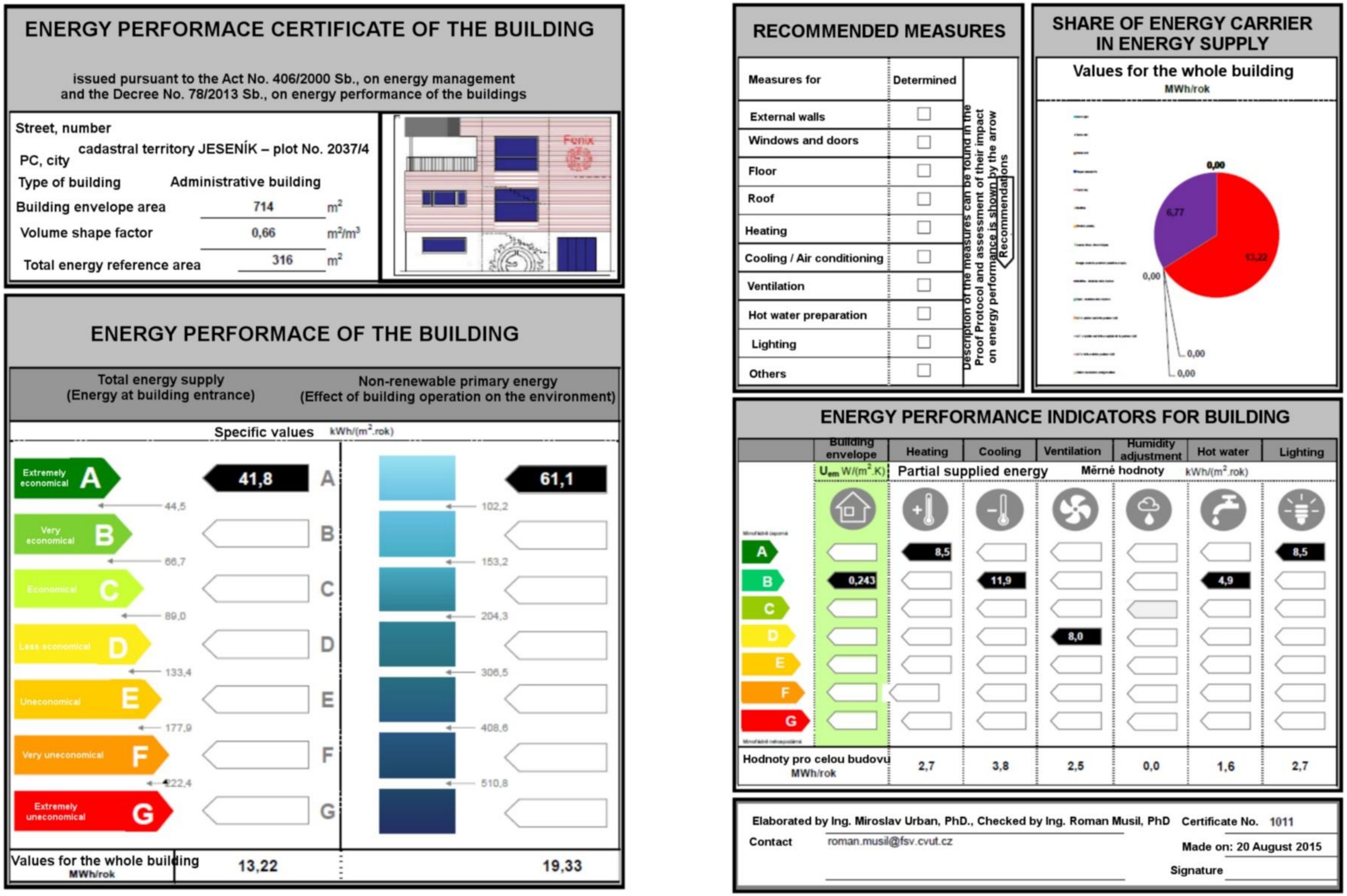
FENIX

nZEB as an active element of the energy system

12 months of operation !

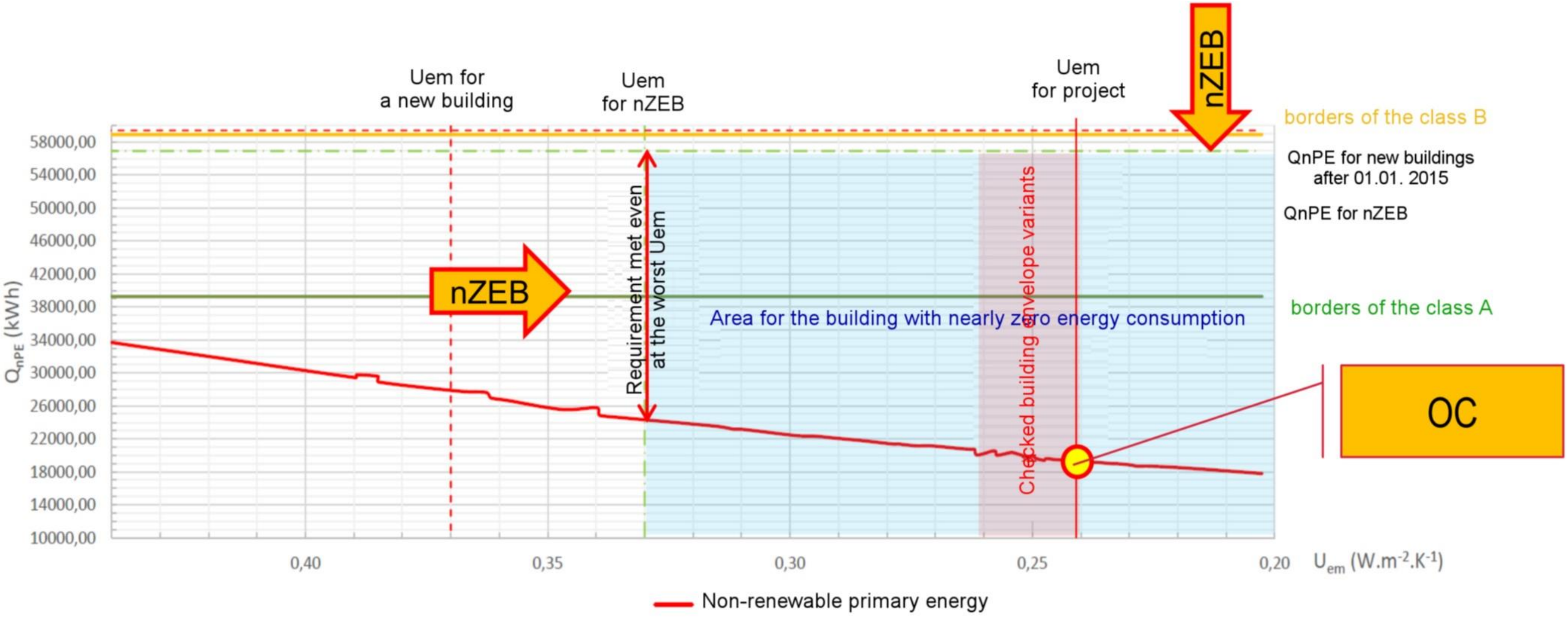
Energy label of the building

calculation according to the 2020 standard



Building in the nZEB standard is electrified fully, equipped with an electric radiant heating system

Evaluation and Classification of PEF



FENIX

Office center - building with nZEB parameters
Fully electrified building as an active element of the network

Introducing the idea of nZEB as an active element of the network – 2014

Design of the building - cooperation with ČVUT 04/2015 - 08/2015
Commencement of construction - 10/2015
Completion of construction - 05/2016

Co-operation of a 7.2 kWp roof PVE with a 26kWh home battery and a power grid. The battery serves not only for 100% in-house utilization of PVE energy, but also for active cooperation with the power grid, i.e. it is charged at the time of the low tariff (LT), during the high tariff (HT) time it takes full energy supply of the building.

The building has been designed with the help of ČVUT – TZB, and a specialized group consisting of representatives of the Ministry of Industry and Trade, Ministry of the Environment, ERU, ČEZ-ESCO, ČEPS and ČVUT (Czech Technical University) has been established for a two-year monitoring.
Collection of the data on energy consumption as well as on quality of the internal environment is provided by ČVUT-UCEEB

Three surprises during construction

Surprise # 1

Total investment costs of the project

Built-up space (m3)		1 750 m3
Total costs (PVE and batteries exclusive)	-	13 642 TCZK
Costs per m3		7 795 CZK/m3
Total costs (PVE and batteries inclusive)	-	14 959 TCZK
Costs per m3		8 547 CZK/m3

Today‘s standard costs of normal buildings (according to ÚRS price system)

7 700- 8 300 CZK /m3

It is evident that in case of the proper pre-project and project preparation it is possible to achieve – even in these highest-standard buildings filled with technologies - the prices comparable with the standard buildings (2015)

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Heating system - return on investment

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

Radiant heating system (underfloor heating - radiant panels - central control with possible remote management controlling each room/area individually) - 174 TCZK

Multisplit AC system +hot service water - 193 TCZK

For both chosen systems - flexible, precise and targeted heat and cold supplies for individual areas, immediate response to heat gains

Heat pump and hot water system - 661 TCZK

High inertia of the system, low flexibility and ability to react to the heat gains in individual areas

Difference - 294 TCZK

Total energy consumption for heating, hot service water - 12 500 kWh/year

Installed power input for heating 9kW

- Maximum possible savings if the heat pump is used - 6 000 kWh / year *
- Actual savings cannot be supported by the available data and are therefore based on table calculations
- From available data - ERU tariff statistics or comparison of real house operation - energy consumption is higher in the houses equipped with hot-water heating and the heat pump

- Return on investment when considering the today's el. energy - 20 years

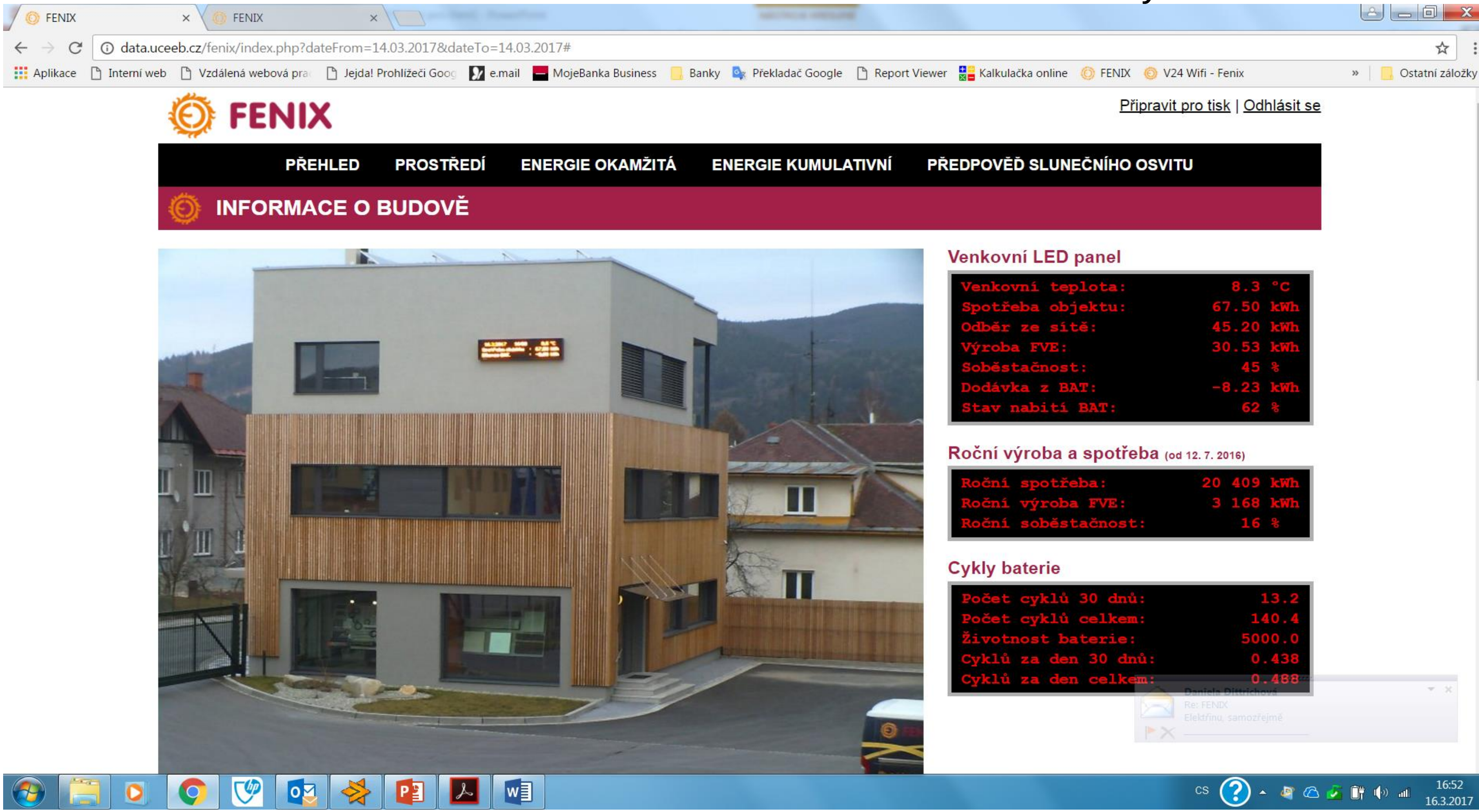
Surprise # 2

Even if HP are understood excellent technologies, especially in case of high energy consumptions, in the concept in question, values of return of HP investment are well above the service life, and installation of heat pumps into similar very economical buildings does not make any economic sense!

Surprise # 3

Battery life in the said mode on 30.09. - 31 years

on 15.03. - 28 years !



Though thanks modified software and allowed controlled overflows, the battery could be used more actively and the number of cycles has increased, the battery life is still over 25 years.

The aim was to harmonize battery life with the expected PVE life - the objective has been achieved ,

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Comparison of expected and actual results after one year of operation:

Expected annual energy consumption UCEEB – 27 000 kWh
Actual consumption 25 126 kWh (- 7%)
Energy consumption for house heating and hot service water : 12 402 kWh

Power consumption for house heating was higher due to a cold and longer winter - the average temperature from 10/16 till 2/17 was 2°C below the long-term average.

In-house production of PVE – 100% utilization PV – 7 200 kWh
Actual production 6 050 kWh

The reason for a lower PVE production was its primary setting so to avoid energy overflow into the grid, even at the cost of lowering the PVE output.

In 2017 the parameters have already been adjusted so that - mainly during the summer months with low consumption and high PVE production - the so-called controlled overflows may occur, based on the program and the HDO signal, i.e. at the request of the network operator only.

It has been verified that this model of controlled supplies is functional fully and can provide benefits both for grid management and for the users themselves - therefore we think it is time to start discussing the possibility of introducing the so-called net metering for these applications.

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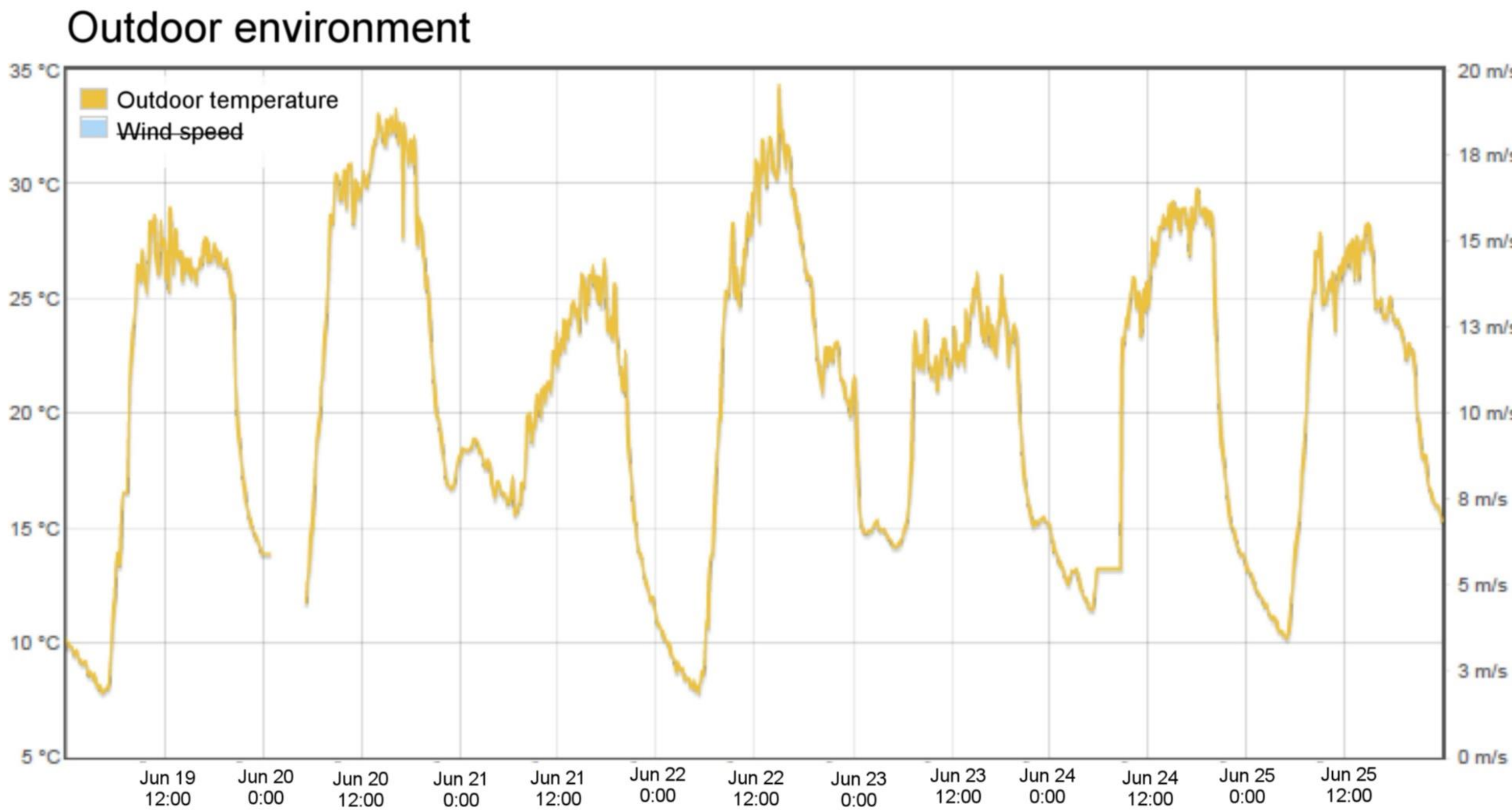
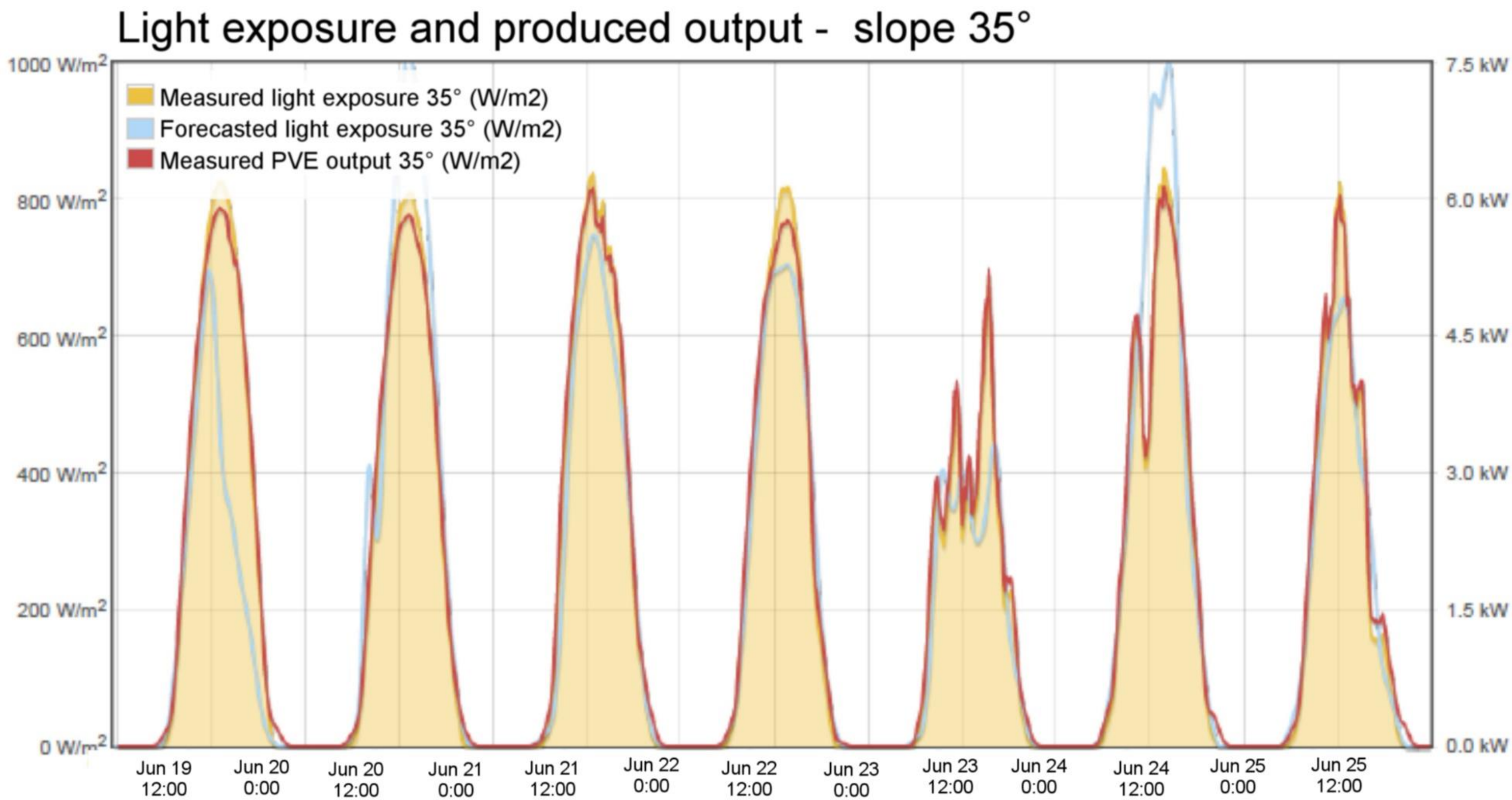
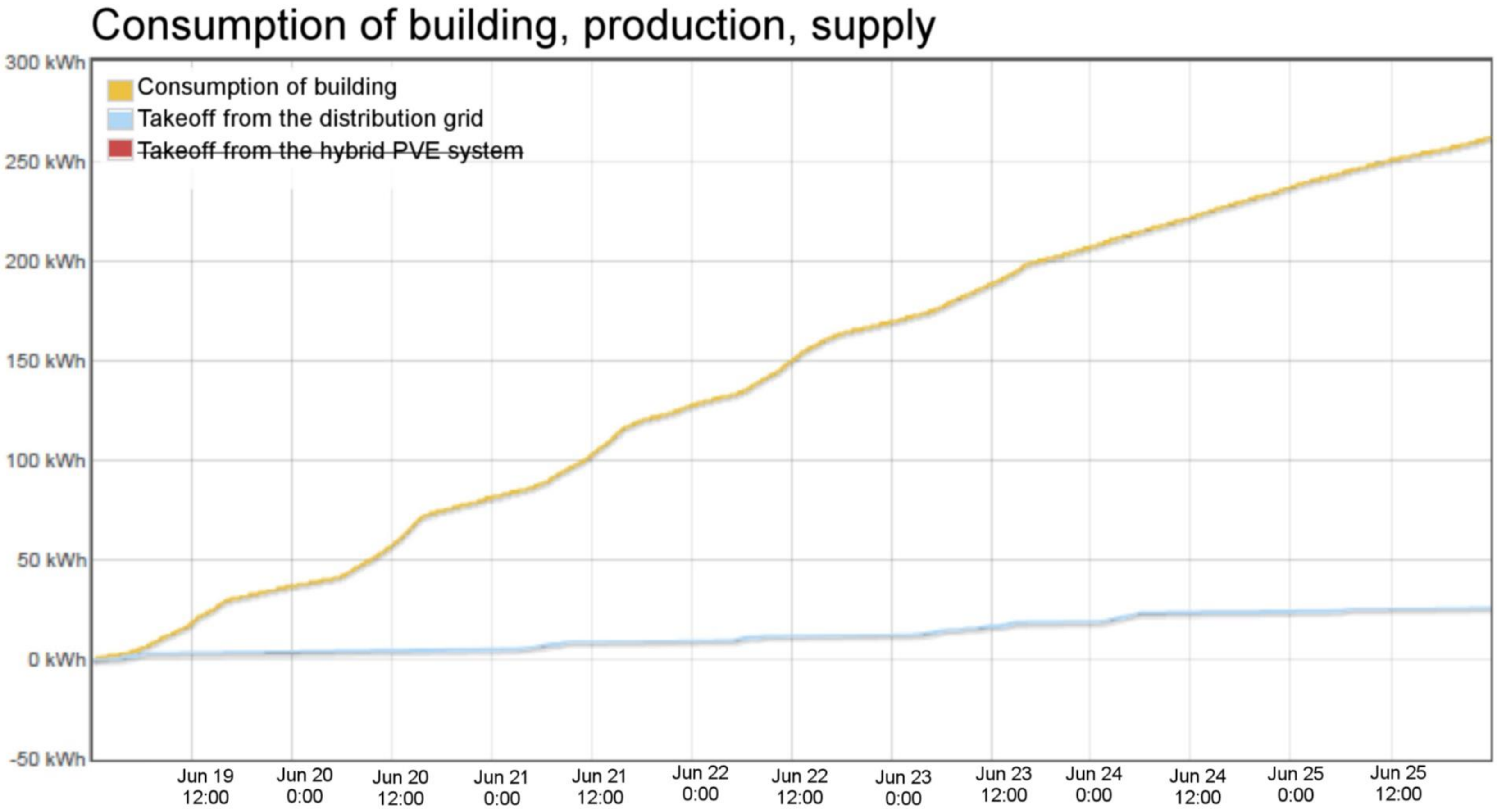
Summer operation – 19. - 25.06. 2017



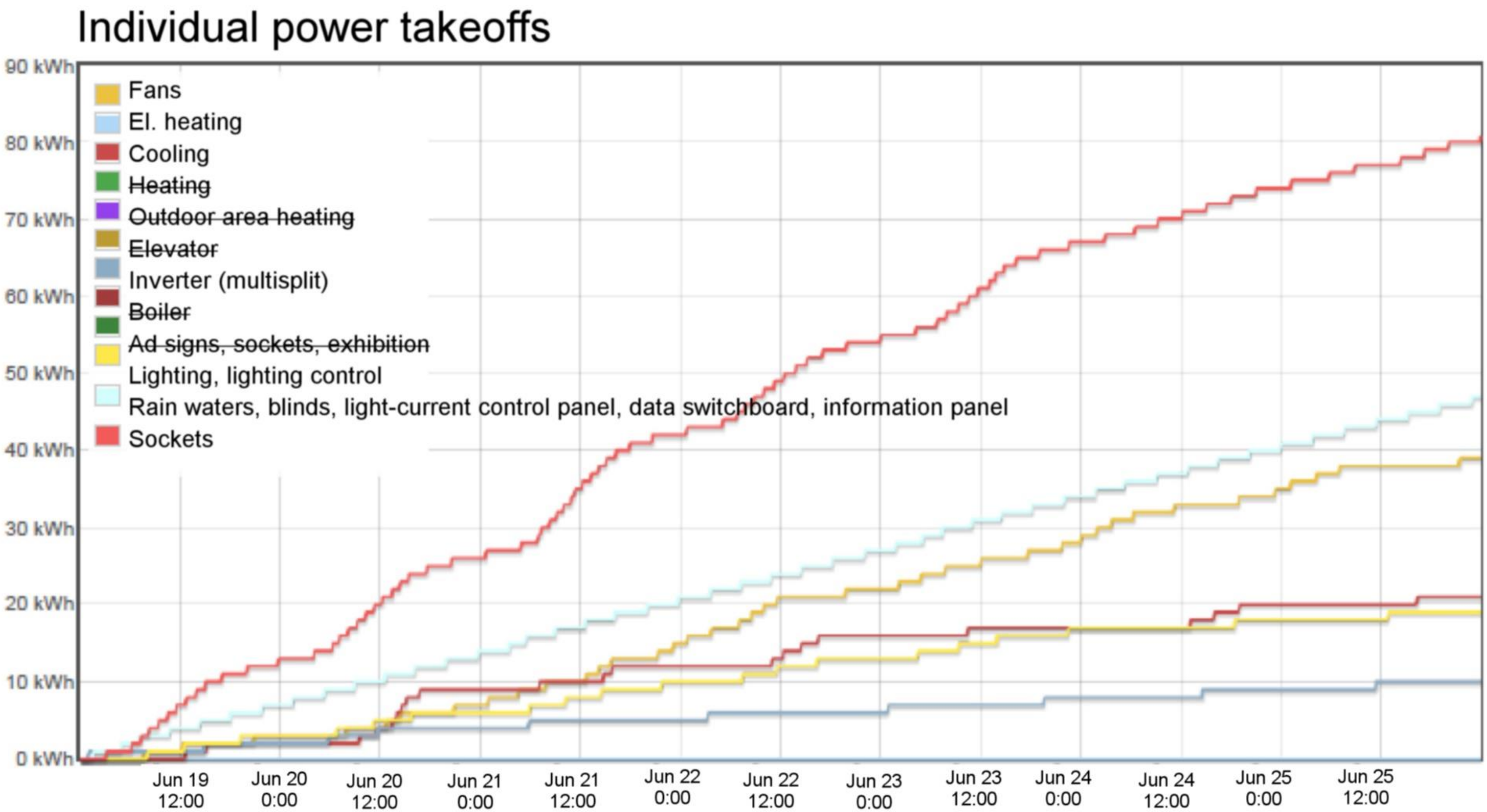
Sunny summer days with daily temperatures over 30°C



Comparison of planned and actual PVE production

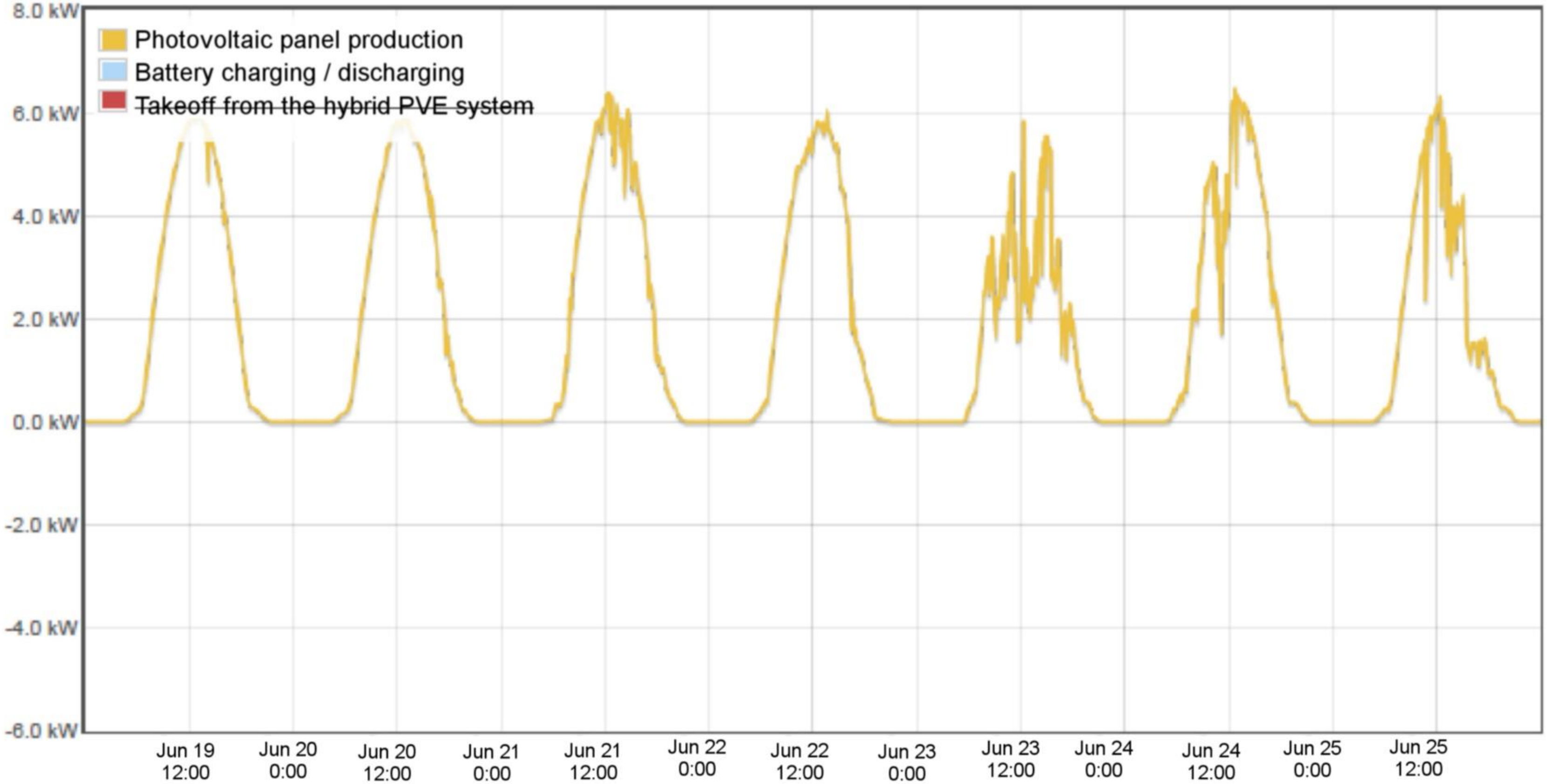


The in-house PVE production covered under these conditions 91 % of energy needs of the building

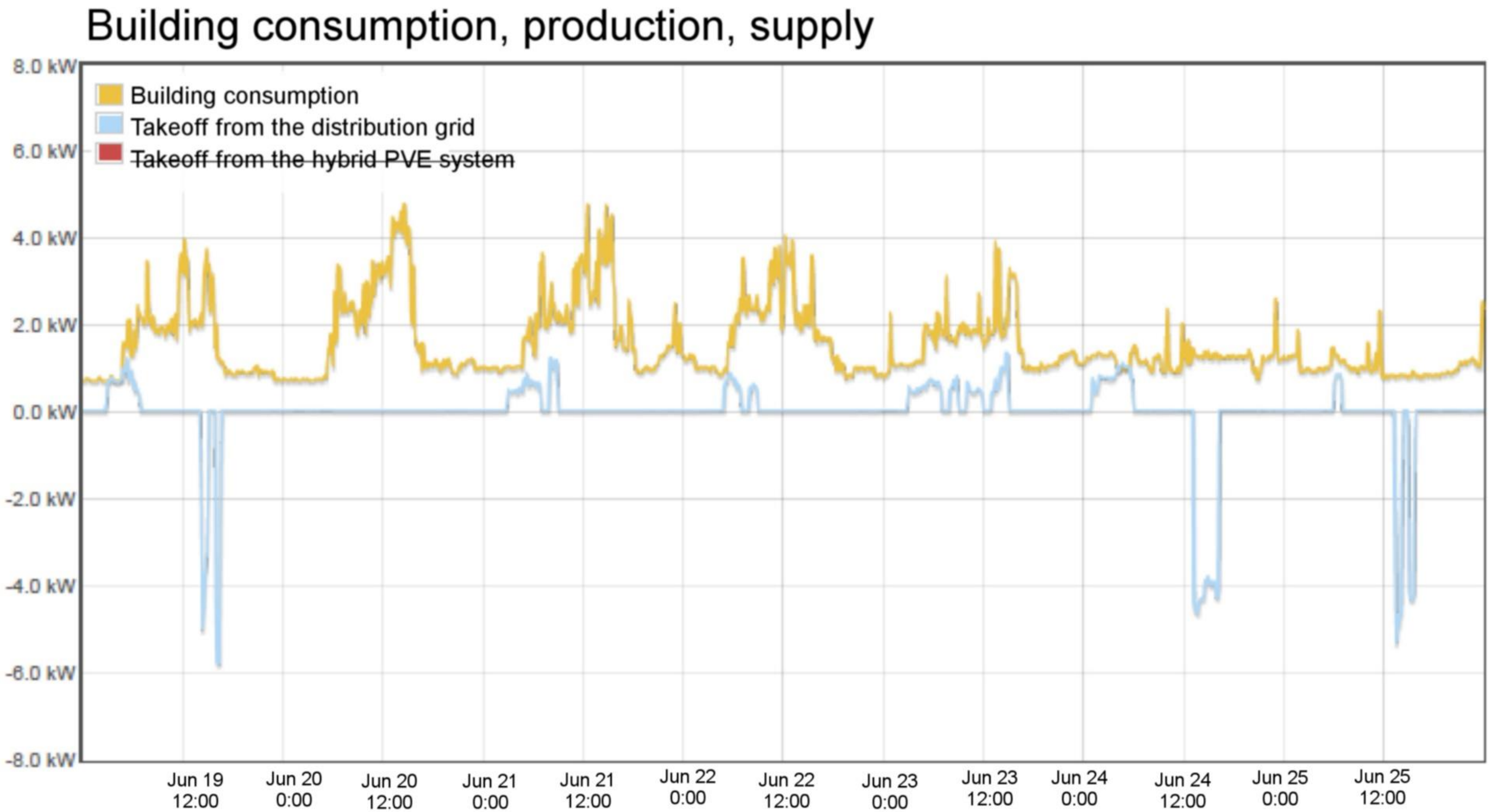


Individual power takeoffs participated in the overall consumption as follows:

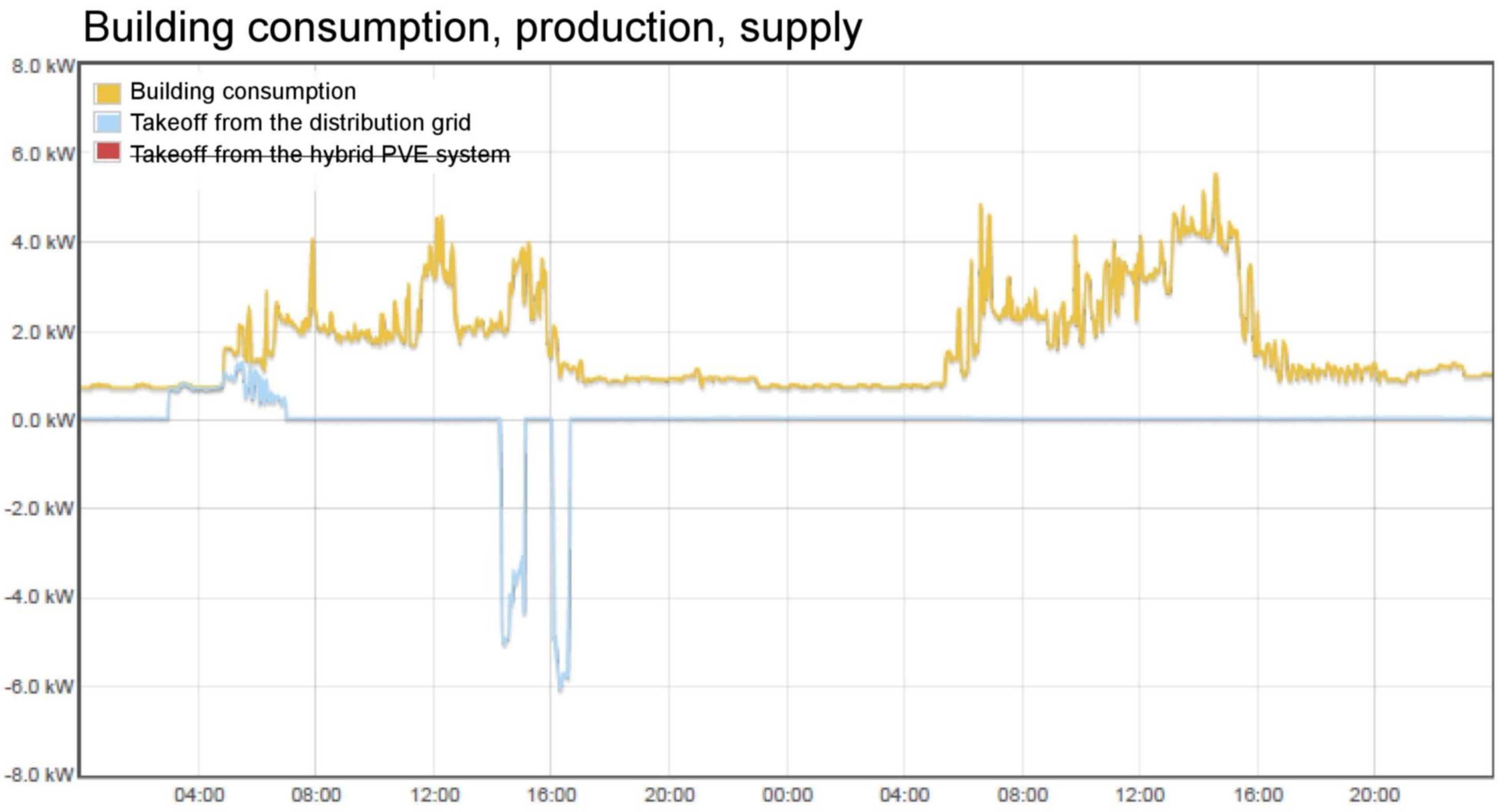
Production and collection



PVE production in individual days was very regular



Comparison of actual consumption of the building with takeoff from the grid - shows minor controlled takeoffs during the night and controlled supplies in daytime (HT)



For a finer displaying – a two-day detail 19.-20.06.2017

FENIX

Battery energy storage system (BESS) operation – 26 kW

Battery charging from PVE and controlled from the grid for max. 4 hours/24 hours
- **Operation verified**

Expected time of controlled autonomous operation - 4 - 7 hours/day
- **Operation verified**

Expected time of reduced stable takeoff (2kW) - 6-9 hours/day

- Verified possibility of using the battery for elimination of peaks and for reduction of the main circuit breaker value. Thus, the building could be operated even in the winter with a 3x 25 A circuit breaker, though a 3x40 A circuit breaker would be appropriate by the output

Verification of the possibility to utilize the building for controlling the ¼ hour maximum.
- Verification was dropped due to a low power input of the building

After shutting down the transformer station, autonomous operation was also checked for the case of a power failure (blackout) - the building was operated from 6.00am to 8:00pm without any restriction and switching to the battery storage did not result in any technology failure.

Battery storage has proven to be a very flexible tool for optimizing building consumption over the 24-hour cycle; it has demonstrated its ability to work with restricted power input to meet all needs. Even in the three-phase scheme the storage significantly contributes to equalization of energy takeoff in individual phases!

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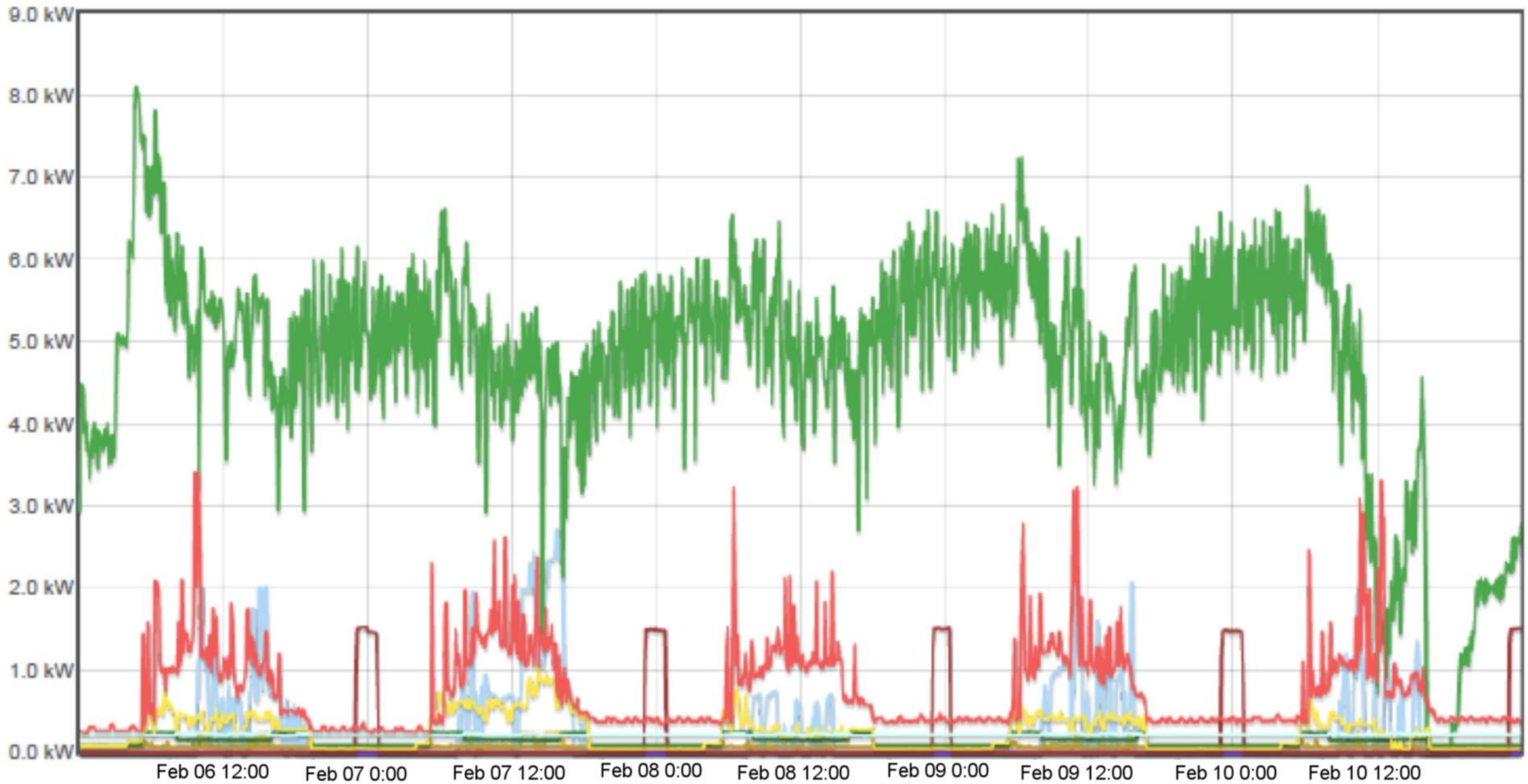
Winter days – 06.-10.02.2017

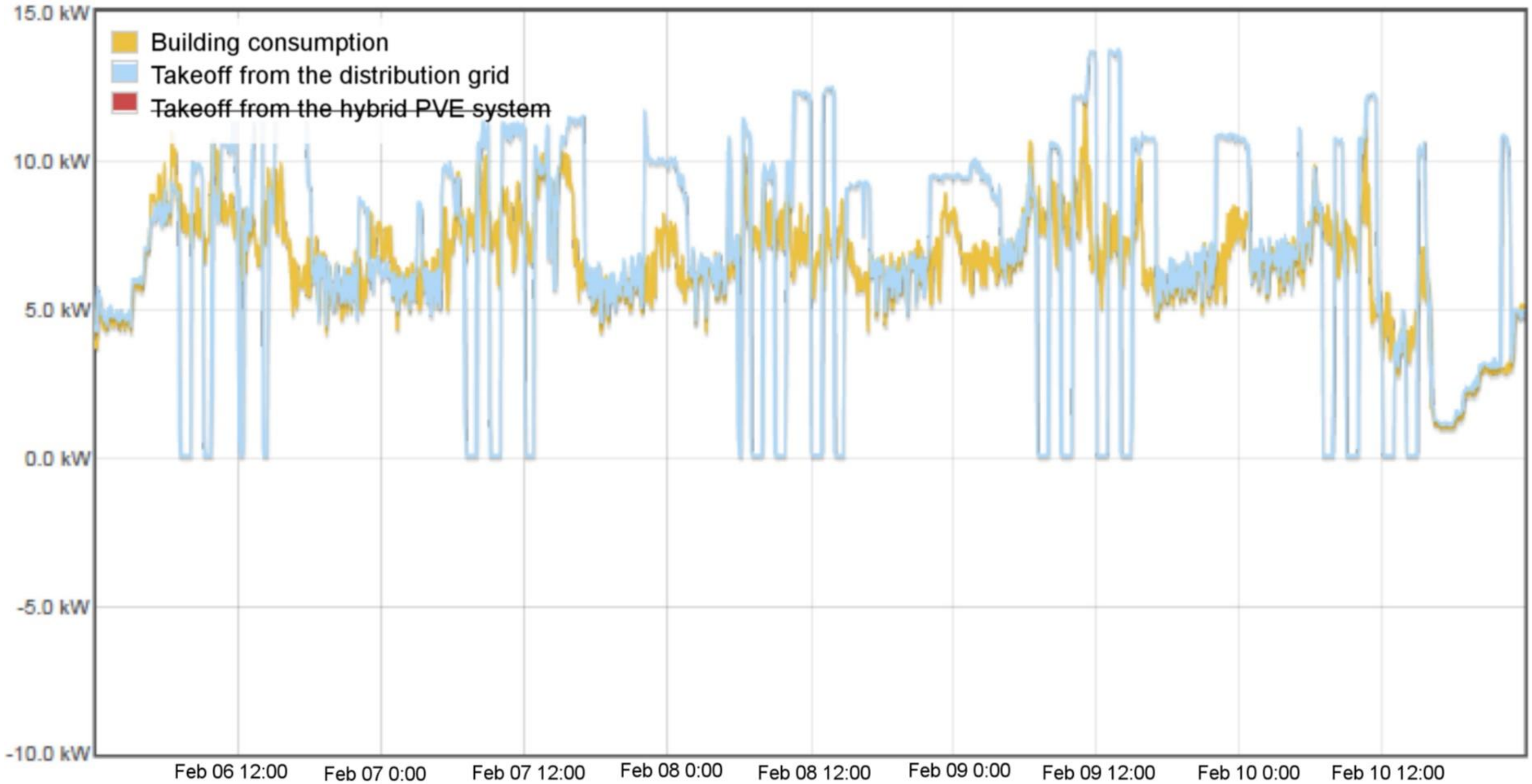
Daily temperatures were below the freezing point, except for Friday 10.2., when the daily temperature went up steeply up to +3°C.

Individual power takeoffs 6.-10.2.2017

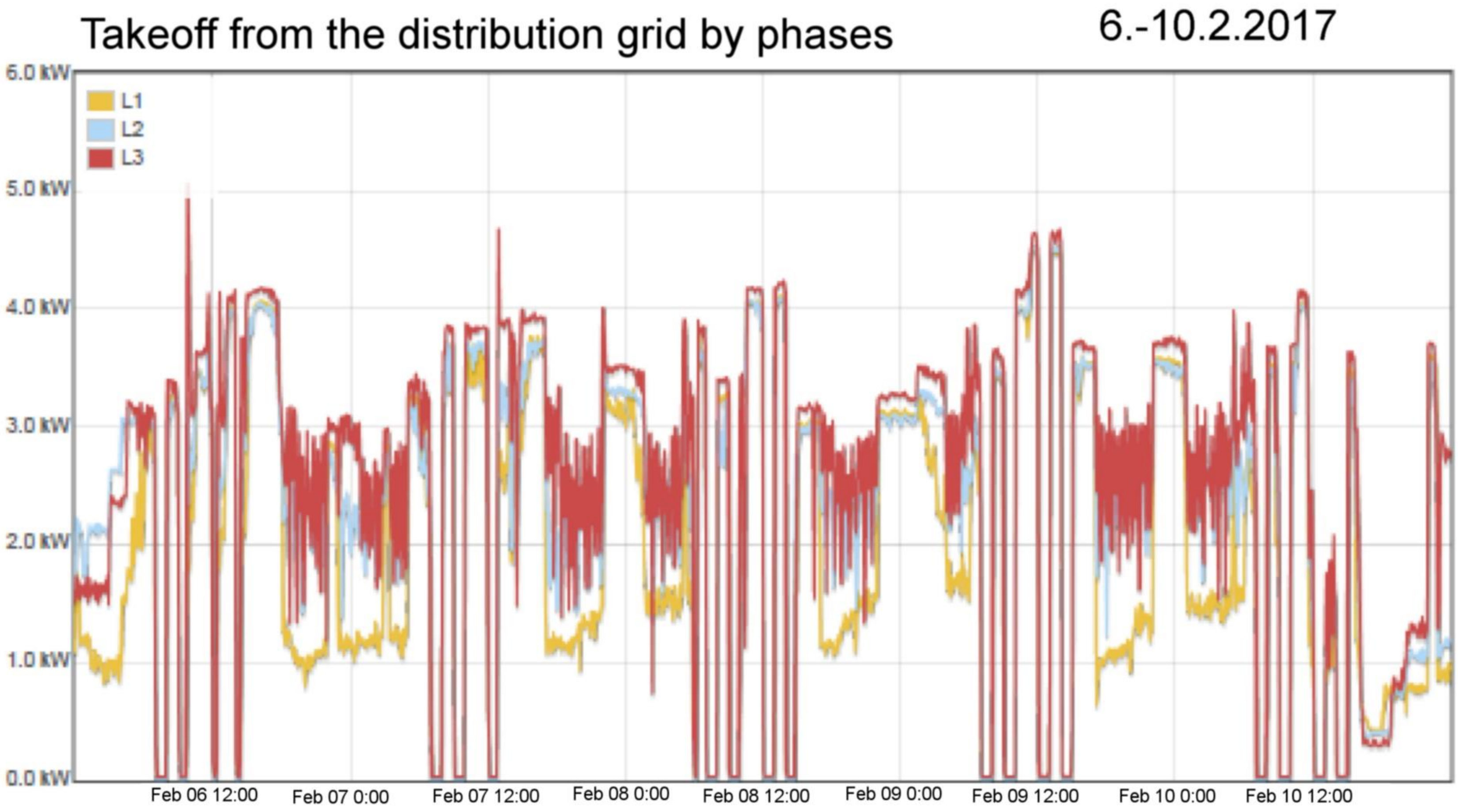


Energy consumption for heating (greenery) is affected by presence of people and by activities of the office technology (lower daily consumptions) and responds significantly to the Friday's warming!

Building consumption, production, supply 6.-10.2.2017

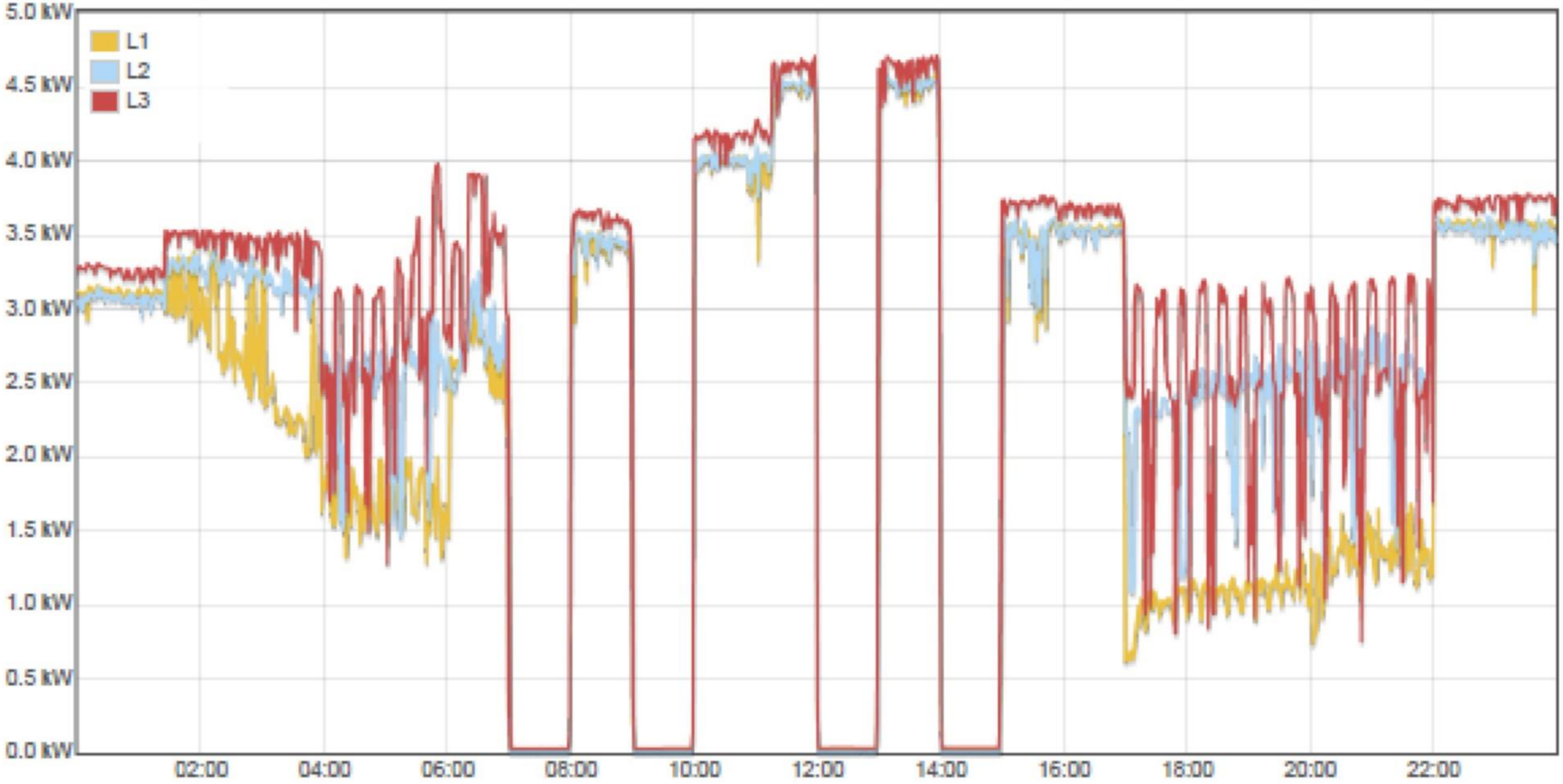


Comparing the actual consumption of the building with takeoff from the grid shows capability of the battery storage to reach the zero power consumption from the grid at peak times (HT) and to harmonize consumption of the building over 24 hours



The storage contributes to the uniform takeoff in individual phases, in the zero takeoff mode the storage ensures the zero takeoff reliably in all phase

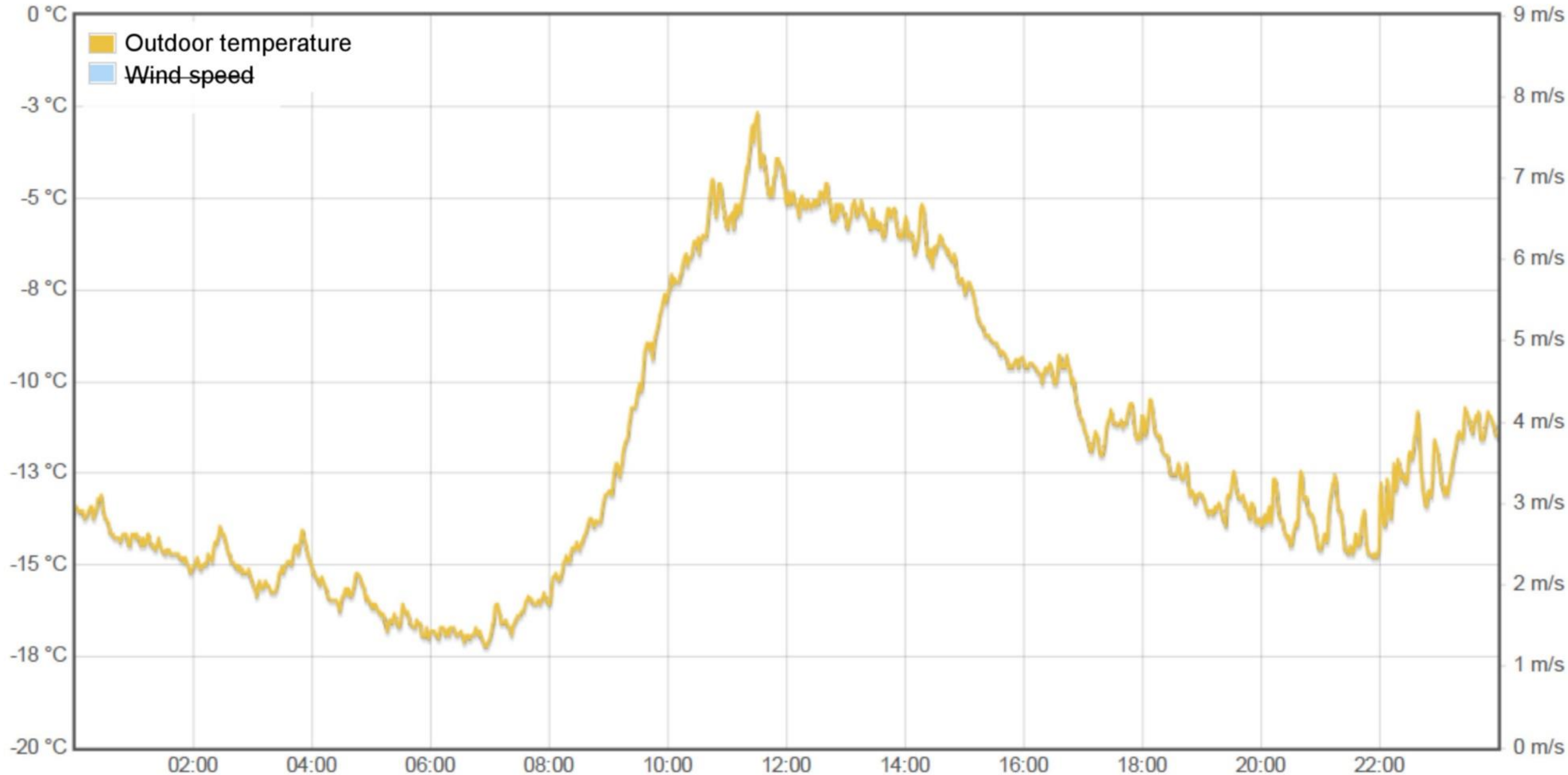
Takeoff from the distribution grid by phases

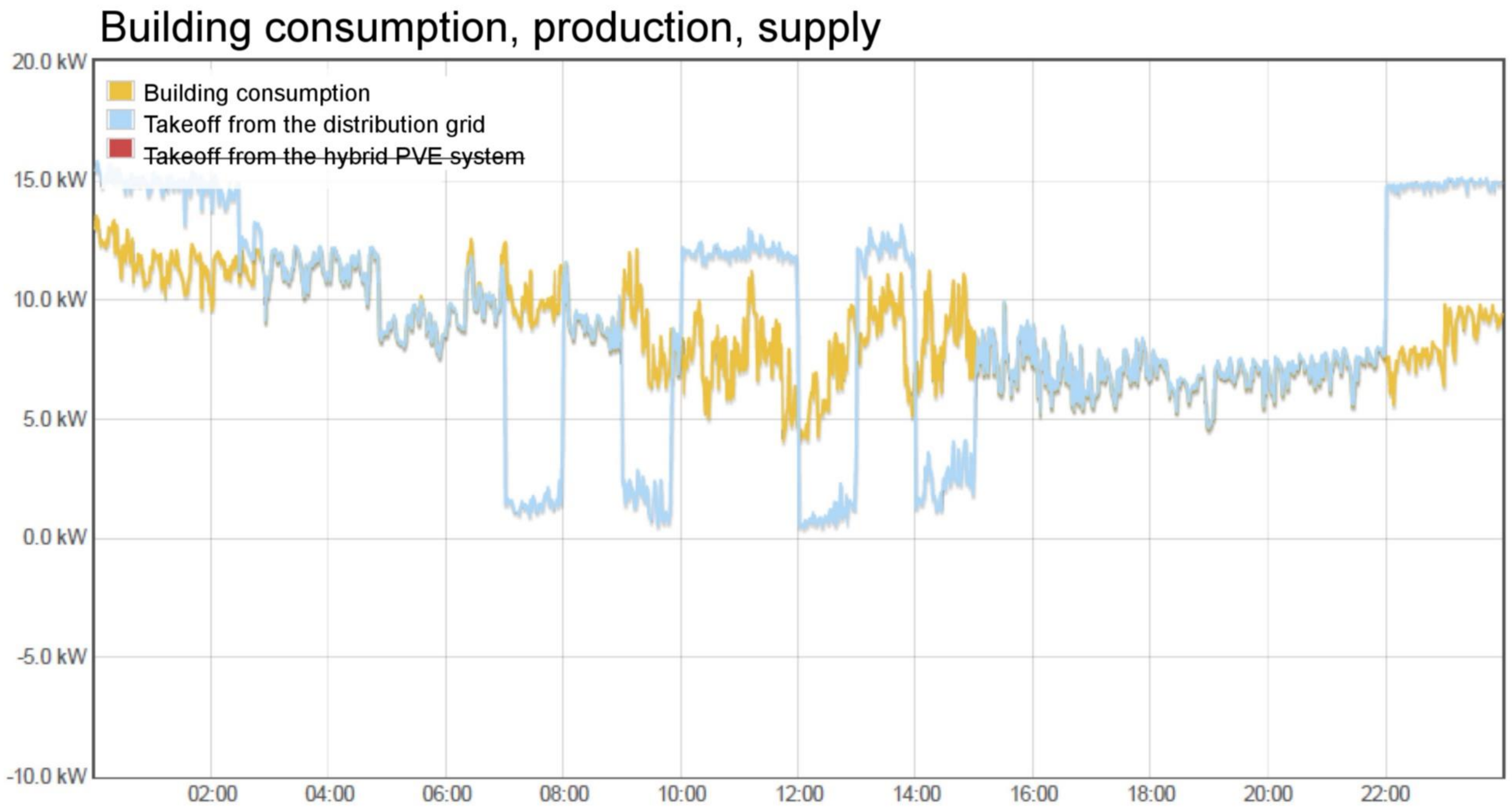


24-hour detail 09.02.2017

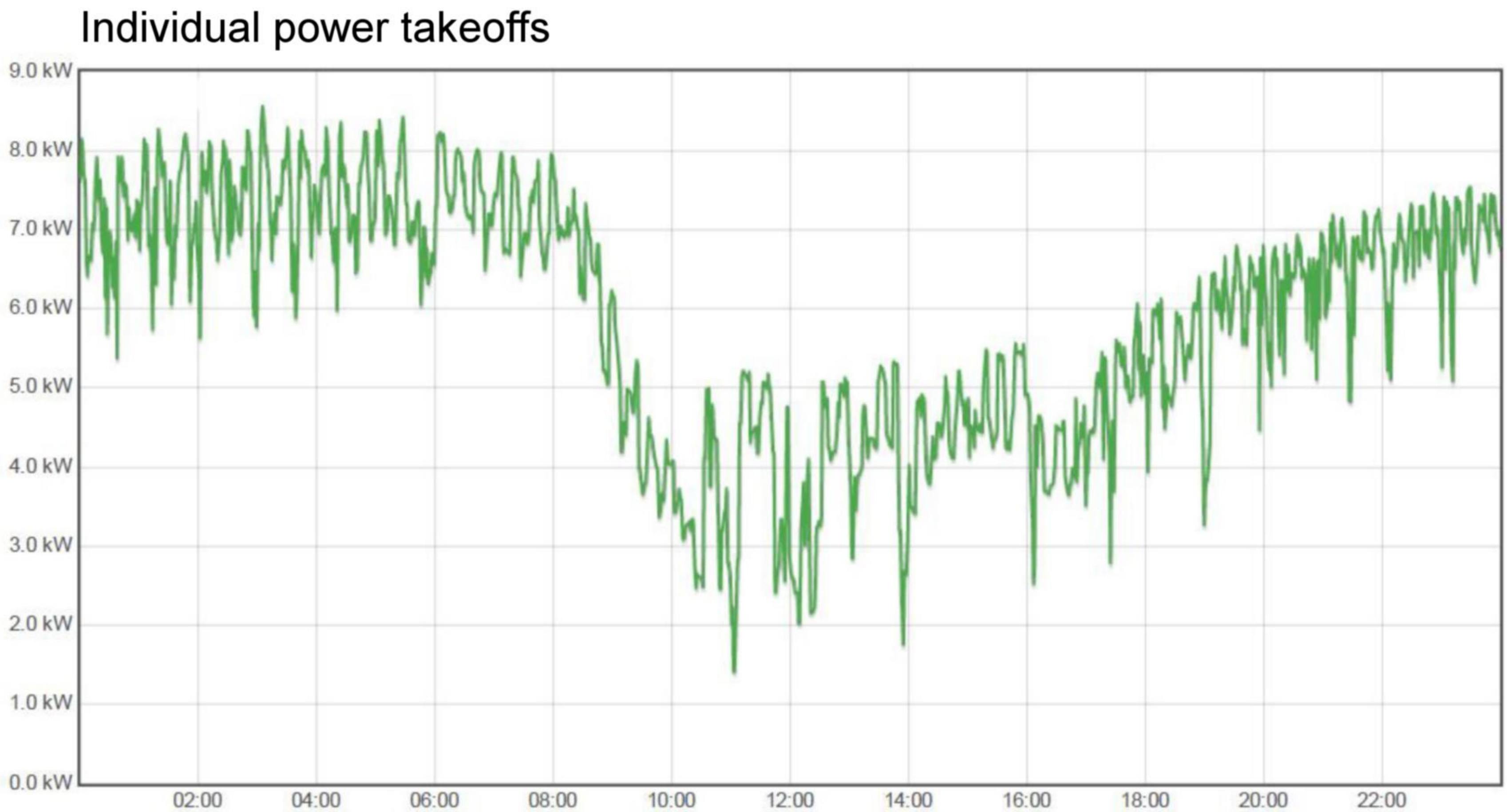
Winter extremely cold day - cloudy
(10.1.2017- average temperature – 12°C)

Outdoor environment





It is clear from the graph that energy consumption is thanks to the technical parameters of the building very uniform in the 24-hour cycle (main consumption: radiant heating). Even under these conditions, this concept provides controlled zeroing of consumption of the building from the grid for 4 hours



Consumption of energy for heating (radiant heating system) responds flexibly to changes of the outdoor temperature and mainly to the random heat gains (people-technology)

Heating

The electric radiant heating system with individual control of each area
(9 kW installed)

Energy consumption for heating was higher than assumed and reached
12,045 kWh in the period 10/16 - 5/17
The following causes have been identified:

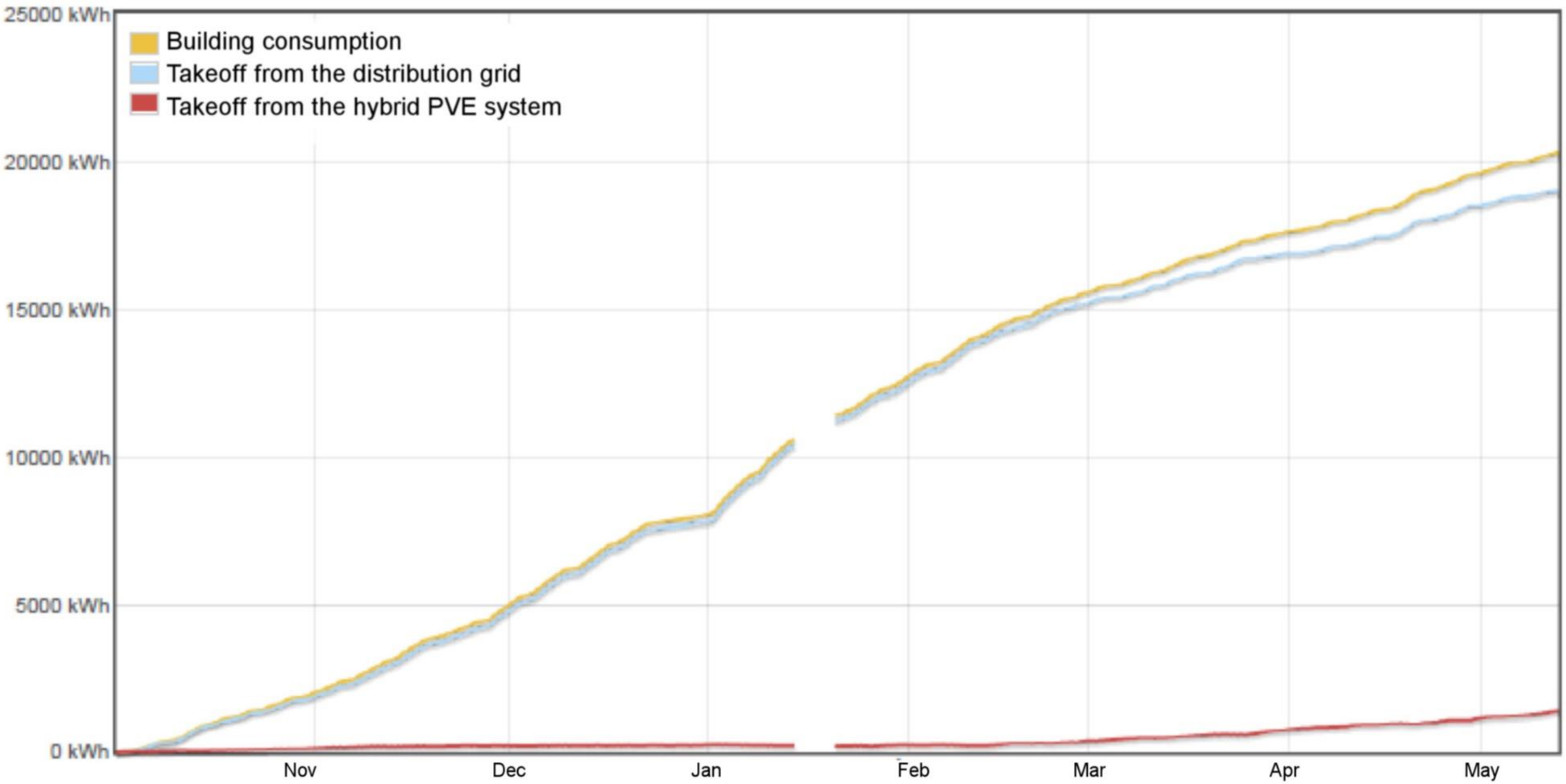
a) Automatic mode of the outdoor blinds prevented utilization of the planned heat gains
Defect removed 12/16

b) Daily temperatures in the period 10/16 - 2/17 were ca 2°C below the long-term average; the heating season ended only on 11.05. 2017. In general, the heating costs are by 8-10% higher than in the previous heating season

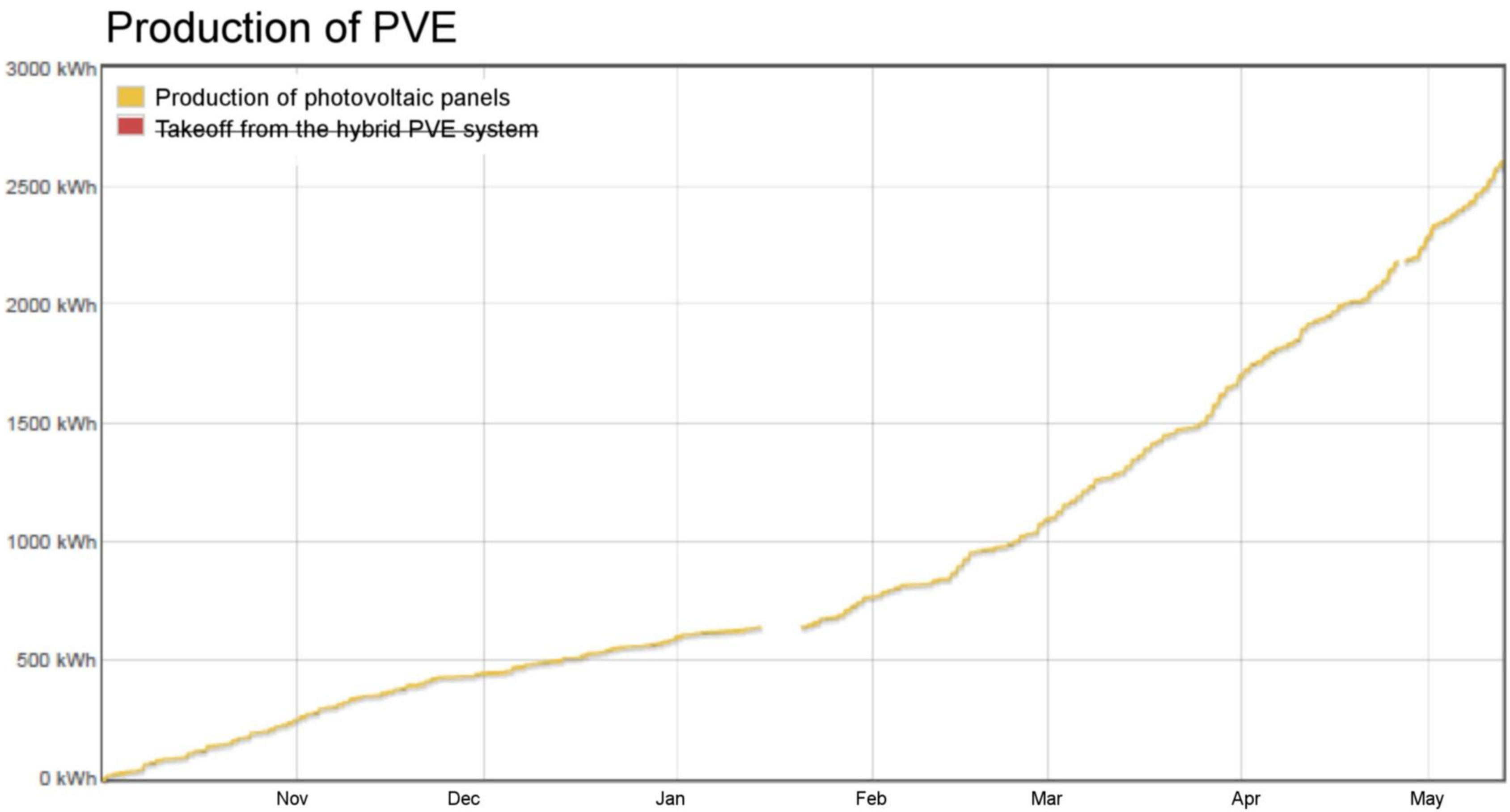
c) It was not possible to prove the advantage of intermittent heating during the working week. As in the mornings the takeoff peaks were observed in the mode with night reduction, no energy savings could been proven - the test will be repeated during the next heating season

In general, the heating system responded very flexibly both to the temperature changes and to occupancy of individual heated zones

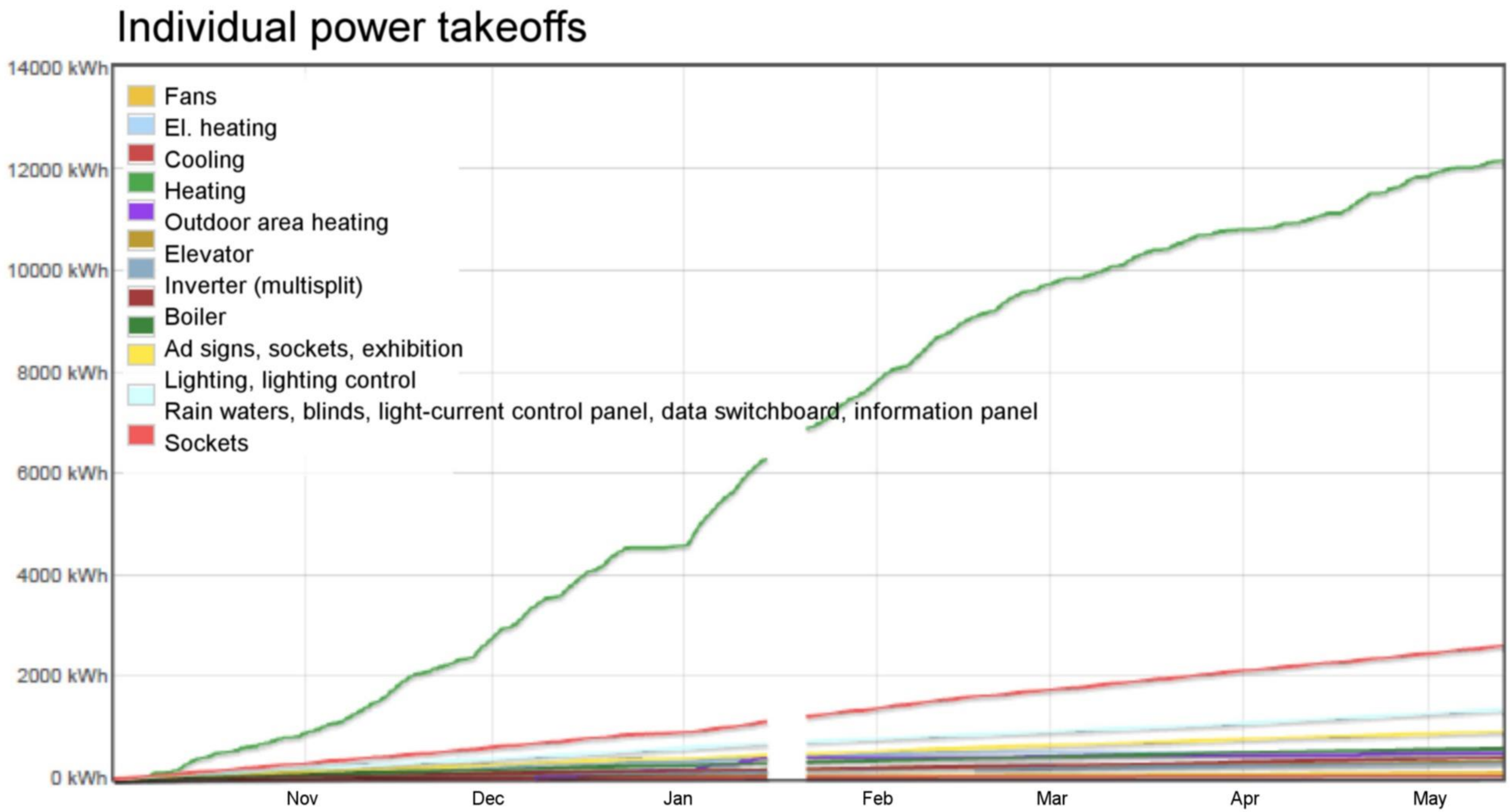
Building consumption, production, supply



During the heating season as many as 20 005 kWh were consumed



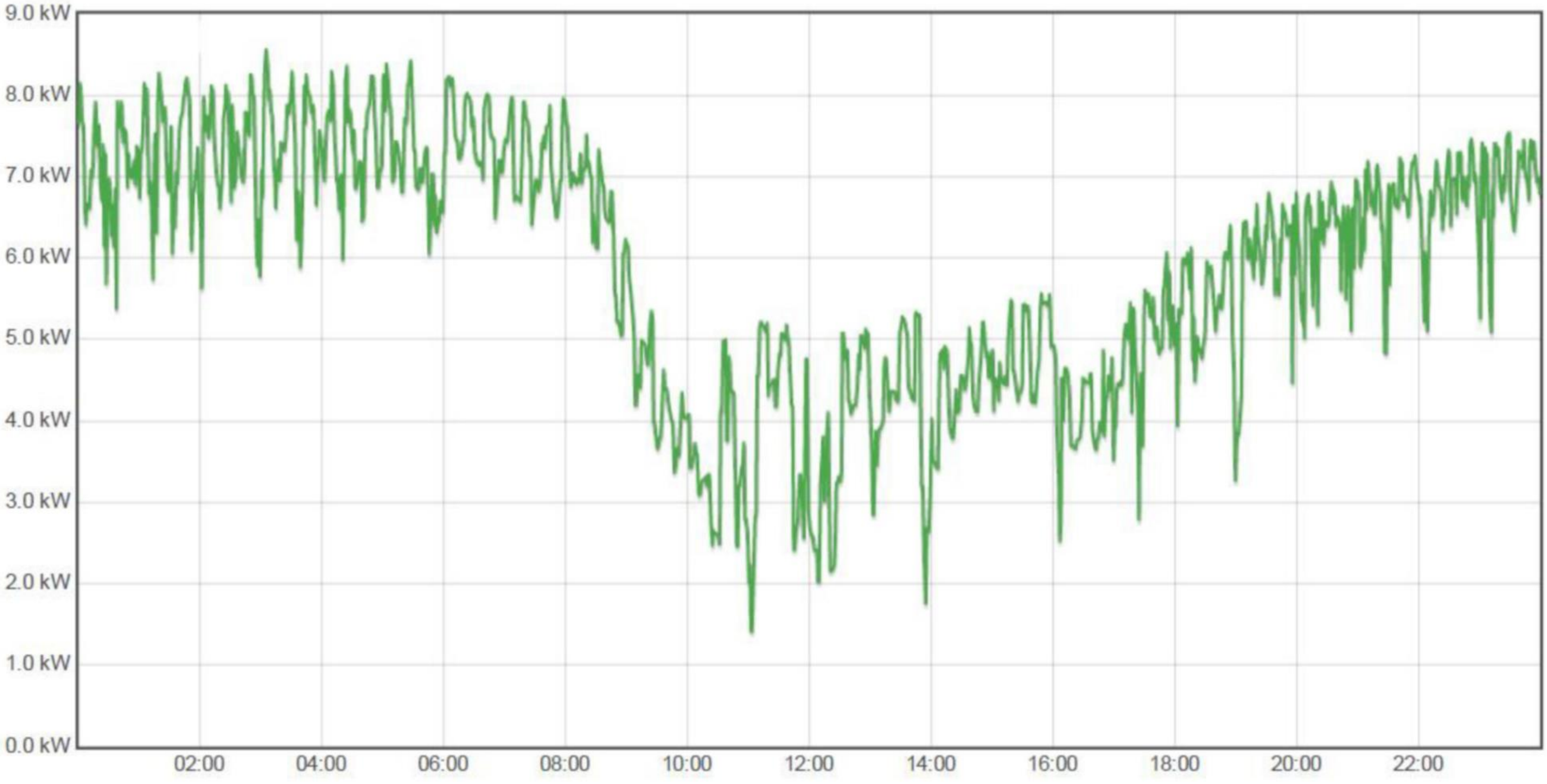
Production of PVE ensured during the heating season 2 507 kWh, i.e. ca 12,5 % of the overall consumption



Electric heating represented a significant part of energy consumption during the heating season and participated in the total consumption by 59.8%
Electric heating accounted for by 48% in the all-year consumption

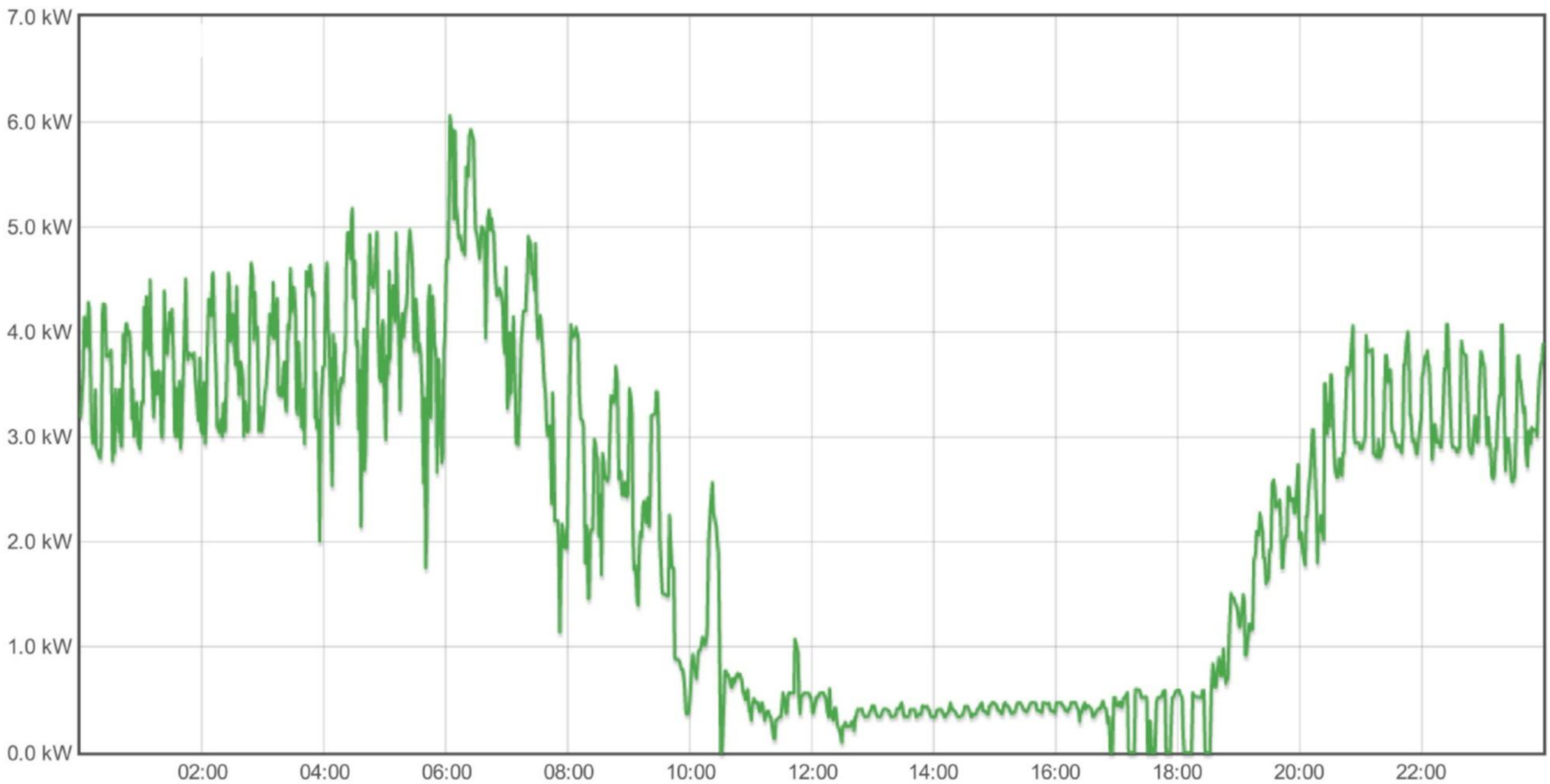
Individual power takeoffs

Extremely cold day (-12°C) – cloudy



Consumption of energy for heating (radiant heating system) responds flexibly to changes of the outdoor temperature and mainly to the random heat gains (people-technology)

Individual power takeoffs Sunny day on 16.02.2017– aver. temperature +4.7°C



Material influence of heat gains (sun-people-technology) on energy consumption can be seen from this graph showing energy consumption for heating. However, full use of this effect requests a flexible heating system capable of rapid response, namely in each heated zone separately.
Classical hot water systems (with any source) do not have this ability in nZEB!

FENIX

Controlled ventilation with recovery - cooling, air conditioning

During the first 5 months the system was set up - the final setting - CO_2 response in individual rooms + ensuring minimum ventilation - in the summer months the intake air temperature was set to 20°C, in the winter months – to the exhaust air temperature

In the summer months, intensive night ventilation of the building was set for the case of high day temperatures

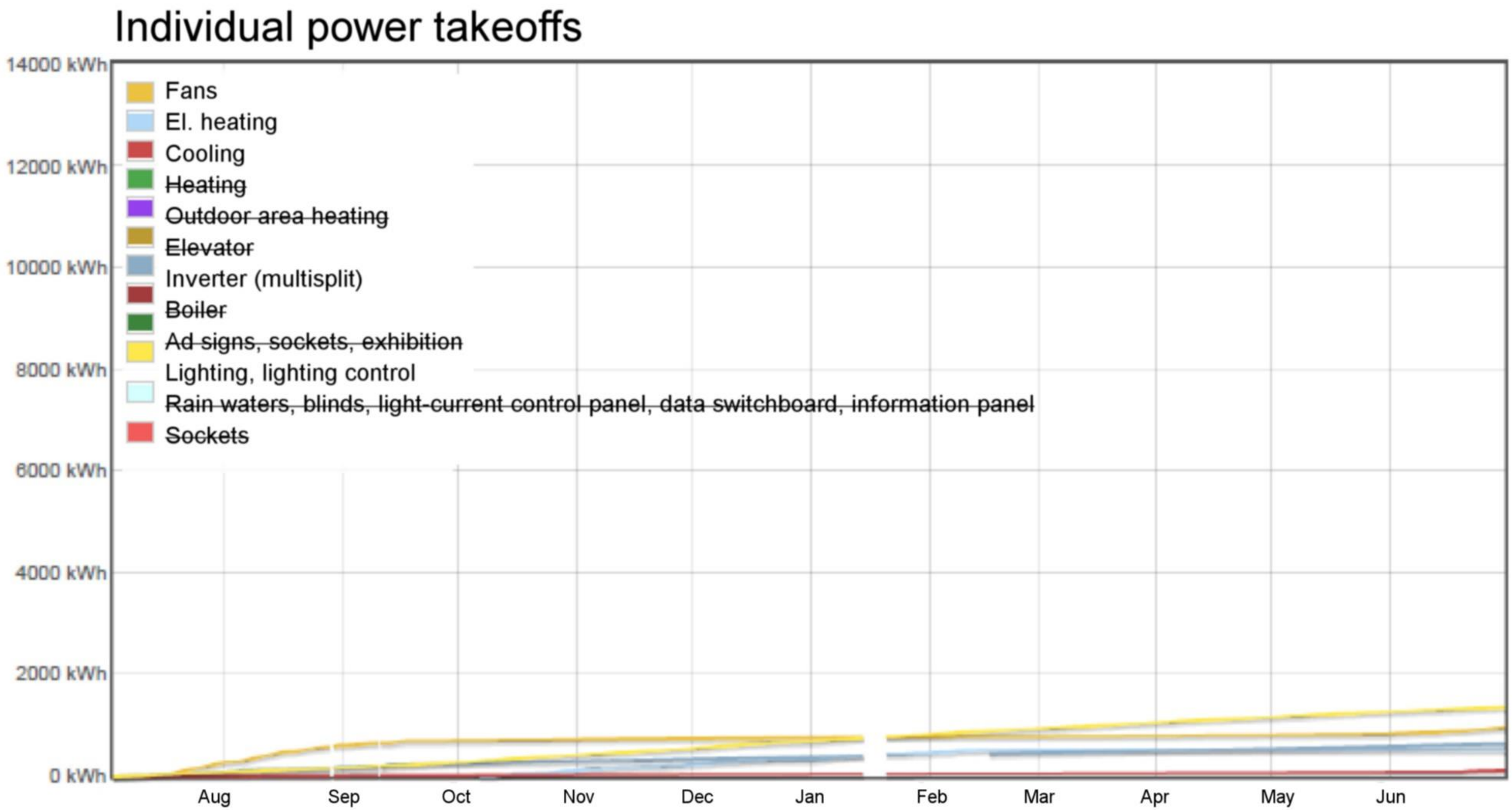
During the summer cooling of the inlet air with air conditioning proved to be more energy demanding than cooling the space with the multi split system unit

However, the subjective feeling of comfort of the present staff was higher in the first case

Use of HVAC inlet air cooling during the summer months seems to be more energy consuming than space cooling by the multisplit AC unit.

Nevertheless, subjective feeling of comfort by the present staff was higher in the first case

Annual energy consumption - ventilation: 980 kWh
- multisplit: 350 kWh



Annual energy consumption – ventilation – multisplit – cooling

Comparison of consumptions when mechanical HVAC cooling or AC during the chosen days has been applied - by the outdoor temperatures.

The following days have been chosen for comparison :

08.08. and 15.08. – max. outdoor temperatures of 30°C

10.08. and 18.08. – max. outdoor temperatures of 35°C

Assessment:

In both cases the overall consumption of the building was lower when the indoor AC units were used.

		Mechanical HVAC cooling [kWh]	AC unit (multisplit) [kWh]	Fans [kWh]	In total [kWh]
tmax + 30°C	08.08.	4	1	9	14
	15.08.	0	3	3	6
tmax + 35°C	10.08.	20	2	11	33
	18.08	0	6	4	10

Further procedure

1) The data are collected online on the UCEEB cloud and everyone involved has access to them

2) By 30 September 2017, UCEEB shall prepare an interim report evaluating and assessing:
    a) expected and actual energy consumption of individual sets
    b) fulfilment of prerequisites for functionality of the building in individual modes
    c) microclimatic conditions inside the building

3) By 30.10. 2018, UCEEB shall prepare a final report assessing the two-year operation of the building in all aspectsh

4) The Working Group shall assess creation of appropriate conditions for extension of the concept.

With respect to the fact that the preliminary results of the project already indicate feasibility and accessibility of the raised objectives and goals, we have decided to move forward in this field:

- In December 2016 the start-up AERS s.r.o. (Advanced Energy Storage Systems) - preparing the AES modular system with the required functionality and covering a given area from minor applications (10kWh) for flats and small family houses up to1000 kWh for shopping centres, production, farm buildings and for the sector of services – was established

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

- At this moment we are finishing (in our production premises Fenix in Jeseník) the project of the battery storage (640 kWh) working with the roof PVE 24kWp namely with the following goals:
    - reduction of the reserved capacity (24-hour distribution of consumption)
    - management of ¼ hour maximum
    - elimination of short-term outages/blackouts that may cause significant damage
- Data from this project will again be available on the UCEEB server

- The building will be monitored for 1 year and then the final report will be issued

- This concept promises an interesting return of investment at the existing storage costs already, and a great potential for the future can be seen in its development.

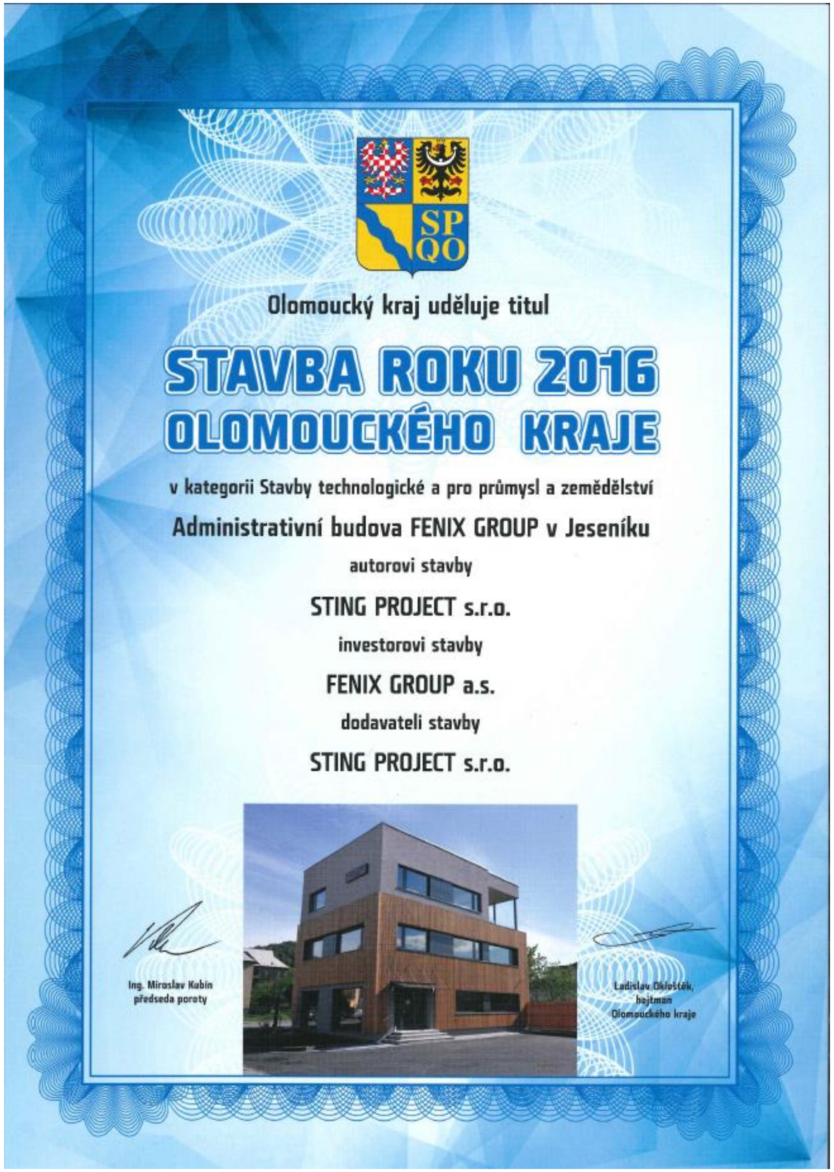
Awards :

1) Concept of the house as an active element of the power system has been awarded a special award: the “Environmental Initiative of the Year in the Power Sector” on 16.06. 2016 at the Prague Castle,
where the CZECH TOP 100 were declared

2) Concept of the house has attracted attention of the organizers of the exhibition INFOTHERMA 2017 so much that the house has become the central exhibition and motto of the whole exhibition. There was also a thematic expert conference organized there and some members of the expert working group took active part in it

3) On 27.03. 2017 the OC project has been awarded the following prize by the Head of the Olomouc Region

Building of the year 2016



Olomoucký kraj uděluje titul

STAVBA ROKU 2016
OLOMOUCKÉHO KRAJE

v kategorii Stavby technologické a pro průmysl a zemědělství

Administrativní budova FENIX GROUP v Jeseníku

autorovi stavby

STING PROJECT s.r.o.

investorovi stavby

FENIX GROUP a.s.

dodavateli stavby

STING PROJECT s.r.o.

Ing. Miroslav Kubín
předseda poroty

Ladislav Okleštěk,
hejtman
Olomouckého kraje

4) We appreciate highly the fact that this project will be presented - **as one of 10 official exhibits in the exposition of the Czech Republic at the World Exhibition in Astana (06/17-10/17)**

Motto of the exhibition: energy savings and energy efficiency

EXPO2017 ASTANA CZECH REPUBLIC

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