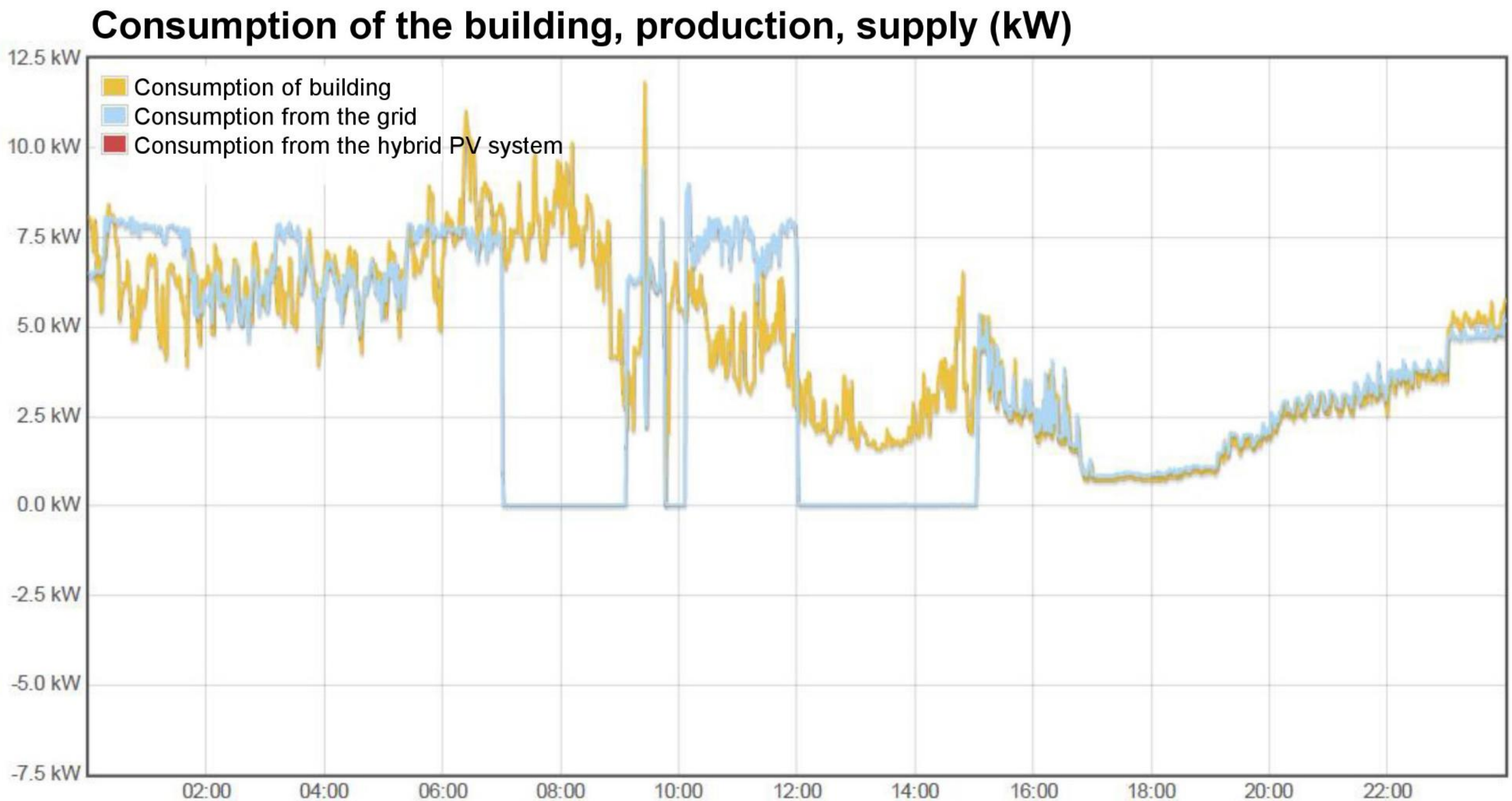
Energy consumed for heating (by the radiant heating system) reacts flexibly to the change in outdoor temperatures and particularly to additional heat gains (people – equipment)

A typical winter day – sunny weather
(27.1.2017)

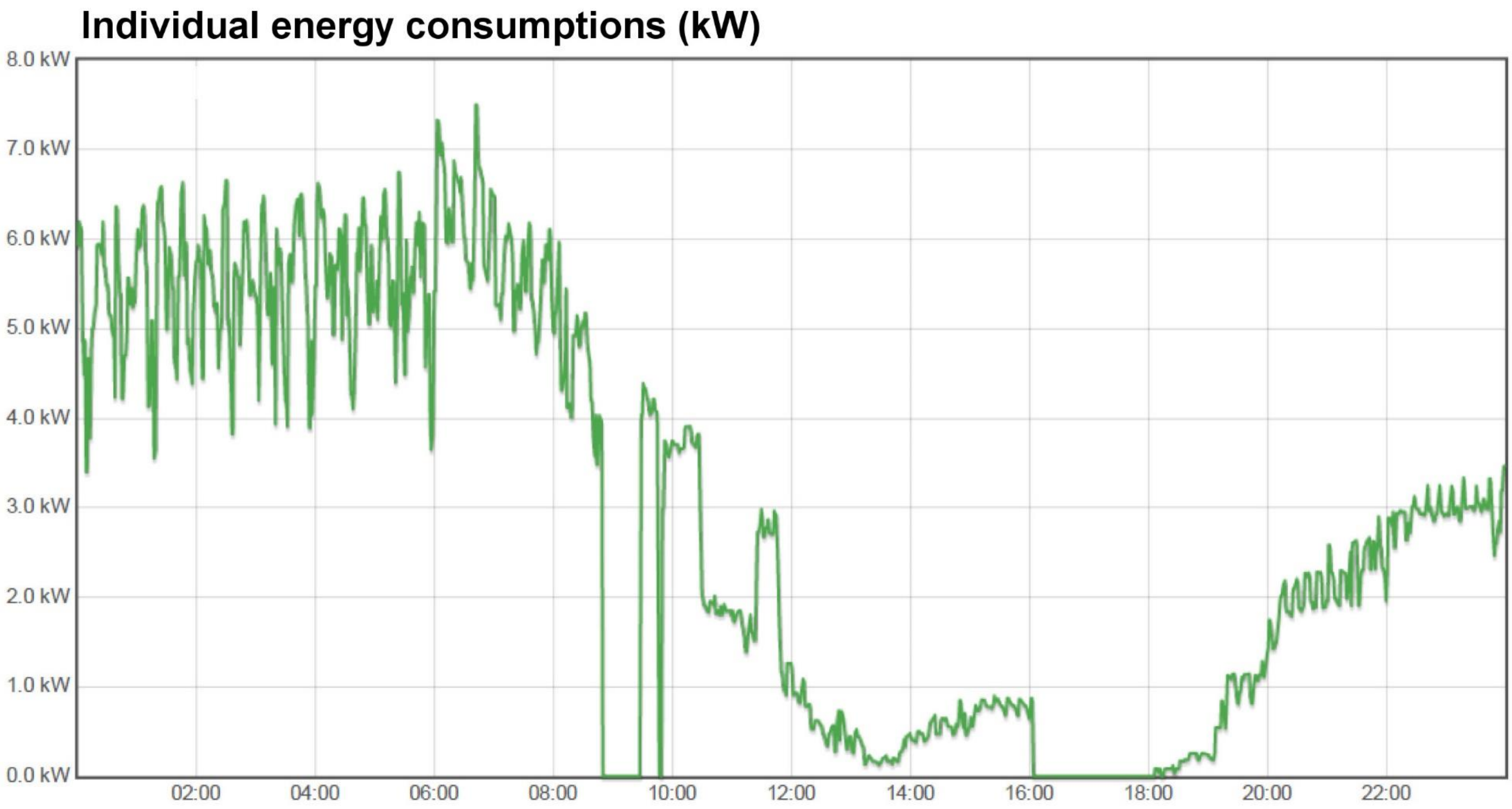
Outdoor environment




Indoor temperature (°C)
27 °C
26 °C
25 °C
24 °C
23 °C
22 °C
21 °C
20 °C
19 °C
18 °C
17 °C
Exhibition area
Office – technicians
Kitchen, cloakroom
WC
Office – Director
Office – Personal Assistant
Office
Kitchen
WC
Utility room
Conference room
Staircase
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

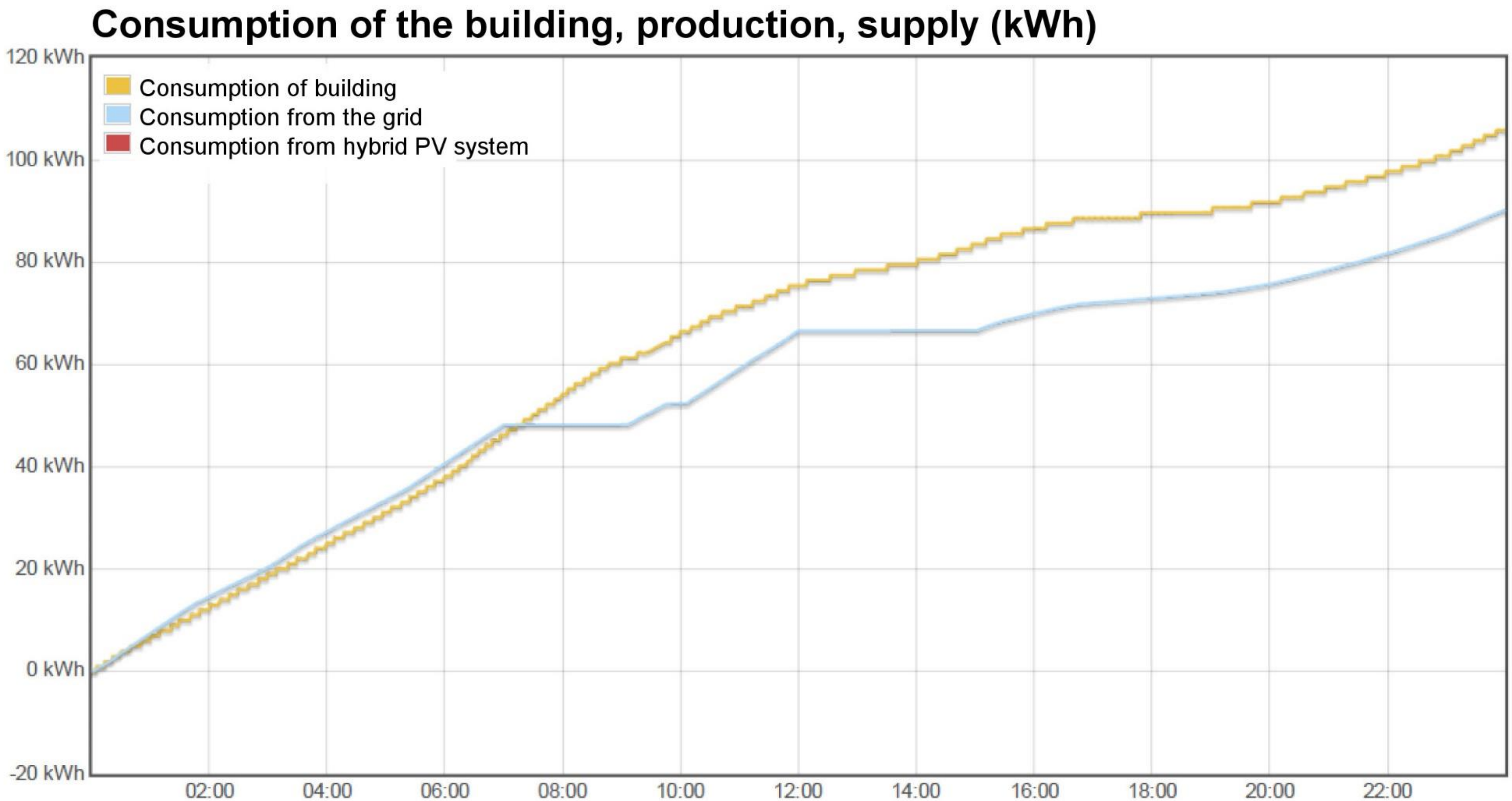


After technical adjustments at the beginning of January, the required energy consumption can now be achieved with great accuracy! In this case, the mode where zero consumption occurs from the grid was maintained for a period of 5.5 hours!

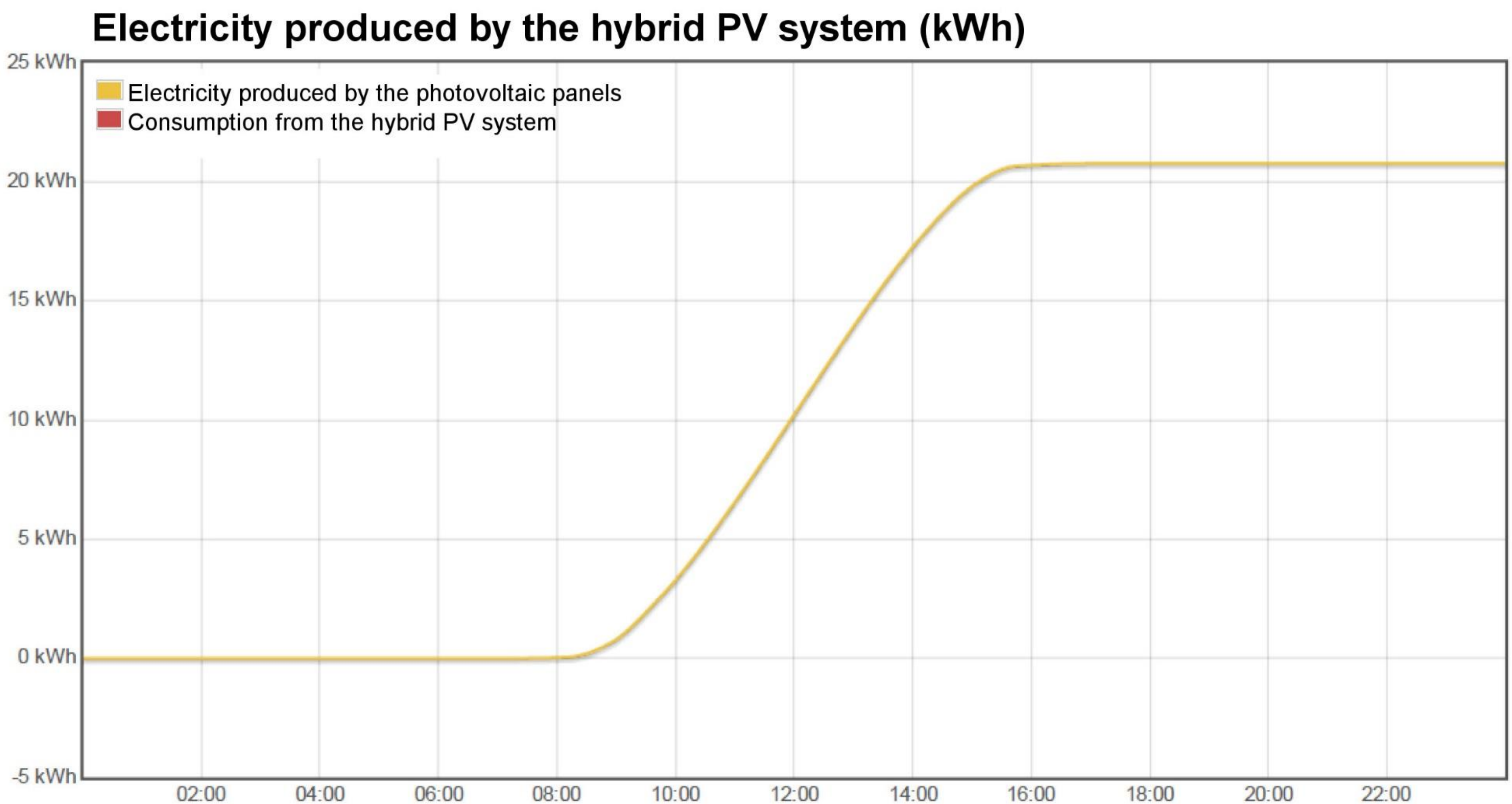


The significant effect of heat gains (sun-people-equipment) on the energy consumption can be seen from this graph, which shows energy consumption for heating. In order to make full use of this effect, It is essential to use a flexible heating system capable of reacting swiftly for each heated area independently.

Standard warm-water systems (with any source) do not have this ability in nZEB!



The total energy consumption was 102 kWh, while the PV system covered 21 kWh, i.e. almost 21% of the energy requirements of the building!


Electricity produced by the hybrid PV system (kWh)
Electricity produced by the photovoltaic panels
Consumption from the hybrid PV system
25 kWh
20 kWh
15 kWh
10 kWh
5 kWh
0 kWh
-5 kWh
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

With regard to the fact that the preliminary results for this project already suggest the realistic nature and attainability of the set goals, we have decided to proceed further in this area:

- the AERS s.r.o. (Advanced Energy Storage Systems) start-up was founded in December 2016. It prepares AES modular systems with the required functionality that cover the given area from small applications (10 kWh) for apartments and small family homes up to 1000 kWh for shopping centres, factories, agricultural buildings and the area of services

- the smallest system, AES 10, will be available from the 2nd half of this year

- at present, we are completing a project involving the cooperation of battery storage (245 kWh) with a 24kWp PV system at our Fenix production plant in Jeseník, The aims are as follows:
  - a decrease in the reserved wattage (distribution of consumption over 24 hours)
  - management of the ¼ hr maximum
  - elimination of short-term failures which can cause significant damage
- data from this project will again be available at the UCEEB server and access information will be available to the members of the working group

- the building will be monitored for a period of 1 year, after which a final report will be issued.
- The concept promises an interesting return rate even with current storage prices and we can see great potential in its future development.