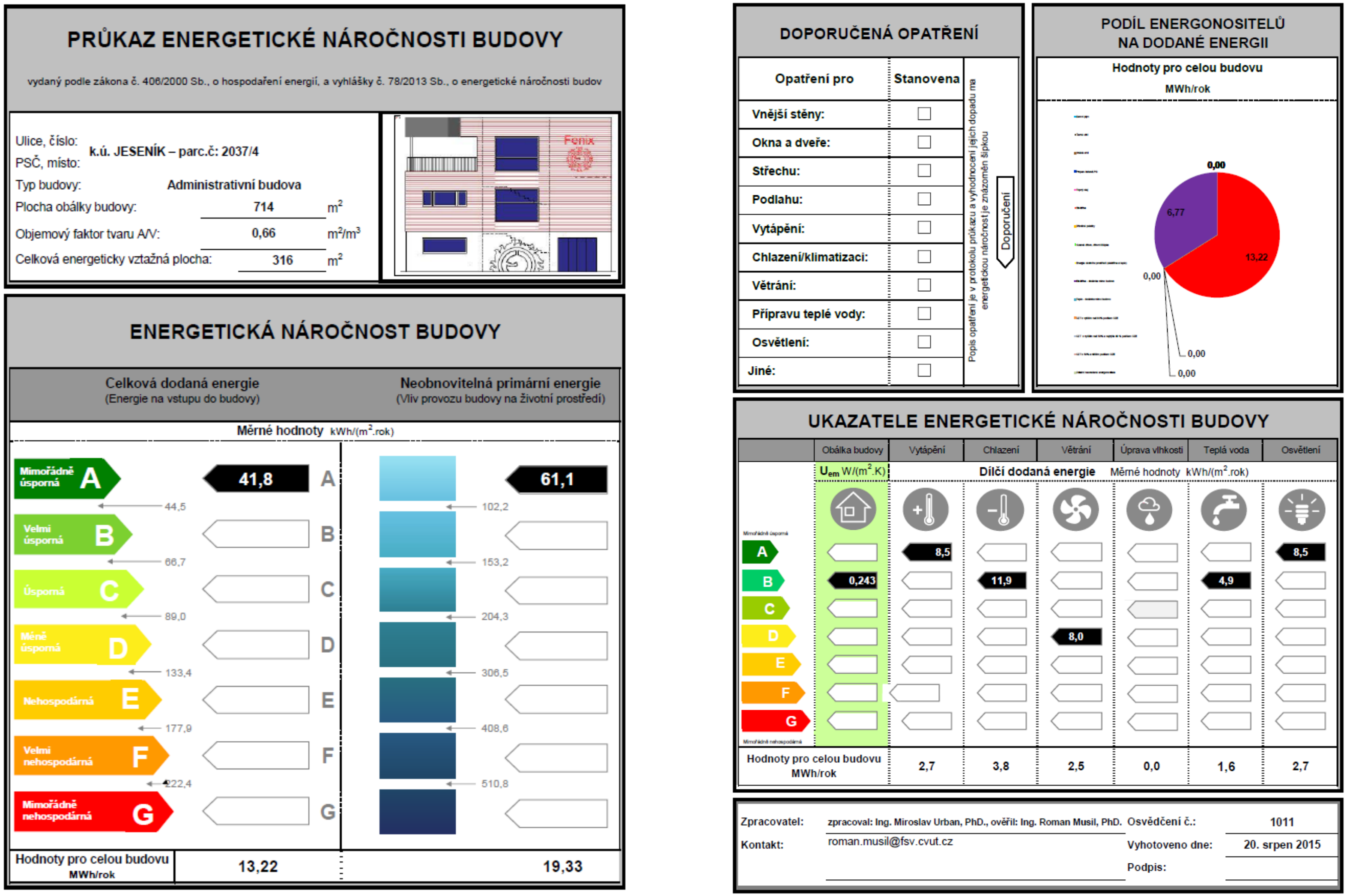
FENIX

The nZEB as the active element of an energy system

20 months of operation!

The building’s energy label

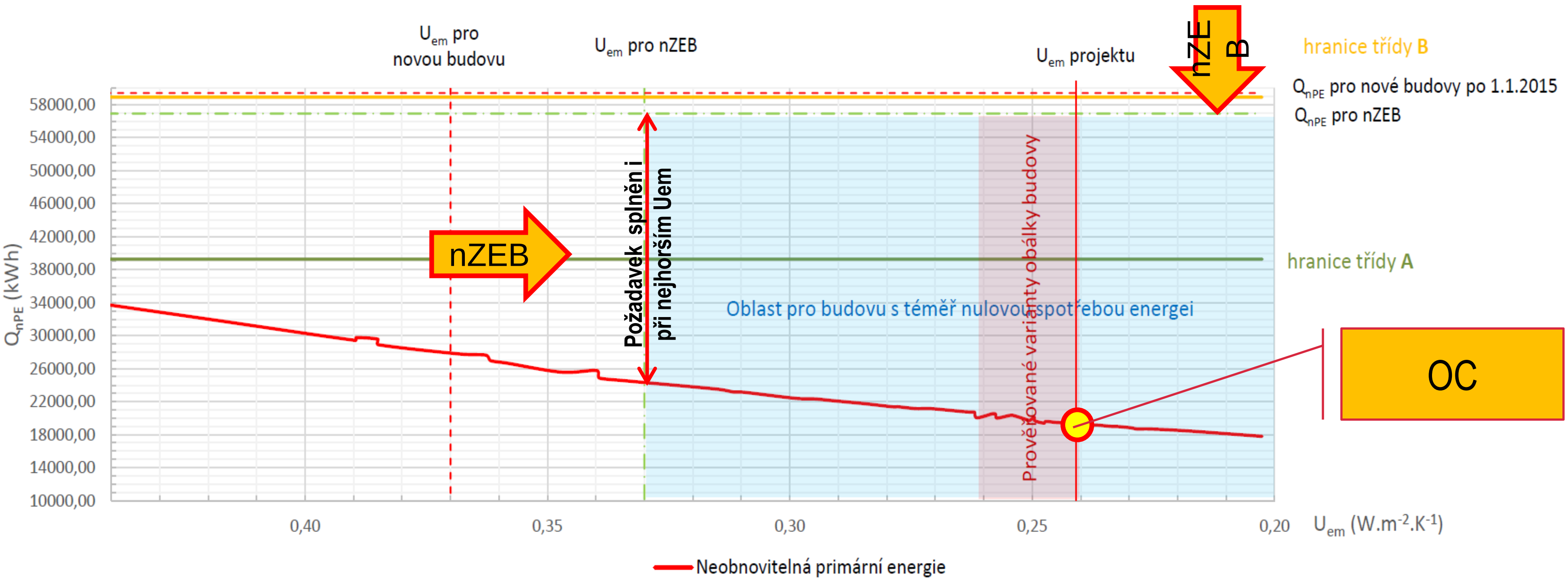
calculated according to the 2020 standard



Built to the nZEB standard, the fully electrified building features an electric radiant heating system.

UCEEB

Achieved level of NPE



FENIX

Office Center - a building with nZEB parameters

A fully electrified building as an active network element

Presentation of the idea of an nZEB as an active network element - 2014

Design of the building – cooperation with the Czech Technical University in Prague 04 / 2015-08 / 2015
Start of construction – 10/2015
End of construction – 05/2016

Cooperation between a 7.2 kWp roof PVP, a 26kWh home battery and the energy grid
The battery is used not only to enable the 100% use by the building of the energy from the PVP but also to allow active cooperation with the network. This means that the battery is charged during the low tariff period and fully takes over supplying the building with energy during the high tariff period.

The building was designed with the help of the building services department of the CTU in Prague and a group of specialists consisting of representatives from the Ministry of Industry and Trade, the Ministry of the Environment, the Energy Regulatory Office, ČEZ-ESCO, ČEZ – Distribution, ČEPS and the CTU in Prague. CTU in Prague - UCEEB is in charge of data collection with regard to the building's energy consumption as well as the quality of its indoor environment.

Three surprises during construction

1) Due to careful project preparation and the optimization of costs, the total investment costs were at the 2015 price level for standard structures of a similar type!

2) The building was equipped with flexible electric radiant heating. The evaluation of a possible alternative variant using a warm-water system together with a heat pump suggested that return on investment would only occur after 25 years of operation, i.e. after approx. double the lifespan of the heat pump. The real energy consumption of the building after 20 months of operation confirmed this information. If the return on investment were calculated just for the heating system (without considering the cooling system, which is practically unused), it would take up to 40 years to occur.

3) Monitoring of the operating cycles of the battery storage system confirmed its lifespan will exceed 25 years.

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

Expected yearly energy consumption	**UCEEB –**	**27 000 kWh**
Real energy consumption		**25 126 kWh (- 7%)**
Consumption of energy from the grid		**21 000 kWh**
Energy loss of HPVP		**1 500 kWh (6%)**
Energy consumption on the heating and warming of water		**12 402 kWh**

Electricity consumption in the 2017 heating season (1.9.-1.3.2017) - 17 000 kWh , heating consumption 9 800kWh

Energy consumption in the 2018 heating season (1.9.-1.3.2018) – 15 050 kWh (-12%), heating 8 500 kWh (-13,3%)

Production of electricity by the PVP – 100% used	**PV – 7 200 kWh**
Real production	**6 050 kWh**

The reason for the lower production of the PVP was its primary setting meant that no overflow of energy into the grid was permitted in any situation, even at the cost of lowering the output of the PVP.

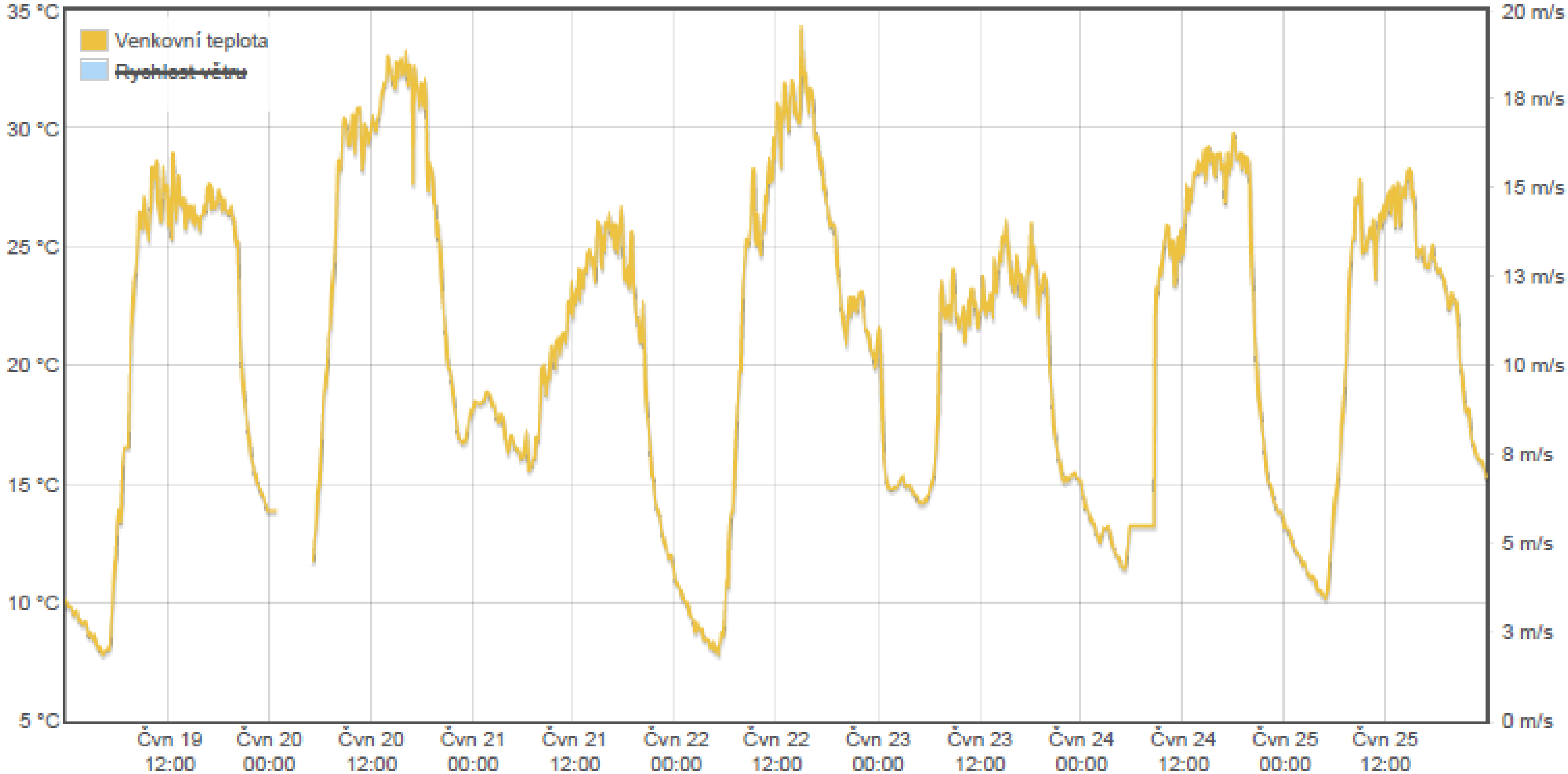
In 2017 the parameters had already been adjusted so that mainly in the summer months when the consumption is low and the production of the PVP is high, "controlled overflows" took place based on the programme and the HDO signal – i.e. only at the request of the grid operator.

It was verified that this controlled delivery system is fully functional and can provide advantages both for the control of the grid and for the users themselves!

FENIX

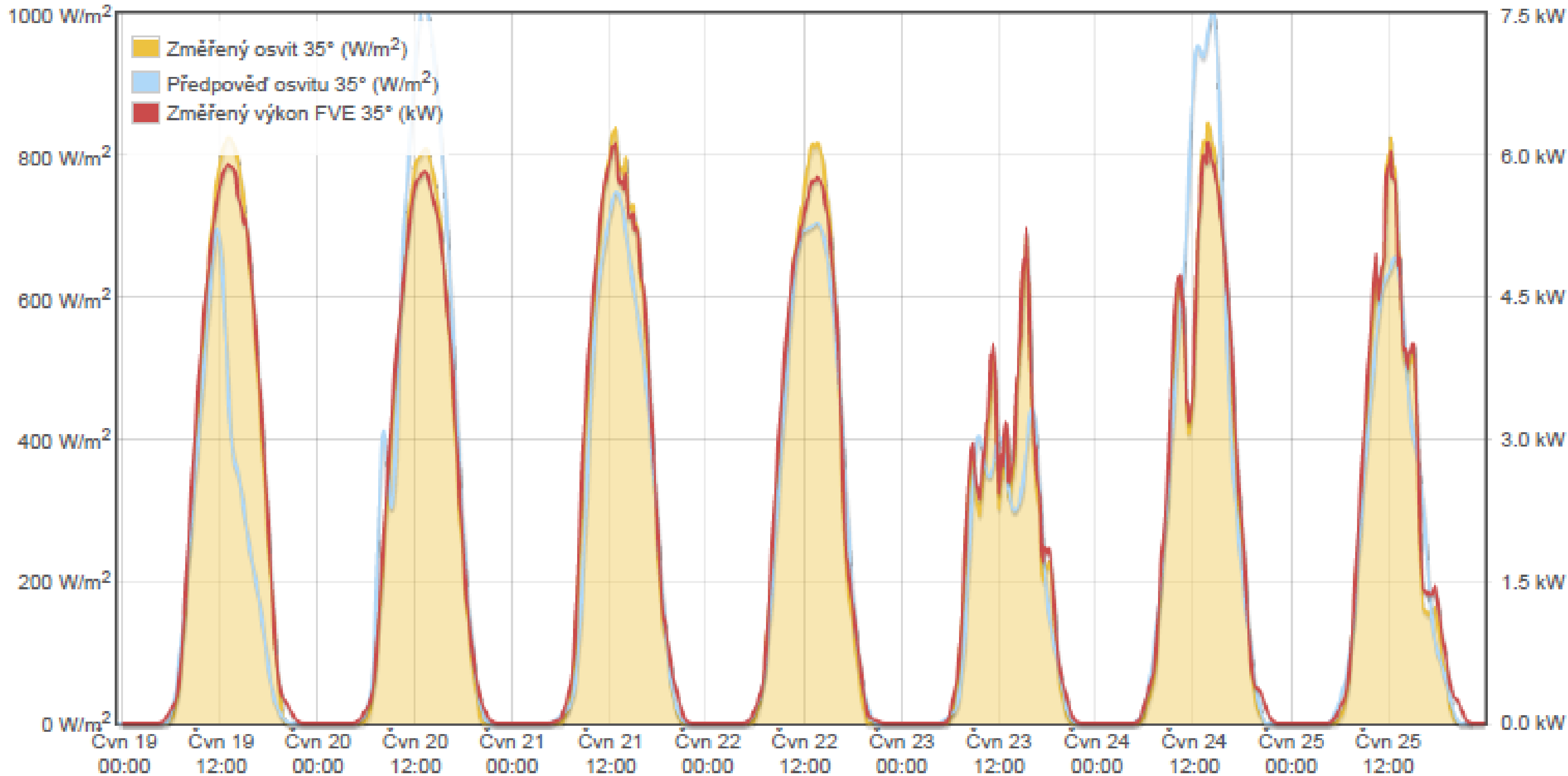
Summer operation – 19. 25.6. 2017

Outdoor environment



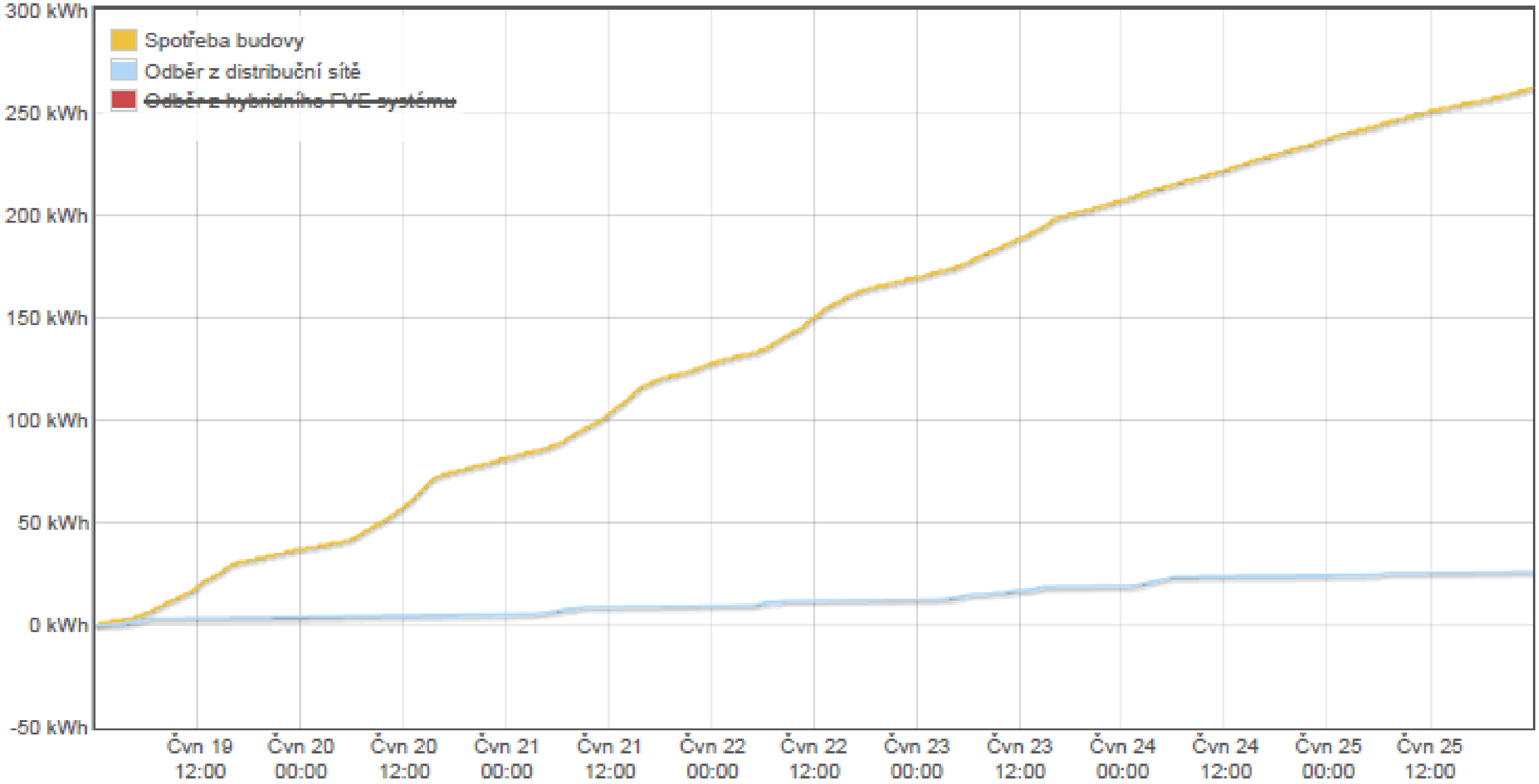
Sunny summer days with day temperatures exceeding 30°C

Exposure and produced output – gradient 35°



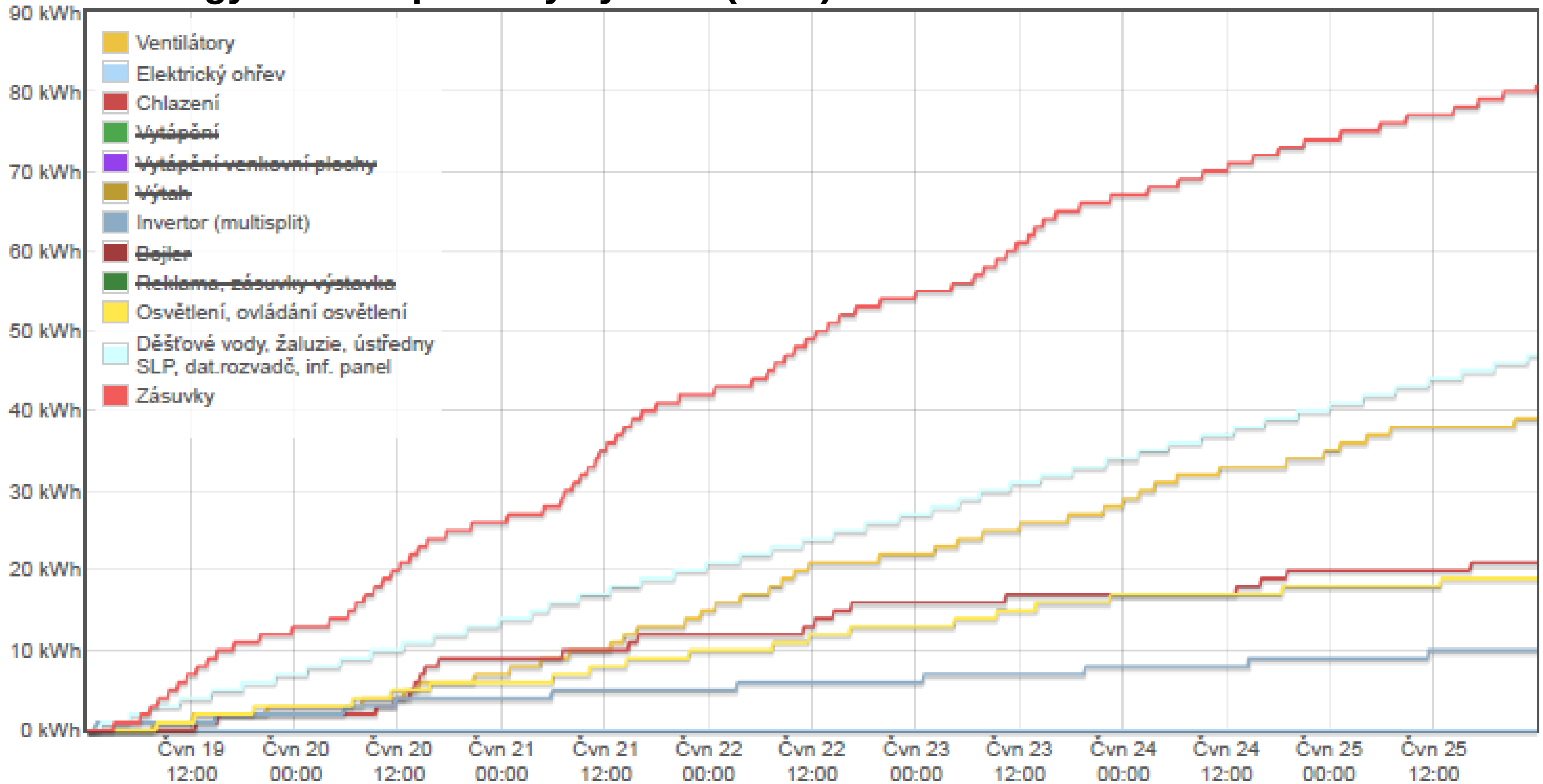
Comparison of the planned and real output of the PVP

Consumption of the building, production and supply (kWh)



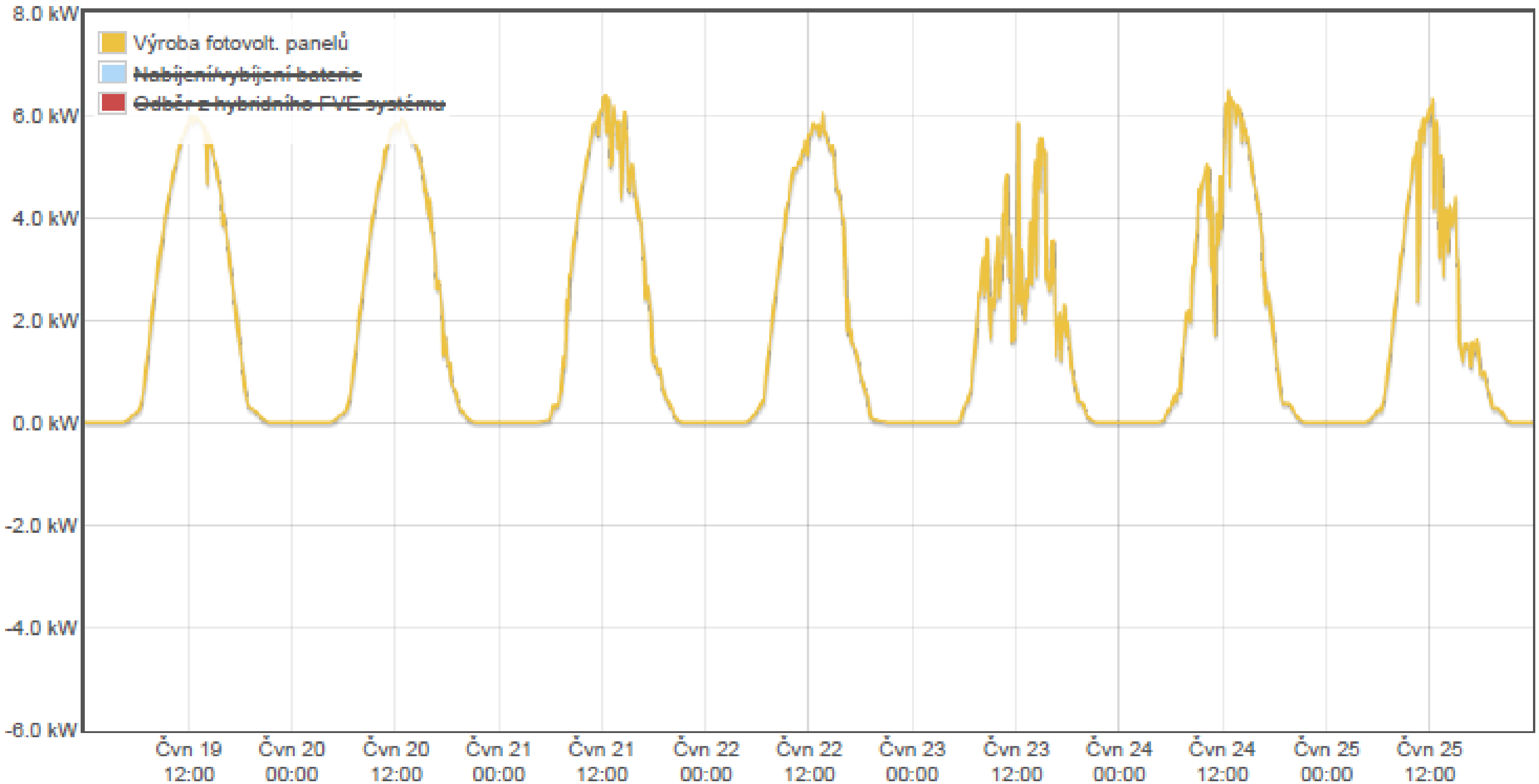
The output of the PVPs covered 91% of the energy requirements of the building under these conditions.

Energy consumption by system (kWh)



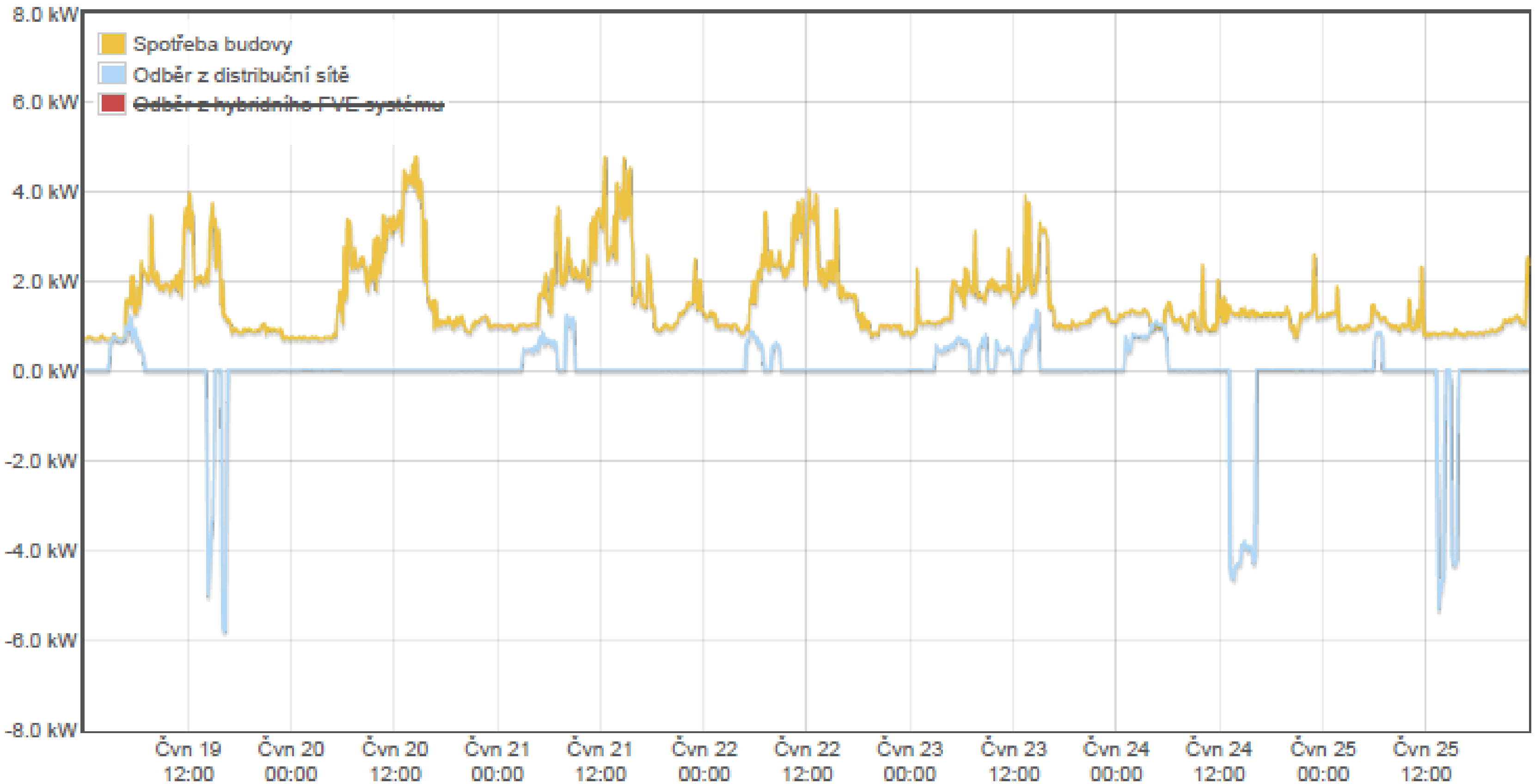
The energy consumption of each individual system had the following share in total consumption:

Electricity production and storage (kW)



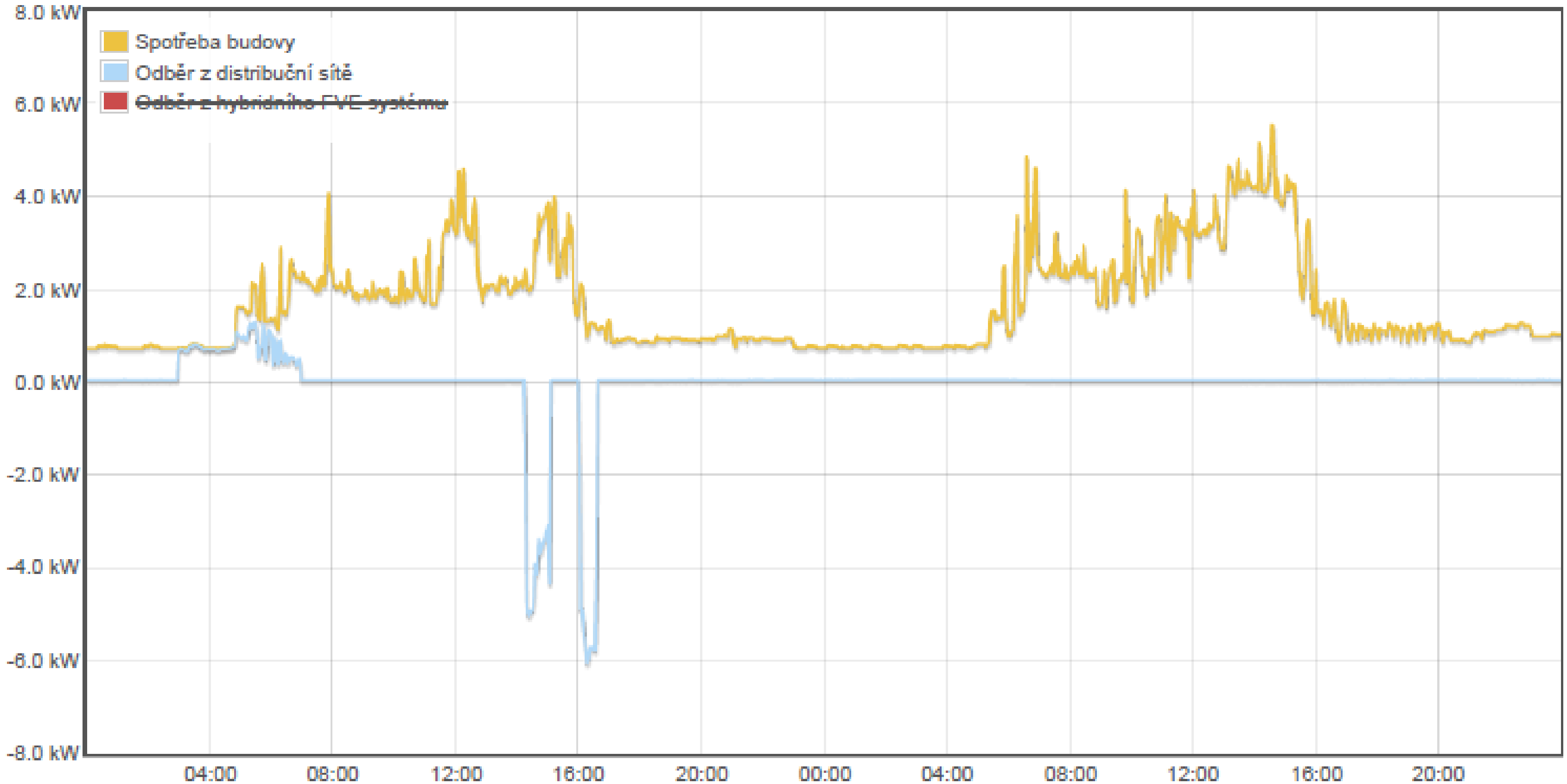
The production of energy by photovoltaic panels was very regular over individual days

The building's electricity consumption, production and supply (kW)



Comparison of the real electricity consumption of the building with consumption from the grid – it shows a small amount of controlled consumption during the night and the opposite (controlled supply) during the daytime (HT)

The building's electricity consumption, production and supply (kW)



For increased precision – a detailed two-day view 19. – 20.6.2017

FENIX

Battery storage system operation – 26 kW

The battery is charged from the PVP and also from the network in a controlled manner for a maximum period of 4hours/24hours
– Operation verified

Expected period of controlled autonomous operation: 4 - 7 hours/day

- **Operation verified**

Expected period of reduced stable consumption (2kW): 6 - 9 hours/day

The option of using a battery to remove peaks and to lower main circuit breaker values was verified. The building could thus operate with a 3 x 25 A circuit breaker during the winter even though the output would suggest a 3 x 40 A circuit breaker would be used.

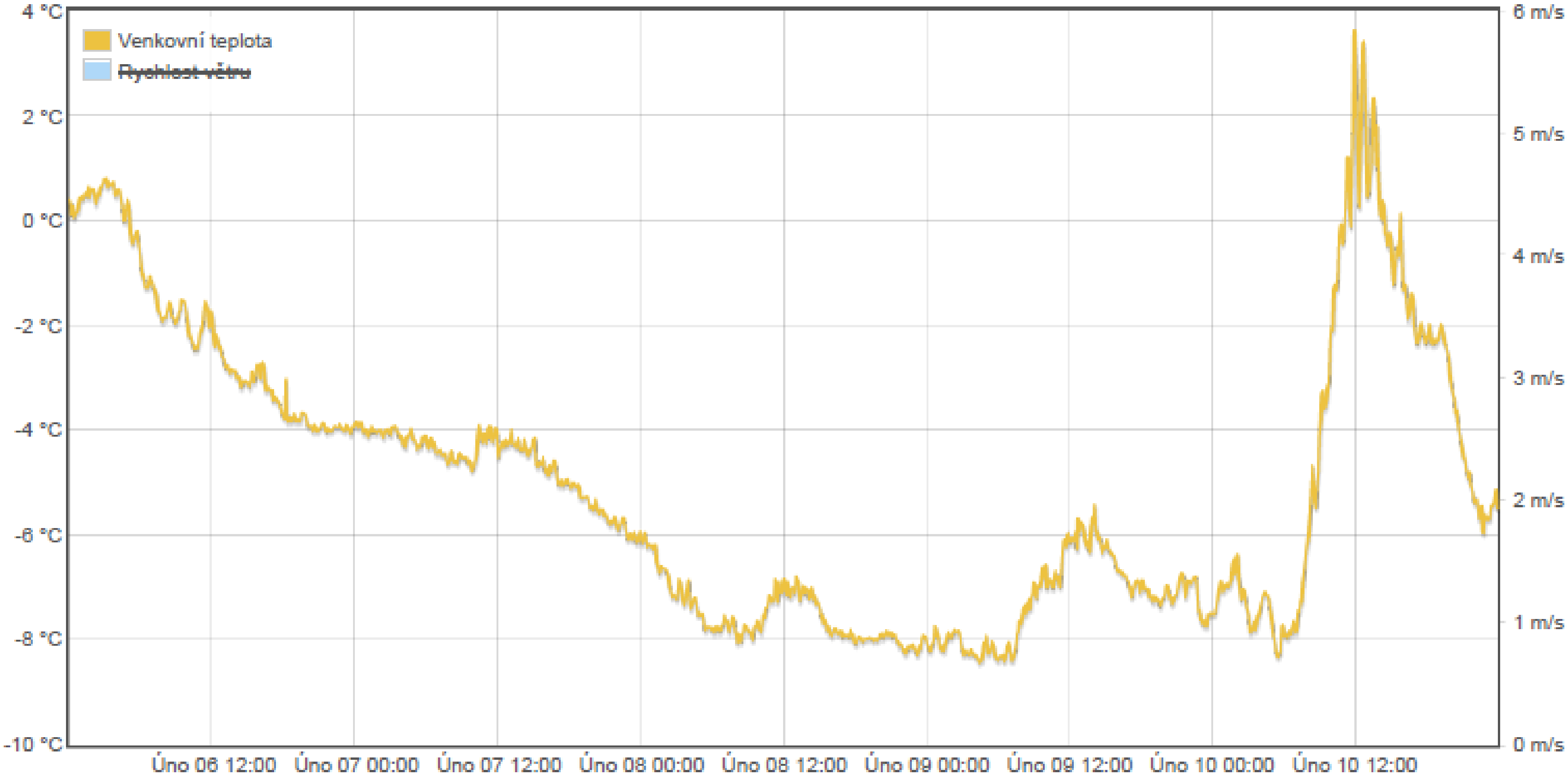
During the shutdown of a transformer station, autonomous operation in the event of a power outage was also verified – the building functioned from 6:00 to 20:00 completely without limitations and no technical failures occurred when power began to be drawn from the battery storage system.

The battery storage system proved to be a very flexible tool for the optimization of the building’s energy consumption during the 24 hour cycle. Its ability to work with limited wattage while satisfying all the needs of the household was proved. A storage system with a three-phase connection also significantly contributes to the balancing of energy consumption during the individual phases of the day!

FENIX

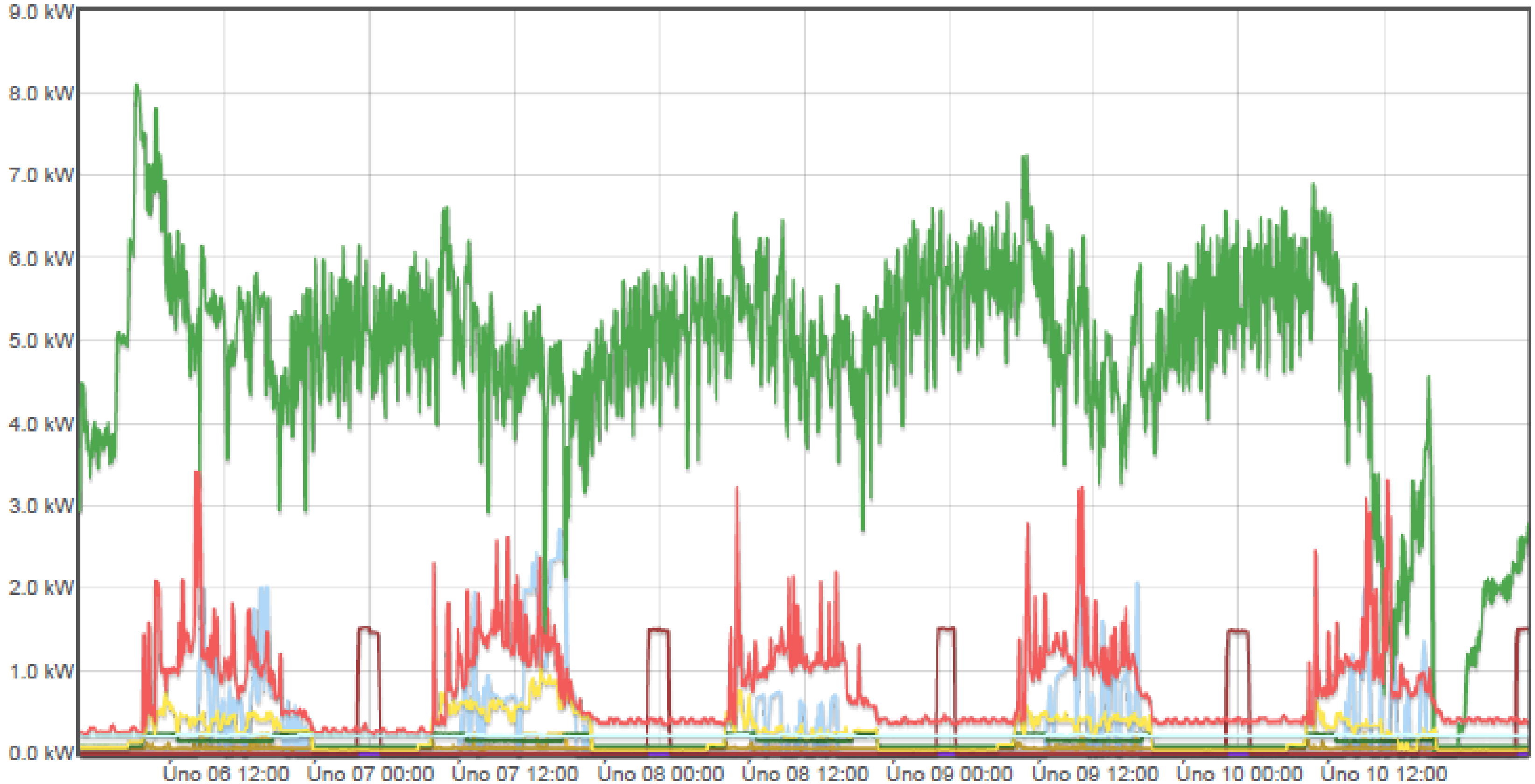
Winter days – 6.-10.2.2017

Outdoor environment 6.-10.2.2017



Daytime temperatures were below freezing point, with the exception of Friday, 10.2.17, when the daytime temperature rose sharply up to +3°C

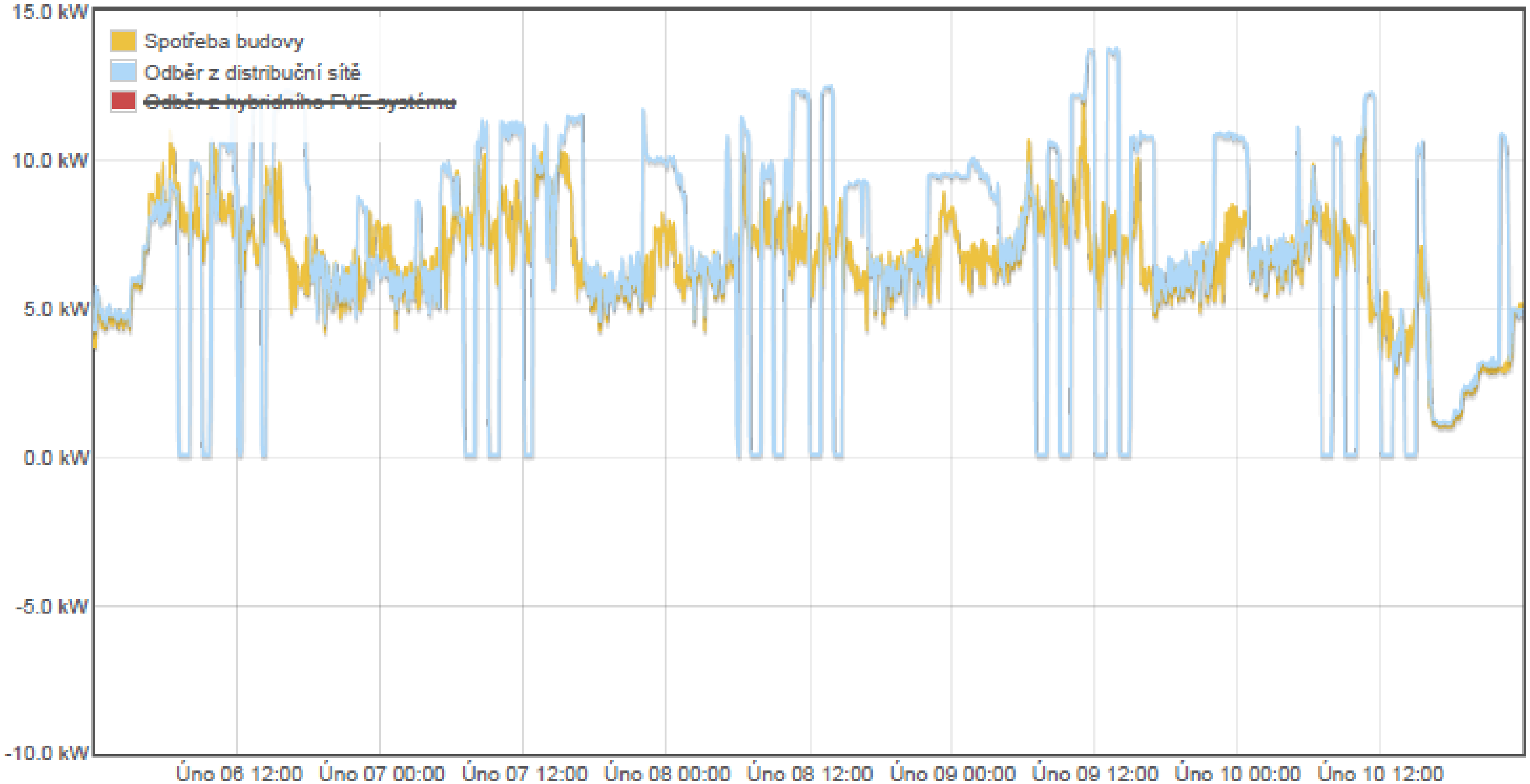
Energy consumption by individual systems (kW) 6.-10.2.2017



Energy consumption for heating (green) is influenced by the presence of persons and the operation of office equipment (lower consumption during the day) and reacts significantly to the warmer weather on Friday 10th!

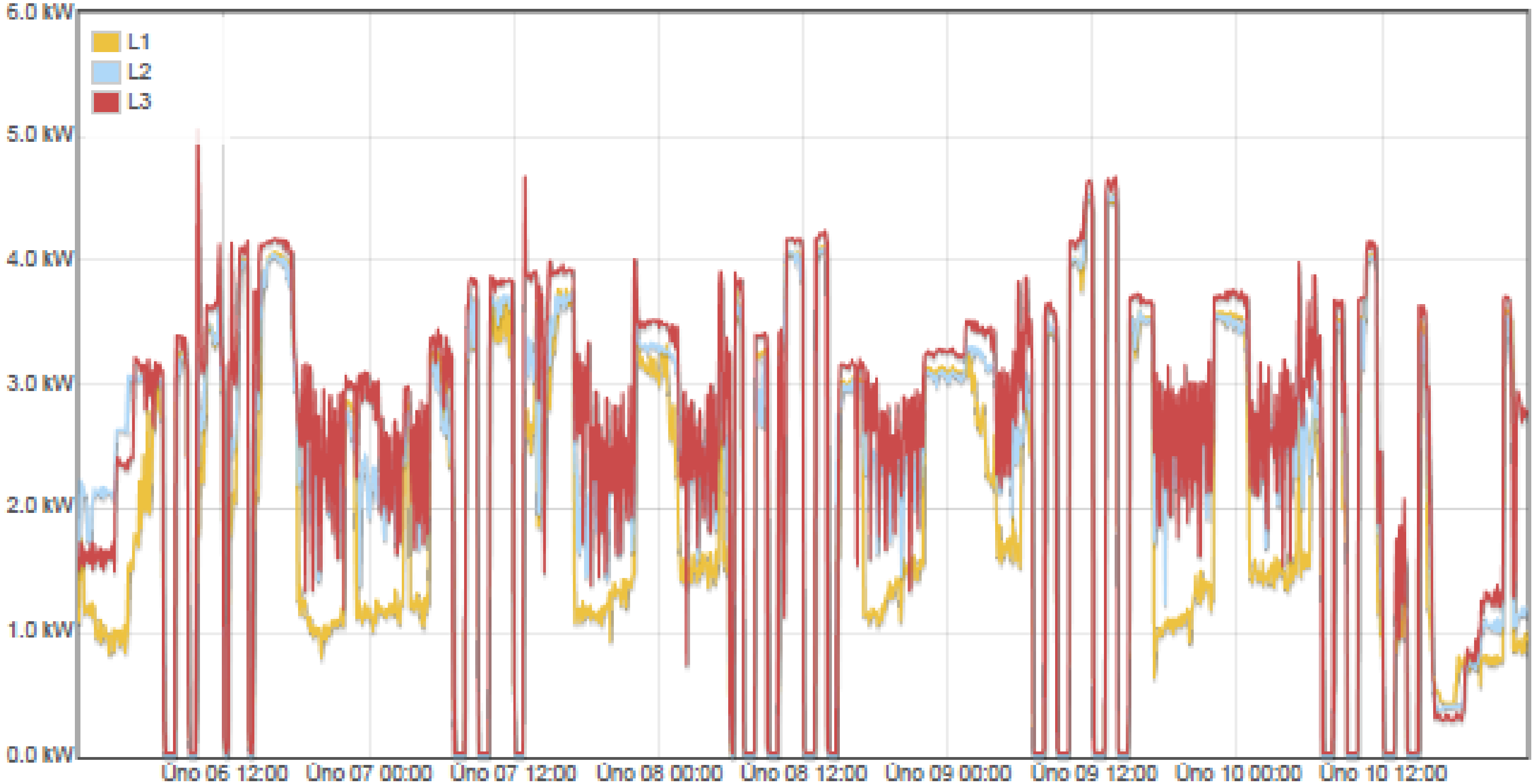
The building's energy consumption, production and supply (kW)

6.-10.2.2017



A comparison of the real energy consumption of the building with its energy consumption from the grid shows the ability of the battery storage system to achieve zero consumption from the grid during peak periods (HT) and harmonize the consumption of the building over 24 hours.

Consumption from the grid in phases (kW) 6.-10.2.2017

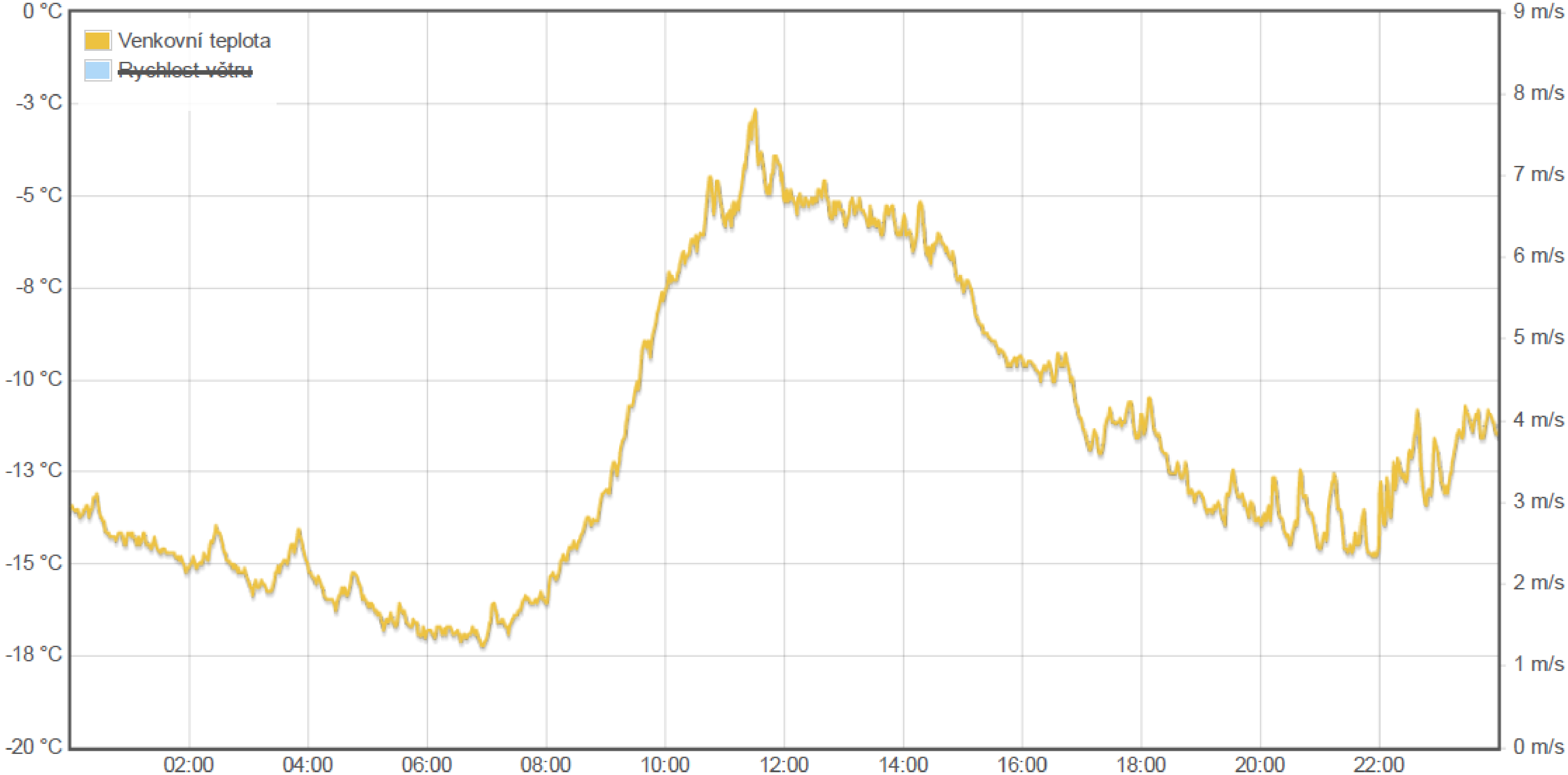


The storage system contributes to the even distribution of consumption in the individual phases. In the zero consumption mode, it reliably ensures zero consumption in all phases.

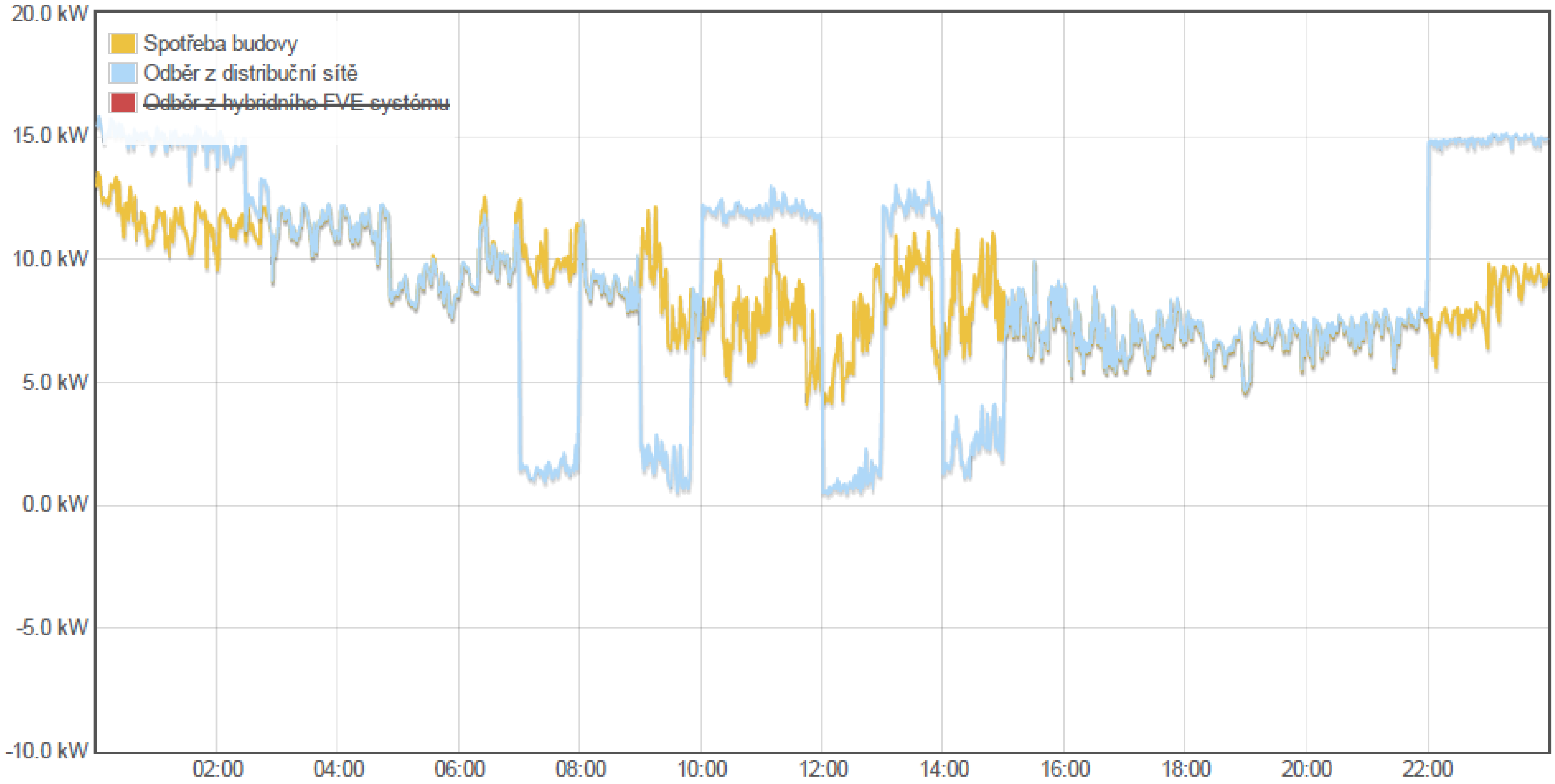
FENIX

An extremely cold winter's day - overcast
(10.1.2017- average temperature – 12 o C)

Outdoor environment

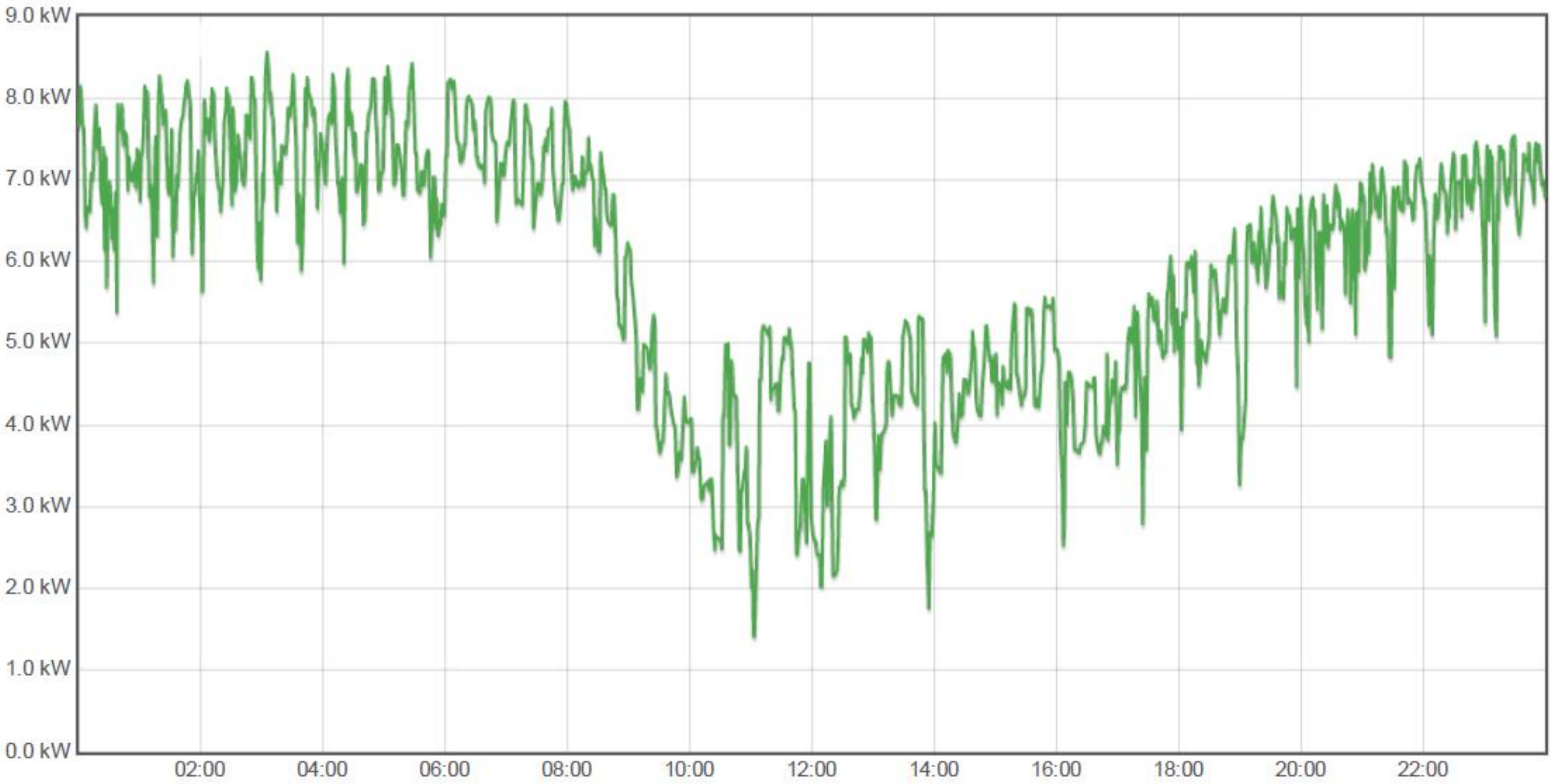


The building's electricity consumption, production and supply (kW)



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

Energy consumption of individual systems (kW)



The consumption of energy for heating (radiant heating system) reacts flexibly to the changes in outdoor temperature, and particularly to random heat gains (people – technology)

Heating

Electric radiant heating system enabling individual temperature control of each separate area (9 kW installed)

Energy consumption on heating was higher than expected and reached 12 045 kWH in the period 10/16 – 5/17
The following causes were identified:

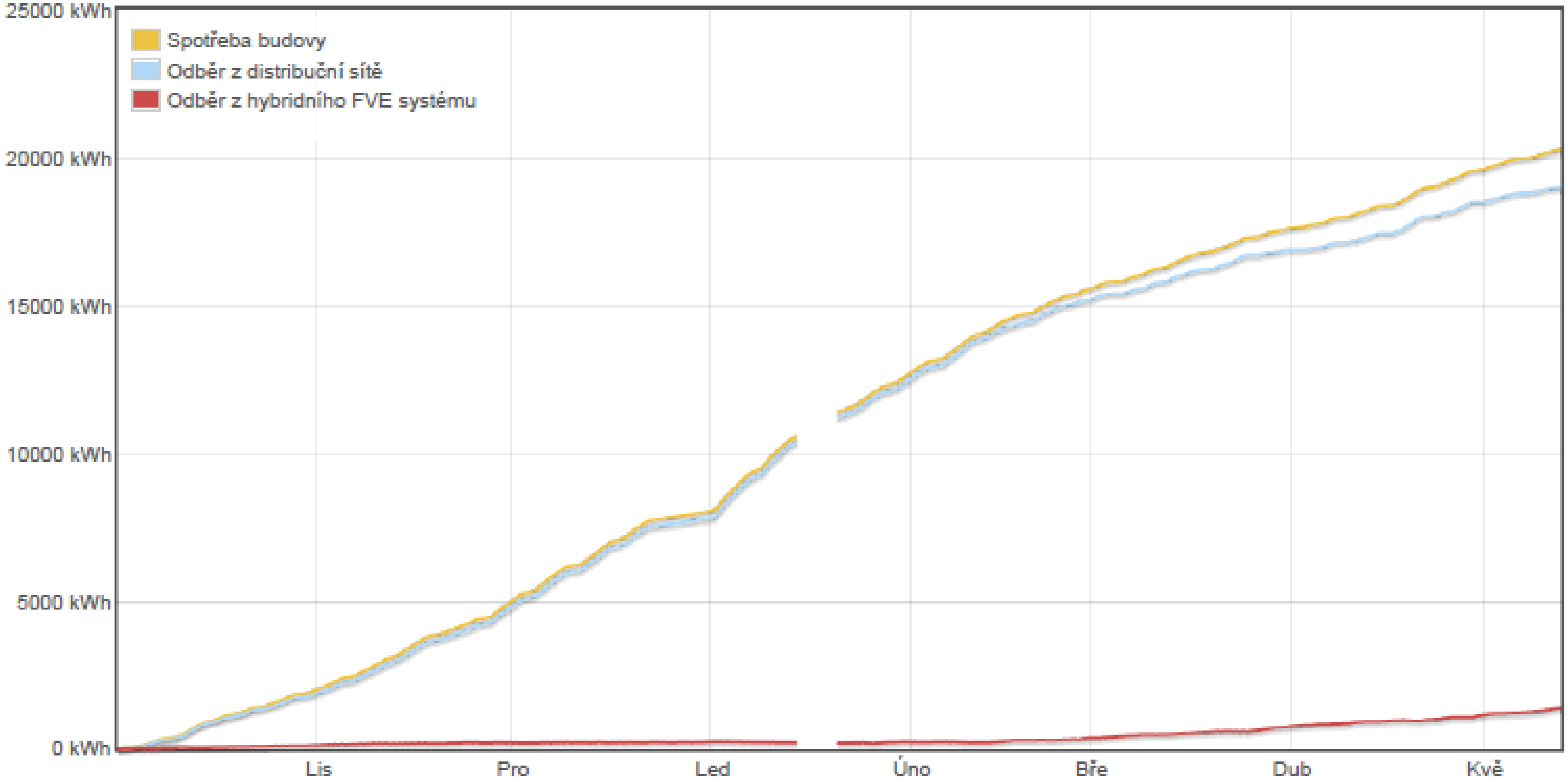
a) The automatic mode of outdoor blinds prevented the use of planned heat gains – problem removed 12/16

b) Daytime temperatures from 10/16 - 2/17 were approx. 2°C below the long-term average, and the heating season didn't finish until 11.5. 2017. Generally speaking, the heating costs were 8-10 % higher than in the previous heating season.

c) The advantage of interrupting heating during the working week wasn´t proved. While there were significant consumption peaks in the mornings in the case of the night attenuation mode, no energy savings were demonstrated – the test will be repeated in the following heating season.

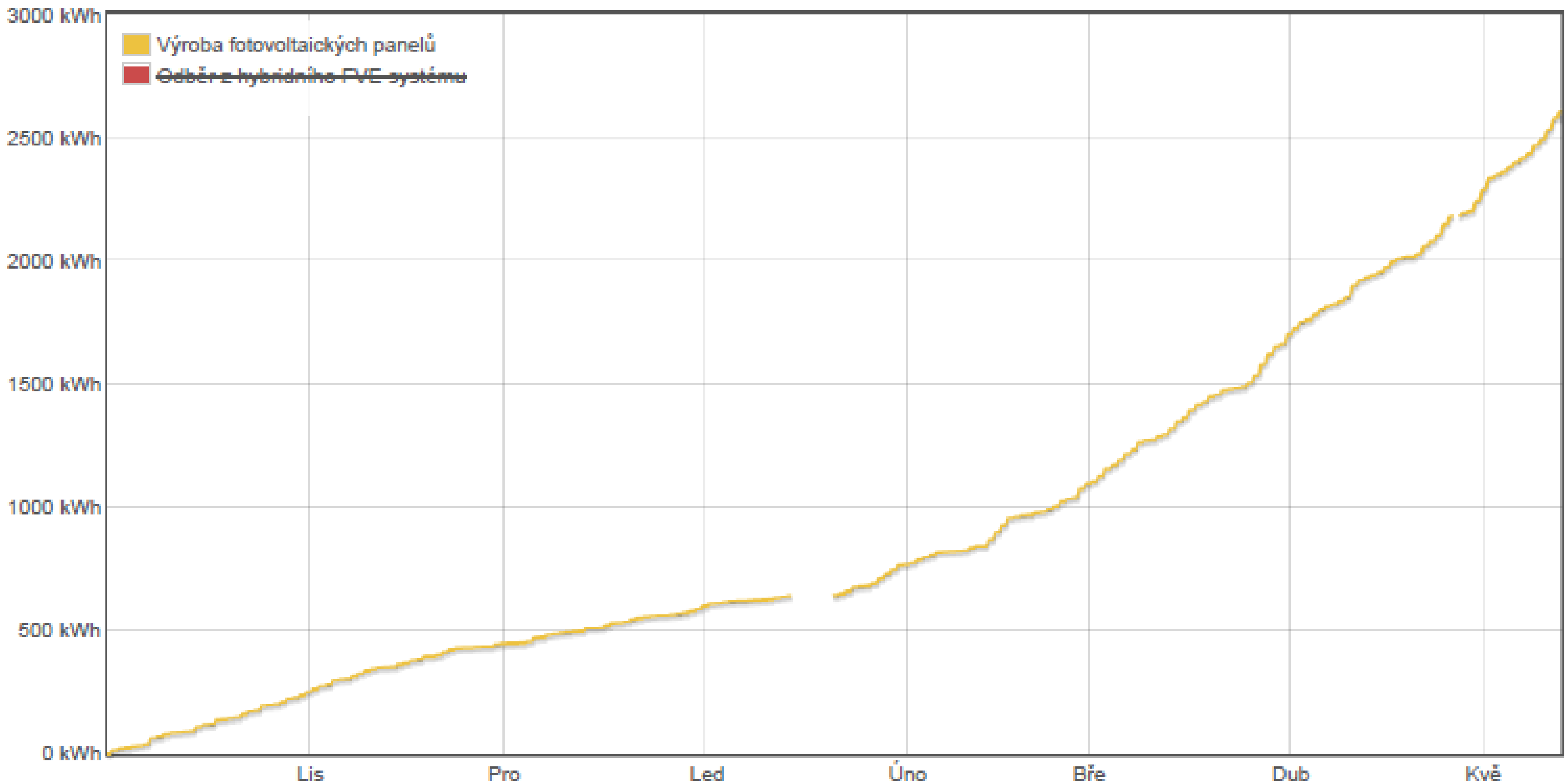
Generally, the heating system reacted very flexibly to changes both in temperatures and in the occupancy of the individual heated zones.

The building's electricity consumption, production and supply (kWh)



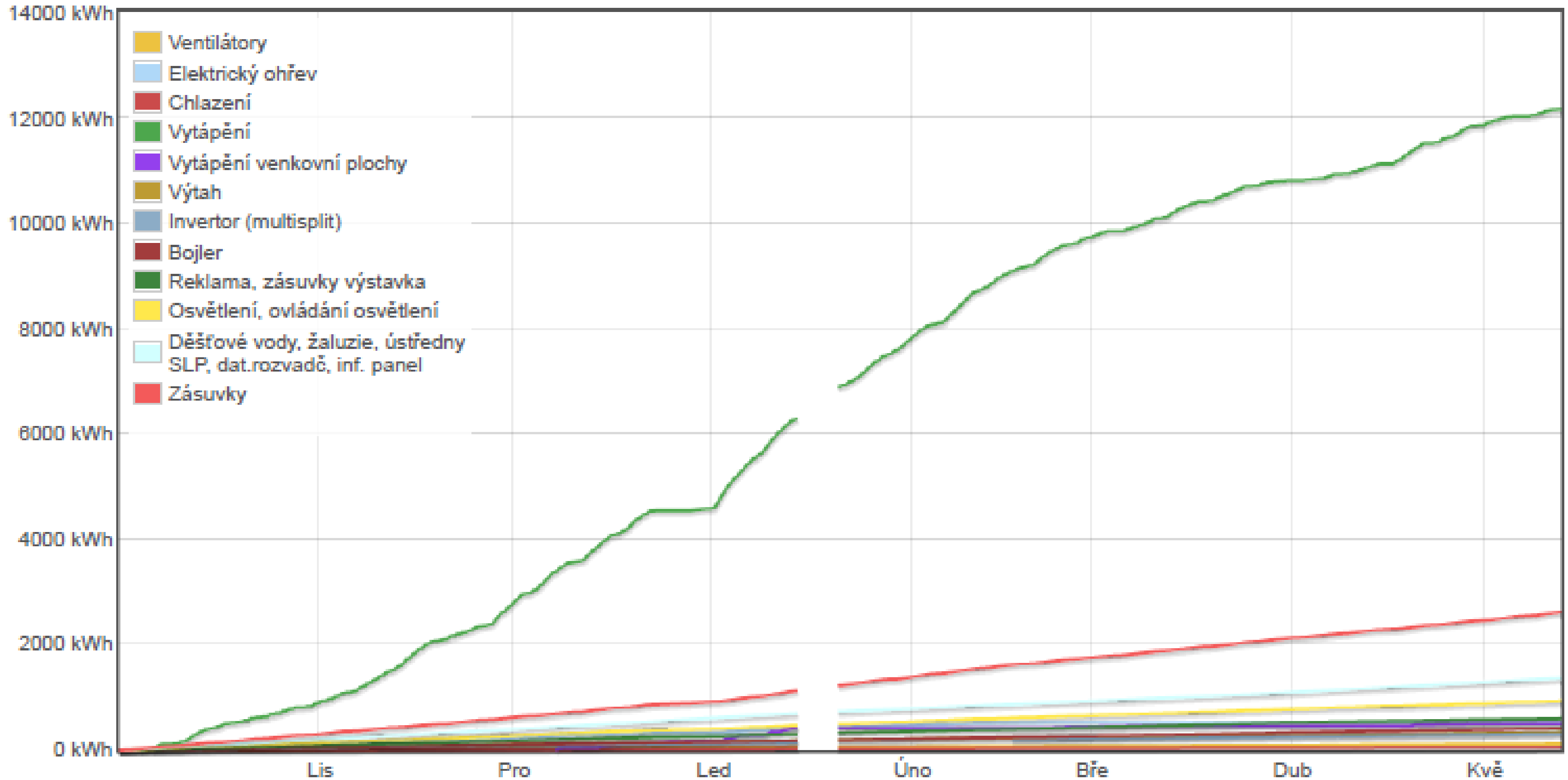
20 005 kWh were used during the heating season.

Electricity produced by the hybrid PVP (kWh)



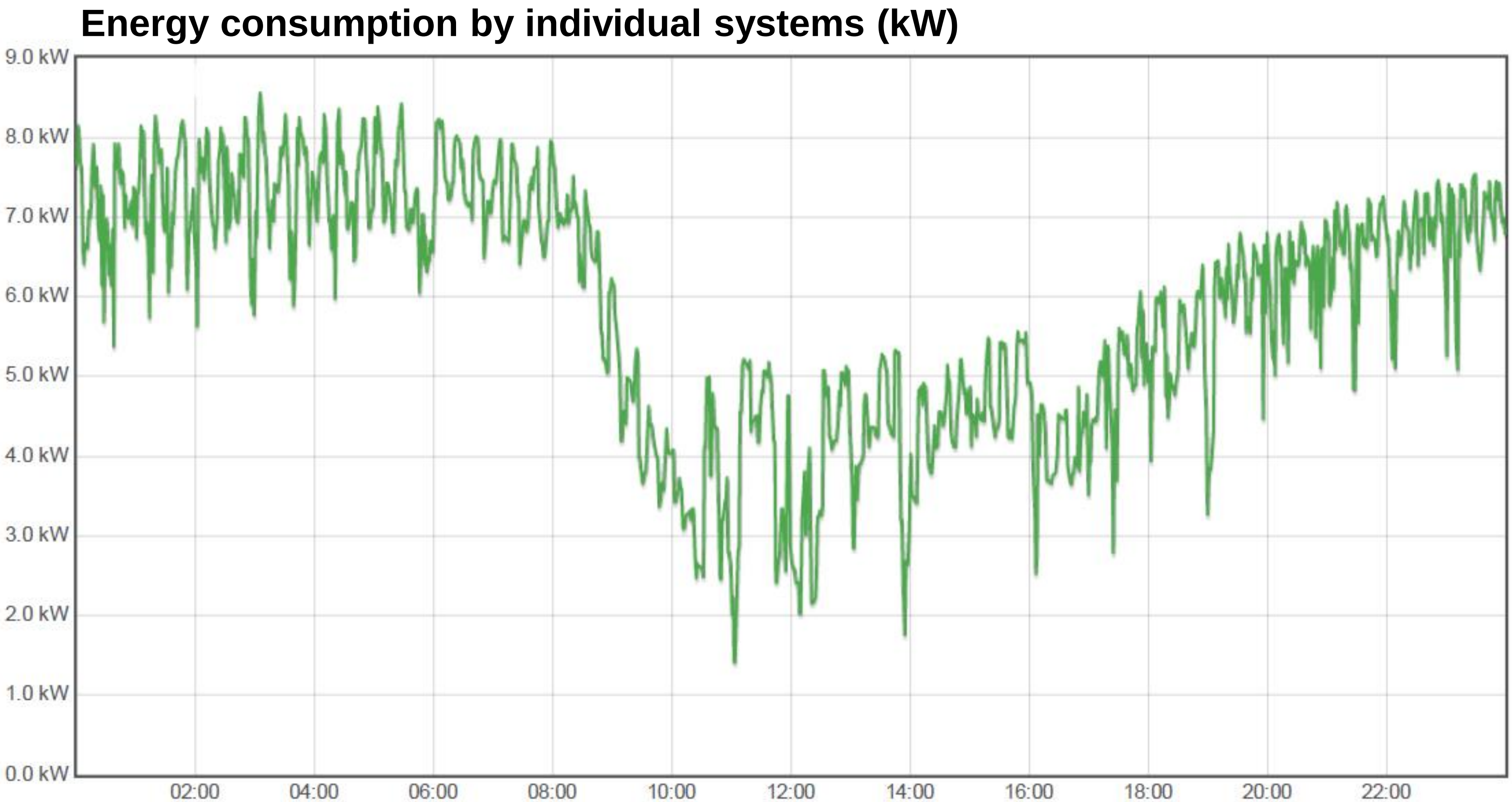
The photovoltaic panels produced 2 507 kWh during the heating season, i.e. 12.5% of the total energy consumed

Consumption of energy by individual systems



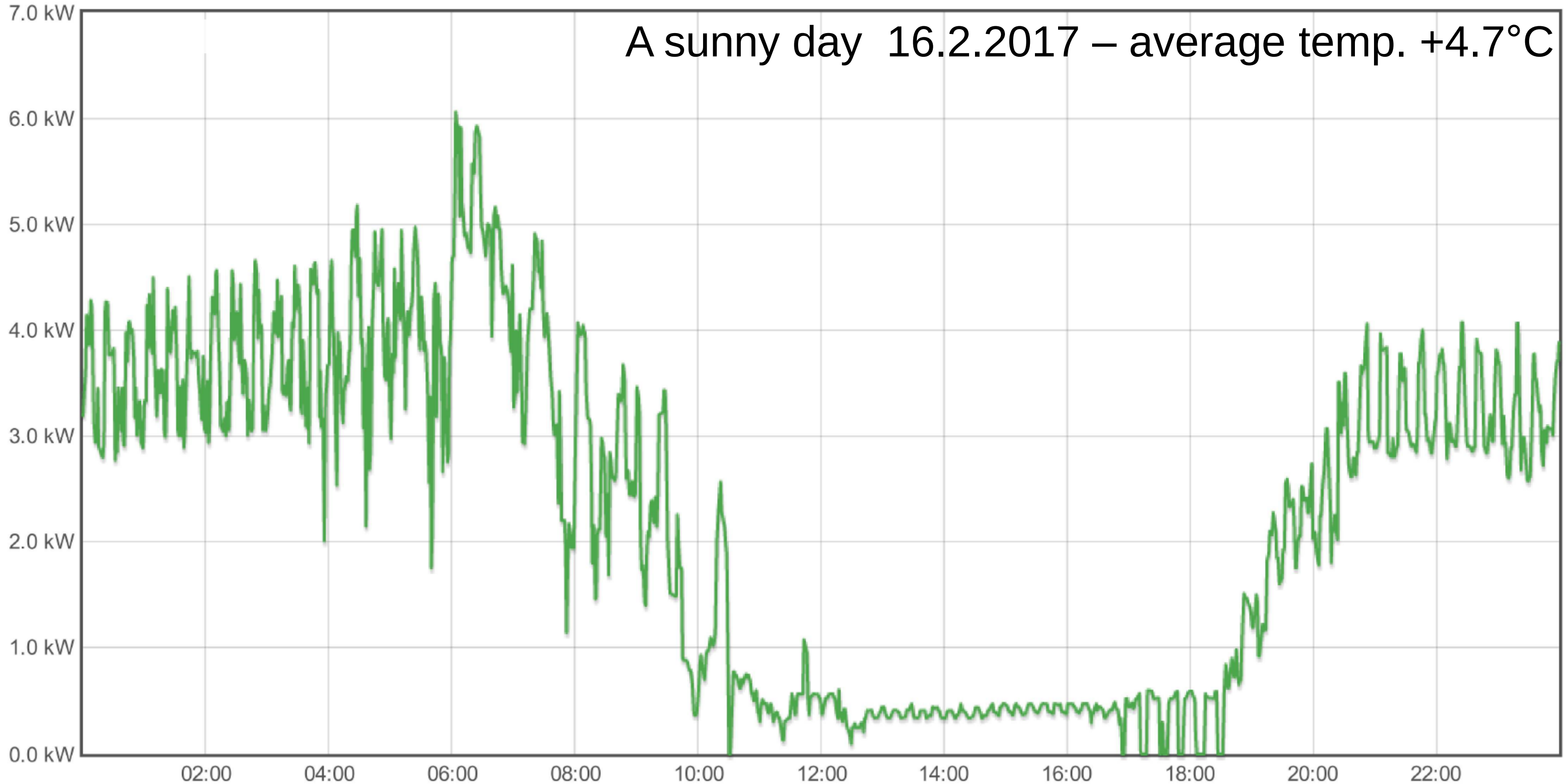
Electric heating had a significant share in the energy consumption during the heating period, amounting to 59.8% of total consumption.
The energy consumed by heating was 48% of the total consumption during the year.

An extremely cold day (-12°C) – overcast



The energy consumed by heating (radiant heating system) reacts flexibly to the changes in outdoor temperatures and mainly to random heat gains (people – technology)

Energy consumption by individual systems (kW)



This graph depicting the energy consumed by heating shows the significant influence of heat gains (sun – people – technology) on the building's energy consumption. In order to exploit this effect fully, it is essential to have a flexible heating system which is capable of reacting quickly in each individual heated area. **Standard warm-water systems (with any source) do not have this ability in nZEB!**

FENIX

Controlled ventilation with recuperation – cooling, air conditioning

During the first 5 months of operation, the system was adjusted – final adjustment – reaction to the level of CO_2 in the individual areas + the provision of minimal ventilation – in the summer months, the input air temperature was set to 20°C, while in the winter months it was set to the temperature of the vented air.

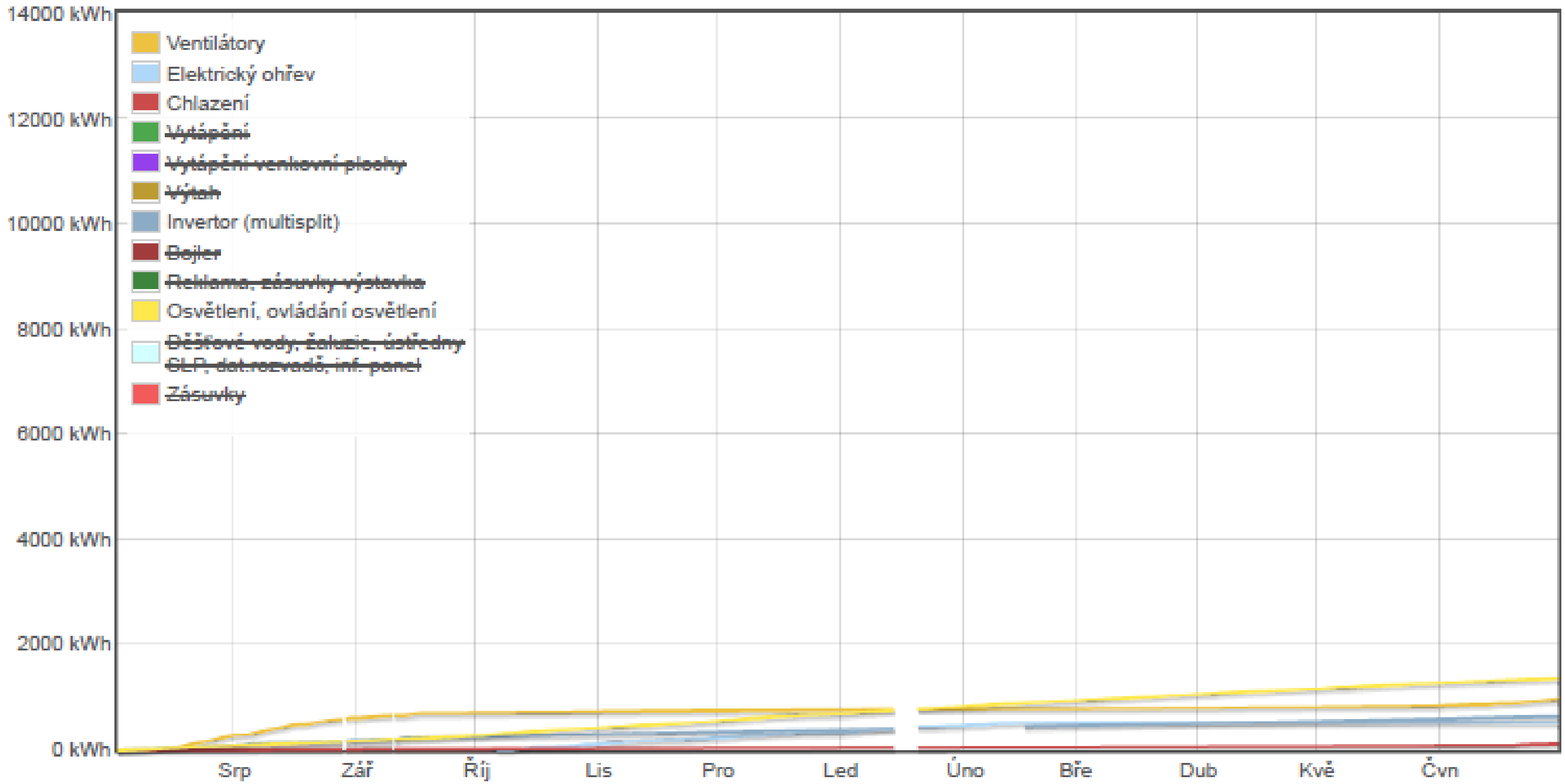
In the summer months, intensive night ventilation of the building was set when high daytime temperatures occurred.

The cooling of the air entering the building via an air handling unit was found to consume more energy than the cooling of the interior using a multisplit air conditioning unit.

However, the subjective feeling of comfort noticed in the building by staff was higher in the first case.

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

Energy consumption by individual systems (kW)



Yearly energy consumption – ventilation – multisplit - cooling

Comparison of the energy consumed by mechanical cooling systems (air handling and air conditioning units) during selected days in relation to the outdoor temperature

The following days were selected for the comparison:

08.08. and 15.08. – maximum outdoor temperature +30°C

10.08. and 18.08. – maximum outdoor temperature +35°C

Evaluation:

In both cases, the total energy consumption of the building was lower when indoor air conditioning units were used. However, the evaluation of comfort by employees was important. With regard to the unsatisfactorily installed multisplit units, the employees preferred to use the ventilators for cooling.

		Strojní chlazení VZT [kWh]	Klimatizace (multisplit) [kWh]	Ventilátory [kWh]	Celkem [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

Interesting facts from 2018

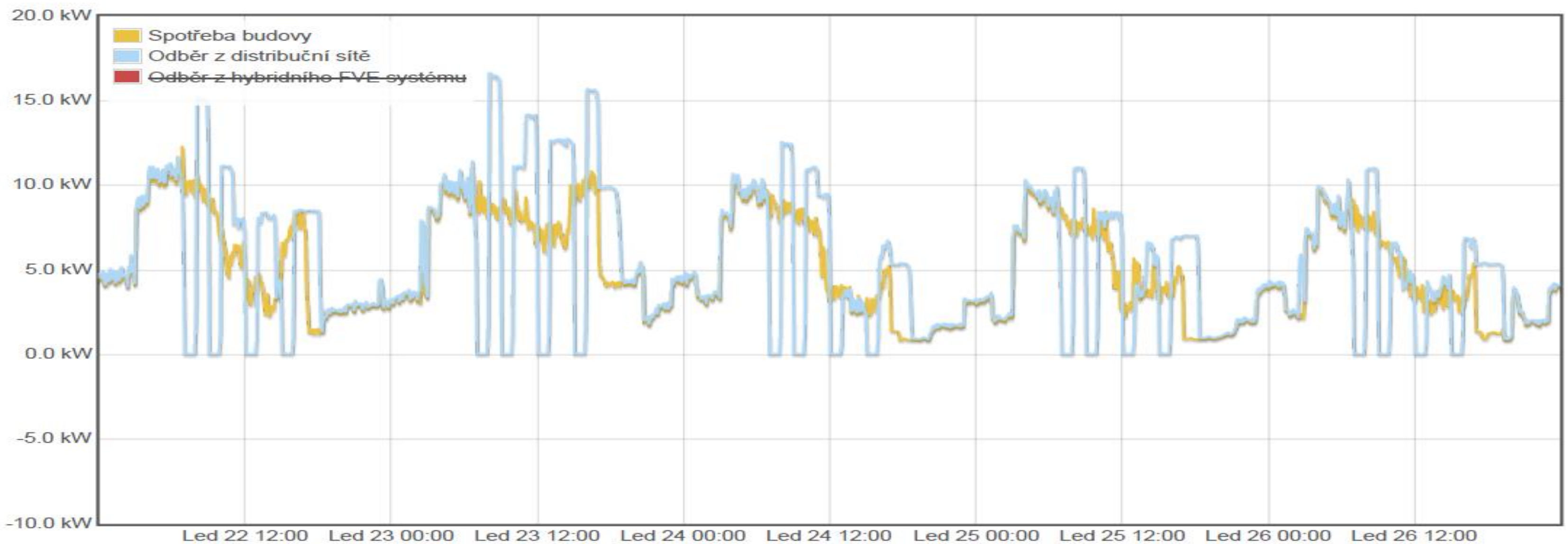
Detailed measurements were taken concerning the influence of the level of heating attenuation outside working hours on the total level of energy consumption.

The approximately two-week-long period of extremely cold weather at the end of February and the beginning of March allowed valuable information to be obtained about the behaviour of the building under such conditions.

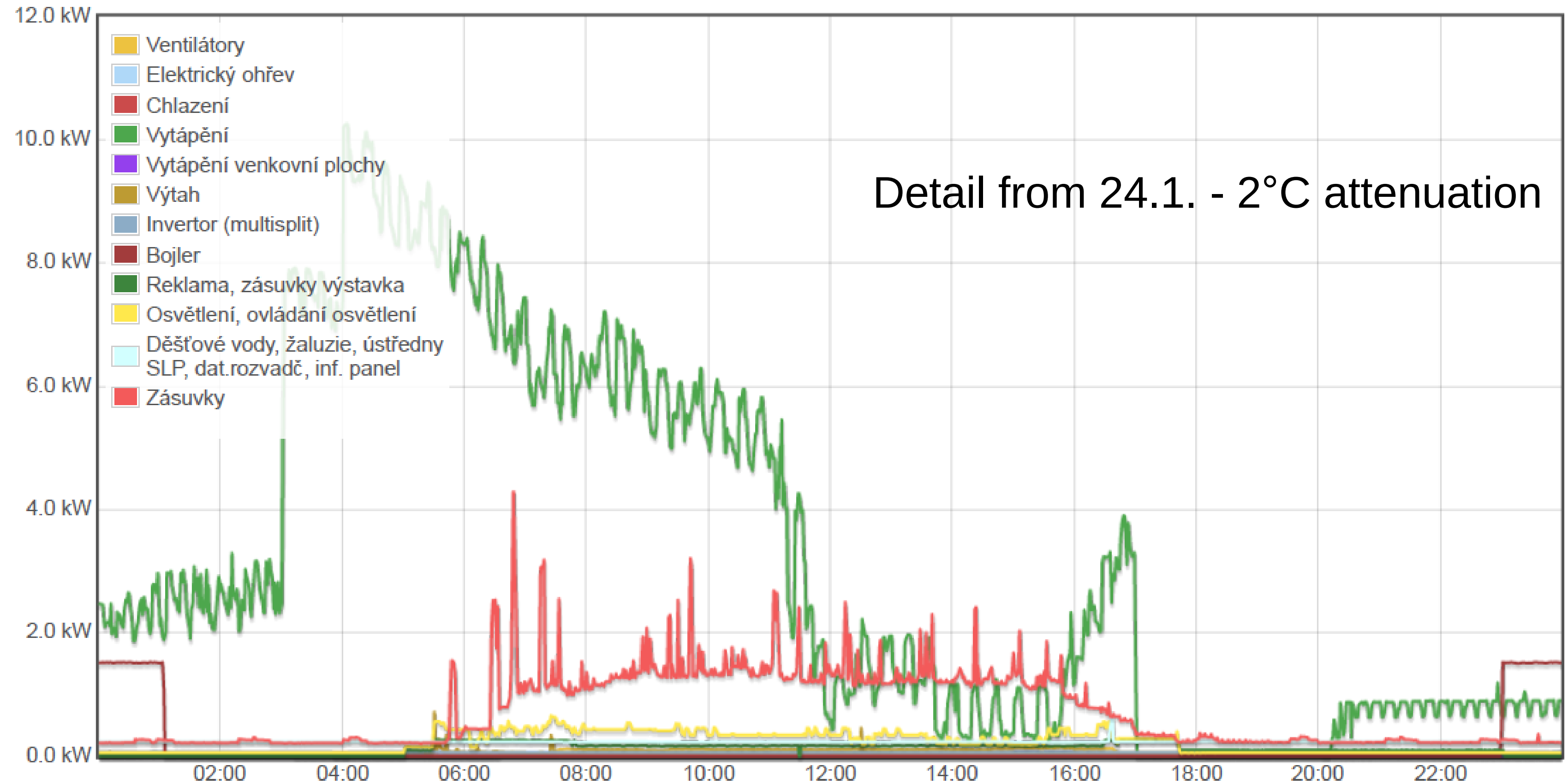
Attenuation 1°C
22.1- 26.1.2018

22. 3. 2018 FENIX

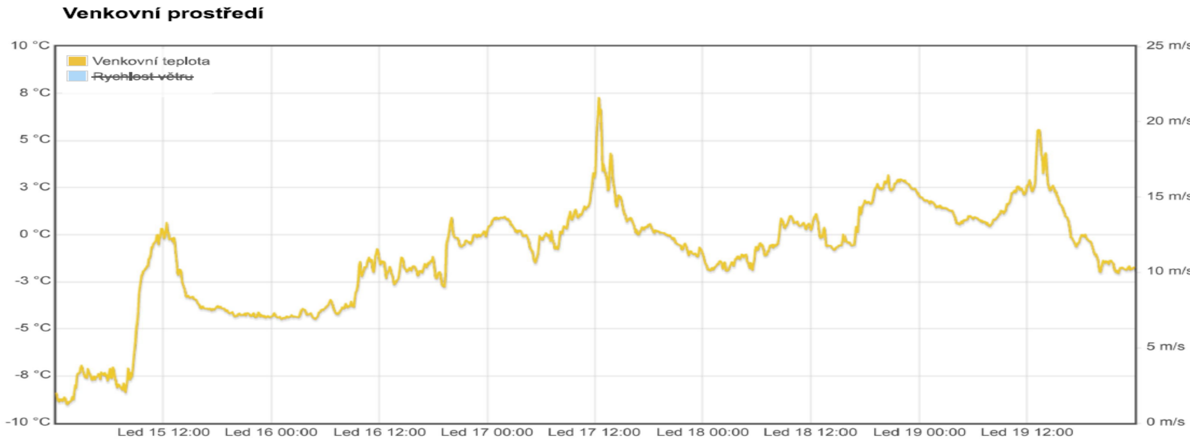
The building's electricity consumption, production and supply (kW)



Energy consumption by individual systems (kW)

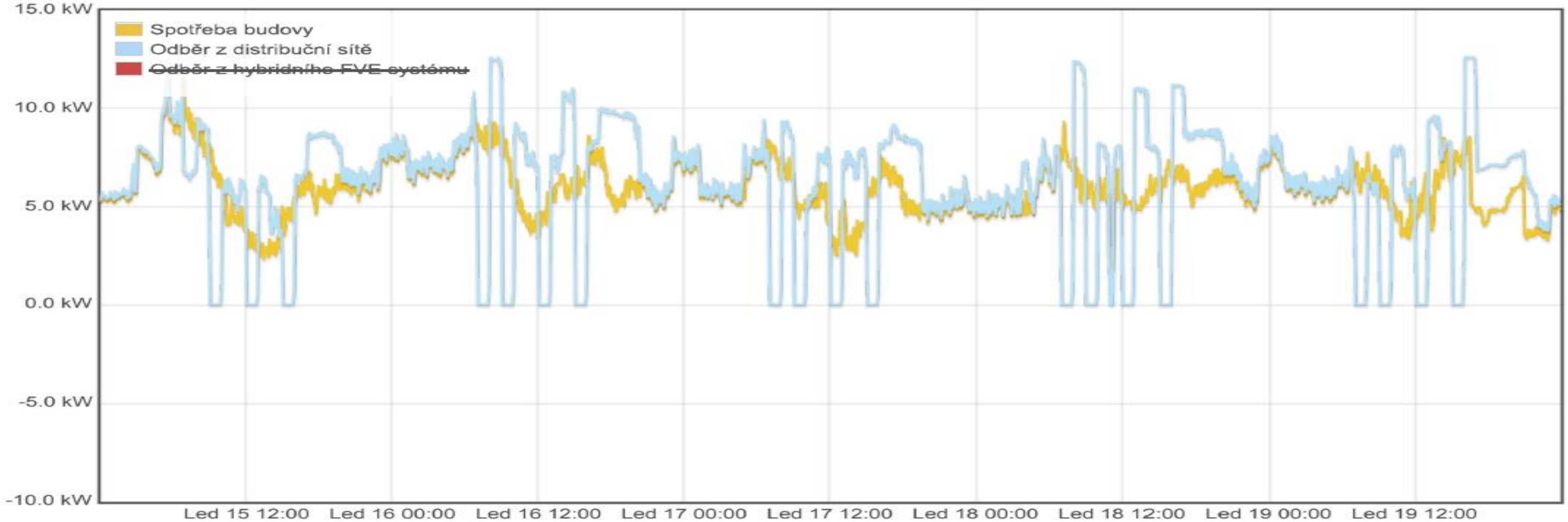


Without attenuation
15.1-19.1.2018

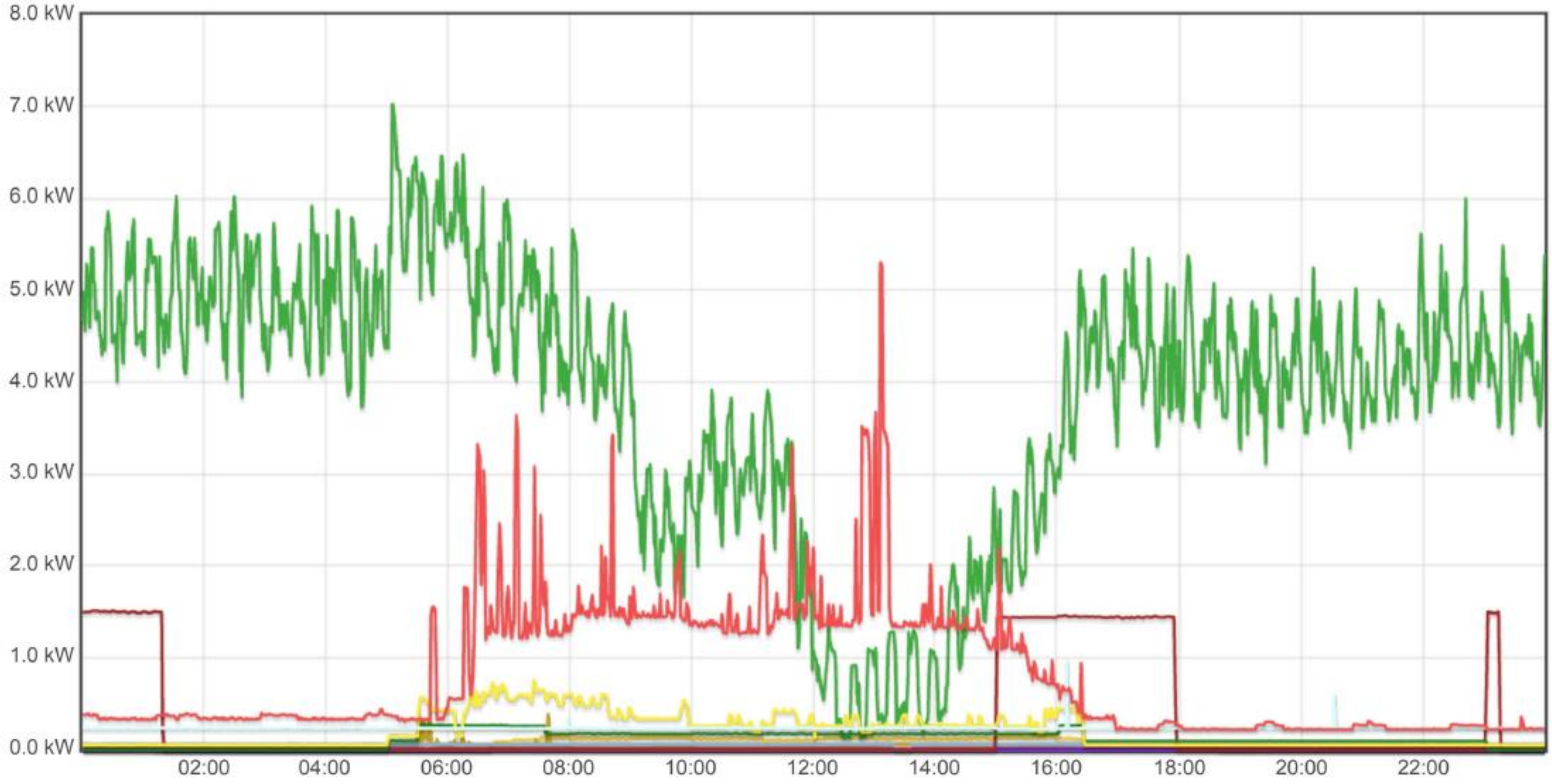


3. 3. 2018 FENIX

The building's electricity consumption, production and supply (kW)



Energy consumption by individual systems (kW)



Under comparable conditions, energy consumption was significantly smoother and without peaks (-40%) in the case of heating without attenuation.

The difference between 3°C and 2°C of attenuation only occurred after the weekend; attenuation wasn´t greater than 2°C in the building during working days in the given period

- According to the report by the Czech Technical University in Prague, which evaluated both the energy aspect of building operation and the quality of the indoor environment, the use of 2°C of attenuation (17:00-03:00) proved to be the most advantageous.

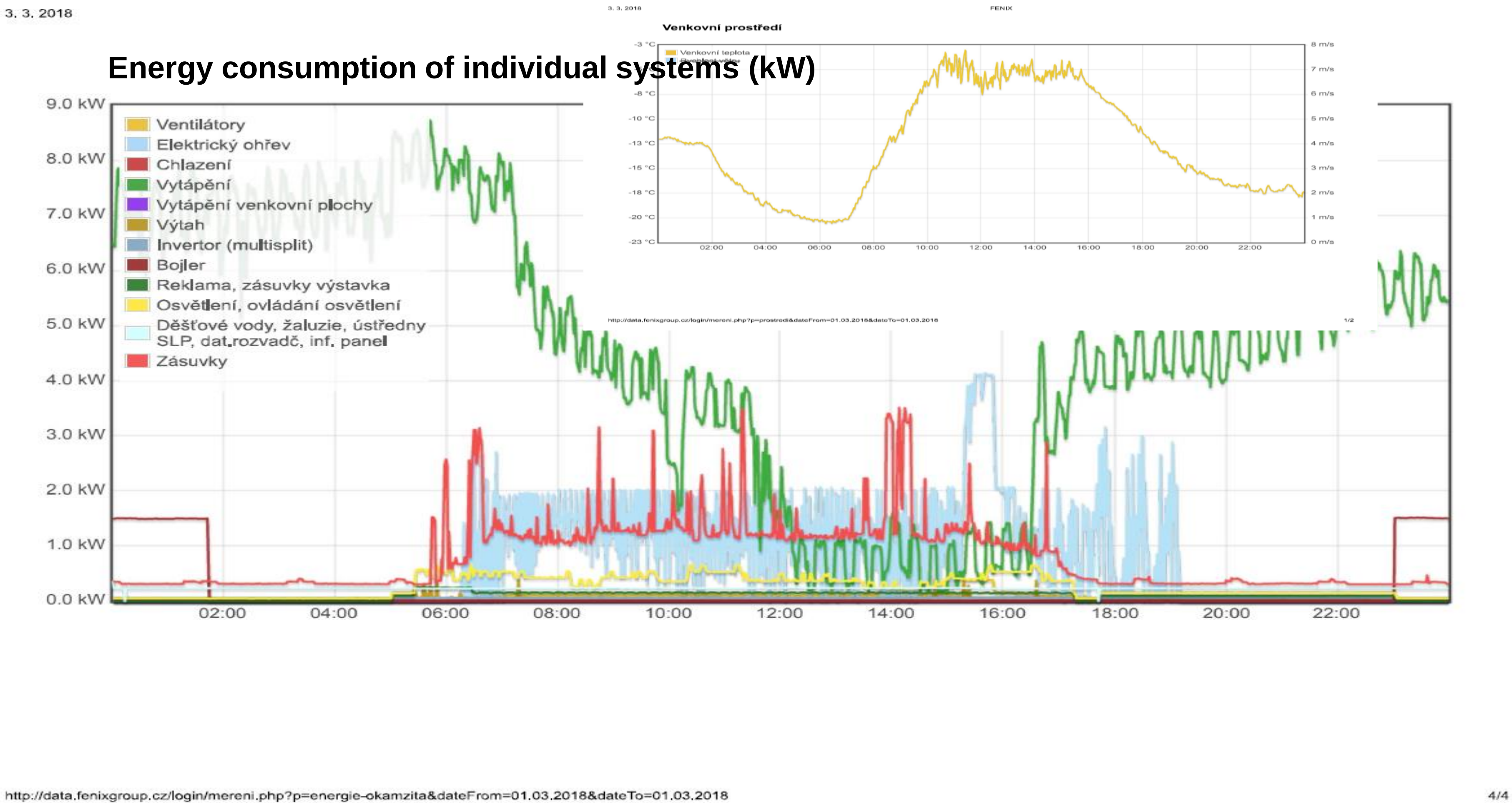
- **High energy savings on heating (amounting to 14-20% while maintaining the quality of the environment in category I) were demonstrated during this mode, which was quite surprising.**

- The attenuation mode also has drawbacks in the form of approximately 20% higher consumption in the period between 07:00 – 16:00 and significantly higher consumption peaks in the morning hours (03:00 – 06:00). However, both these drawbacks can be eliminated with a correctly dimensioned battery storage system.

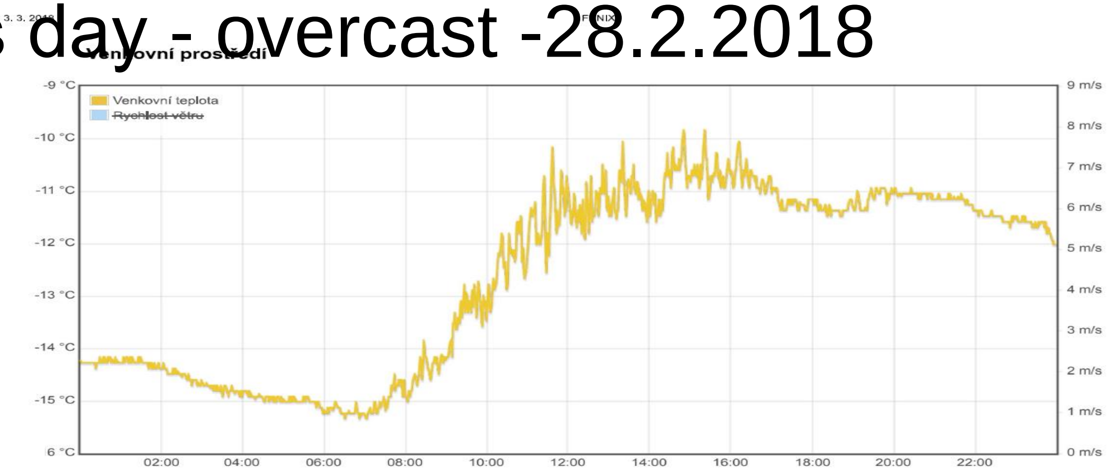
- During this experiment, an evaluation was also made of the speed of the decrease in the level of CO_2 in various ventilation modes as well as with the ventilation switched off completely.

An extreme winter's day - sunny (1.3.2018)

Energy consumption of individual systems (kW)

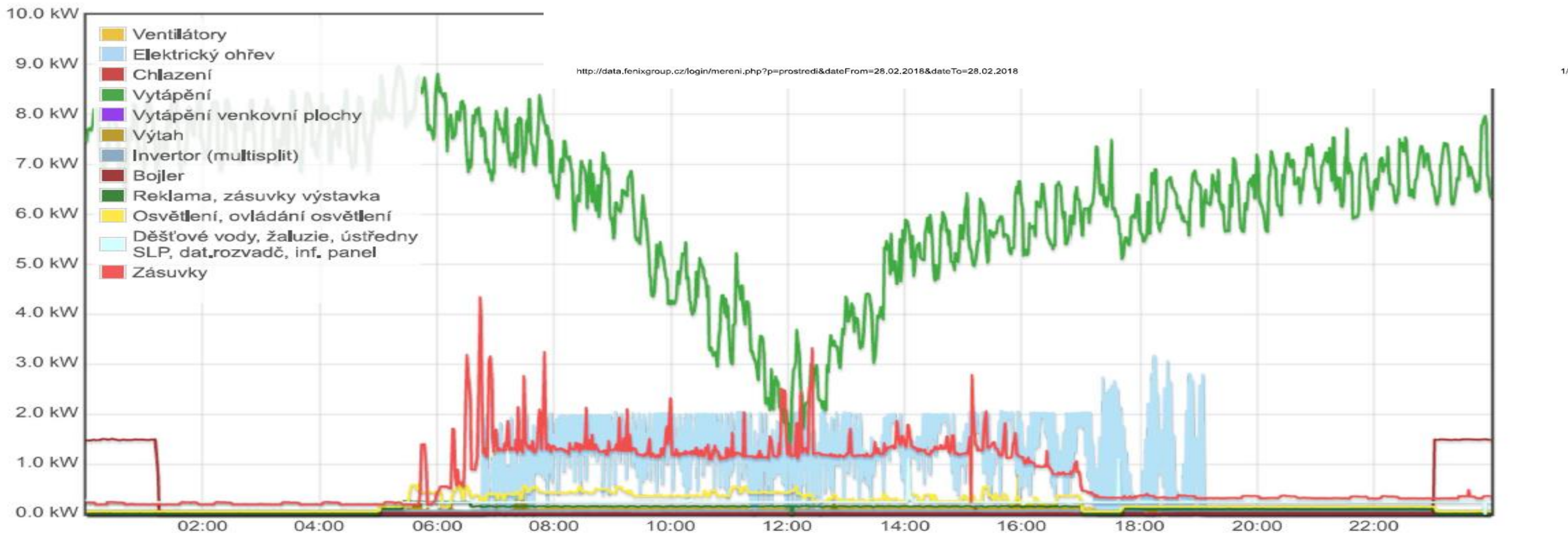


An extreme winter's day - overcast -28.2.2018



3. 3. 2018

Energy consumption of individual systems (kW)



ČEZ distribution testing modes

Smoothened supply point diagram with regard to the grid

- Aim – the longest possible operation in the constant mode

Islanding operation balance (with a connection to the grid)

- Aim – maintain zero consumption from the network for as long as possible (the “hairy zero” mentioned at the meeting)

The supply of electrical energy to the grid forced by the Distributor

- Aim – supply the maximum possible power to the grid upon the request of the Distributor

Limitation of the power overflow from the PVP to the grid to a pre-arranged proportion of the installed PVP output

- Aim – supply lower power (e.g. half) than the electricity production system could supply at a given moment to the distribution network, upon the request of the Distributor

Consumption limited by the Distributor to a pre-arranged level

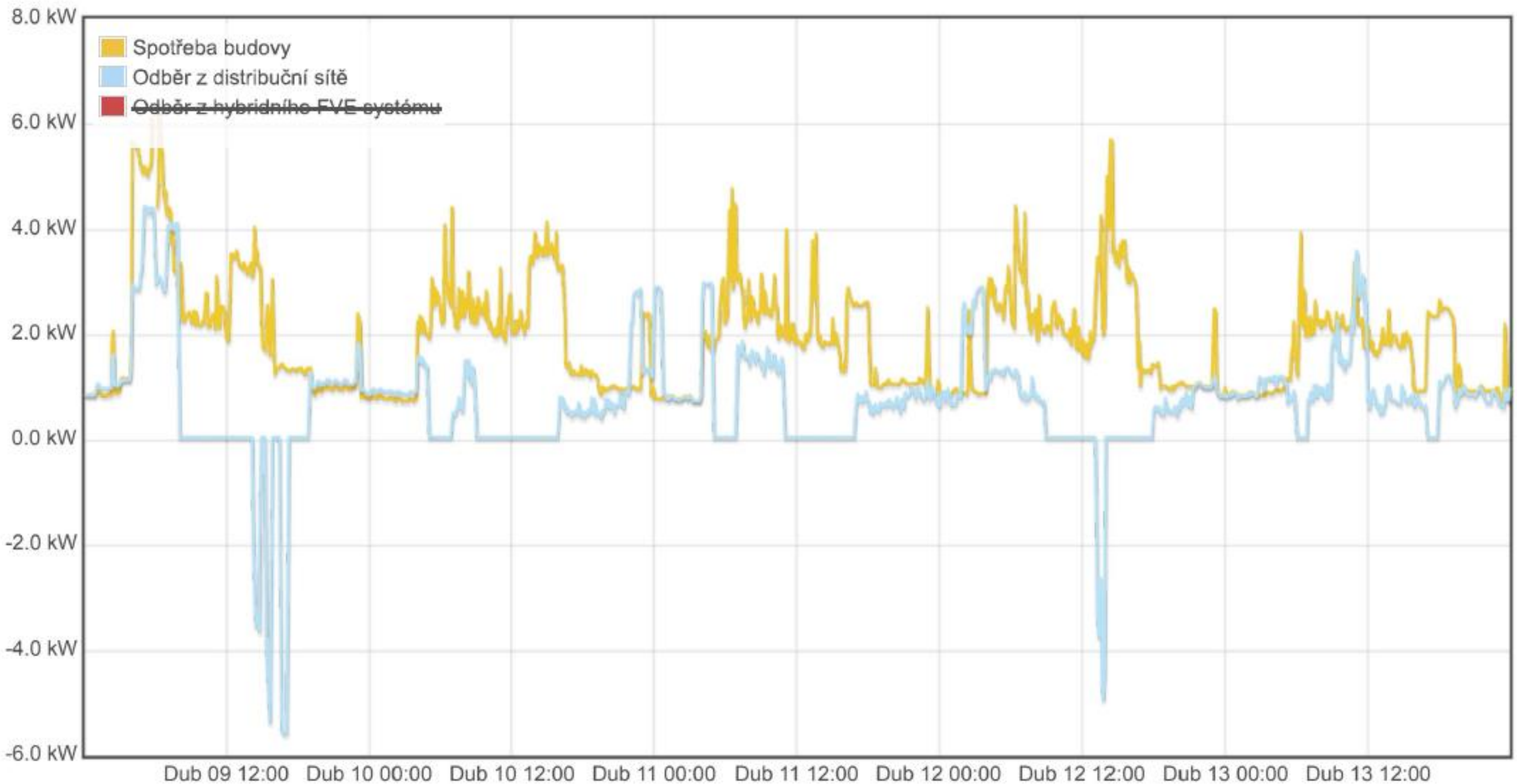
- Aim – to take less (e.g. half) power from the grid than was consumed by the supply point at a given moment upon the request of the Distributor.

The tests will take place from 14.5. 2018

Testing mode, even consumption with lowered maximums

9.-13.4.2018

The building's electricity consumption, production and supply (kW)



A clear shift and significant decrease in peaks in consumption from the grid. In the case of surpluses, controlled supply to the grid.

The building's electricity consumption, production and supply (kW)

Maximum total consumption of the building was 5.2 kW (14:00 -16:00)
Maximum consumption from the network was 2.9 kW (22:00-23:00)

Further procedures

1) Data are collected online on the UCEEB cloud. All those involved in the project have access to them

2) UCEEB produced an interim report for the period to 30.9.2017 evaluating:

   a) the expected and real energy consumption of the individual files

   b) the fulfillment of the prerequisites for the functionality of the individual modes

   c) microclimatic conditions in the building

3) UCEEB will produce a final report for the period up to 30.10.2018 evaluating all aspects of the two years of building operation

4) A working group will evaluate the creation of suitable conditions for the expansion of the concept.

With regard to the fact that the preliminary results of this project have already confirmed the reality and feasiility of the set goals, we have decided to proceed further in this field :

- in December 2016, the start-up AERS s.r.o. (Advanced Energy Storage Systems) was founded. It is preparing a modular AES system with the required functionality covering the given area, ranging from small applications (10kWh) for apartments and small family homes up to 1000 kWh for shopping centres, manufacturing and agricultural buildings, as well as for the field of service provision.

- the smallest system, AES 10, will be available from 07/18

- We are currently completing a battery storage system project (640 kWh) at our Fenix production plant in Jeseník. This cooperates with a roof PVP of 24 kWp with the following goals :
  - lowering of the reserved performance (distribution of consumption over 24 hours)
  - control of the ¼ hour maximum
  - elimination of short-term outages which can cause significant damage
- Data from this project will again be available at the UCEEB server from 06/18

- The building will be monitored for a period of 1 year, after which a final report will be published

- This concept promises interesting return on investment even at the current price of storage and we can see great potential for its development in the future.

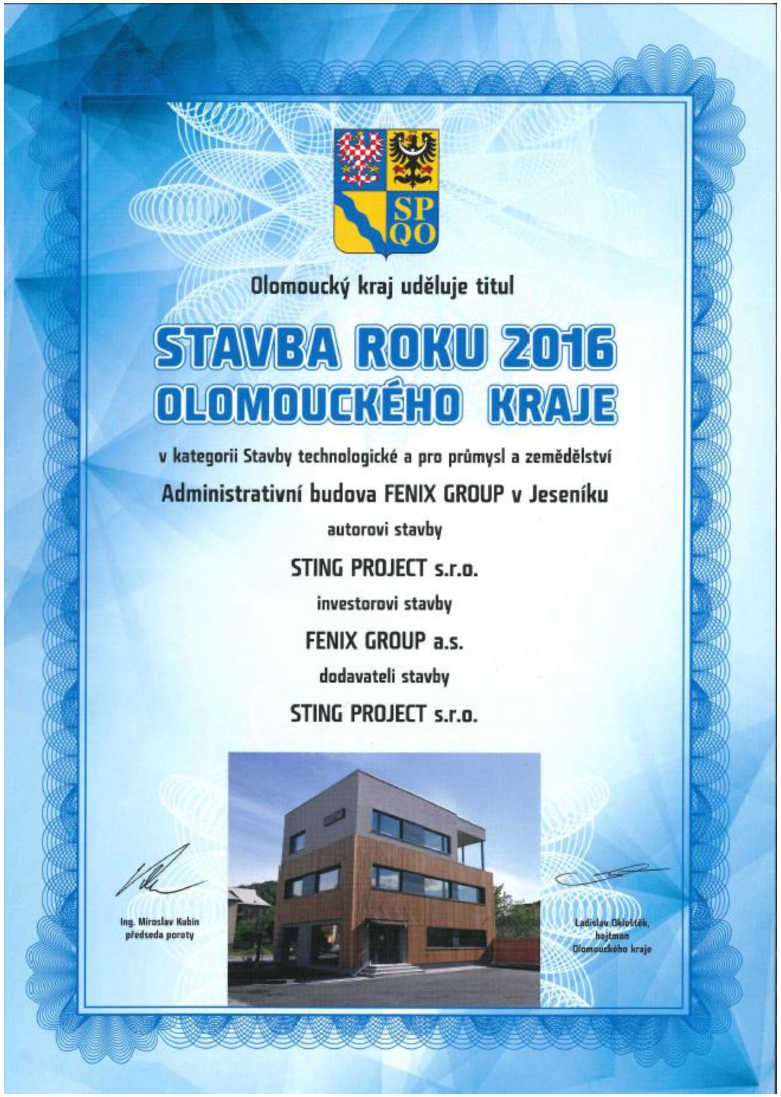
Awards :

1) The concept of the house as an active element of the energy system received a special award as part of the CZECH TOP 100 awards announced at Prague Castle on 16.6.2016: Environmental feat of the year in power engineering

2) The house concept attracted such great interest from the organizers of the INFOTHERMA 2017 exhibition that they made it into the central exhibit and took it as the motto for the whole exhibition. A thematic conference for specialists also took place here and some members of the specialized working group also took part.

3) On 27.3. 2017, the OC project was awarded a prize by the county representative of the Olomouc region

Building of the Year 2016



4) One of the greatest awards is, in our opinion, the fact that this project will presented as one of the **10 official exhibits in the Czech display at the international exhibition in Astana** (06/17-10/17)

The motto of the exhibition is energy saving and energy efficiency.

EXPO2017
ASTANA
CZECH
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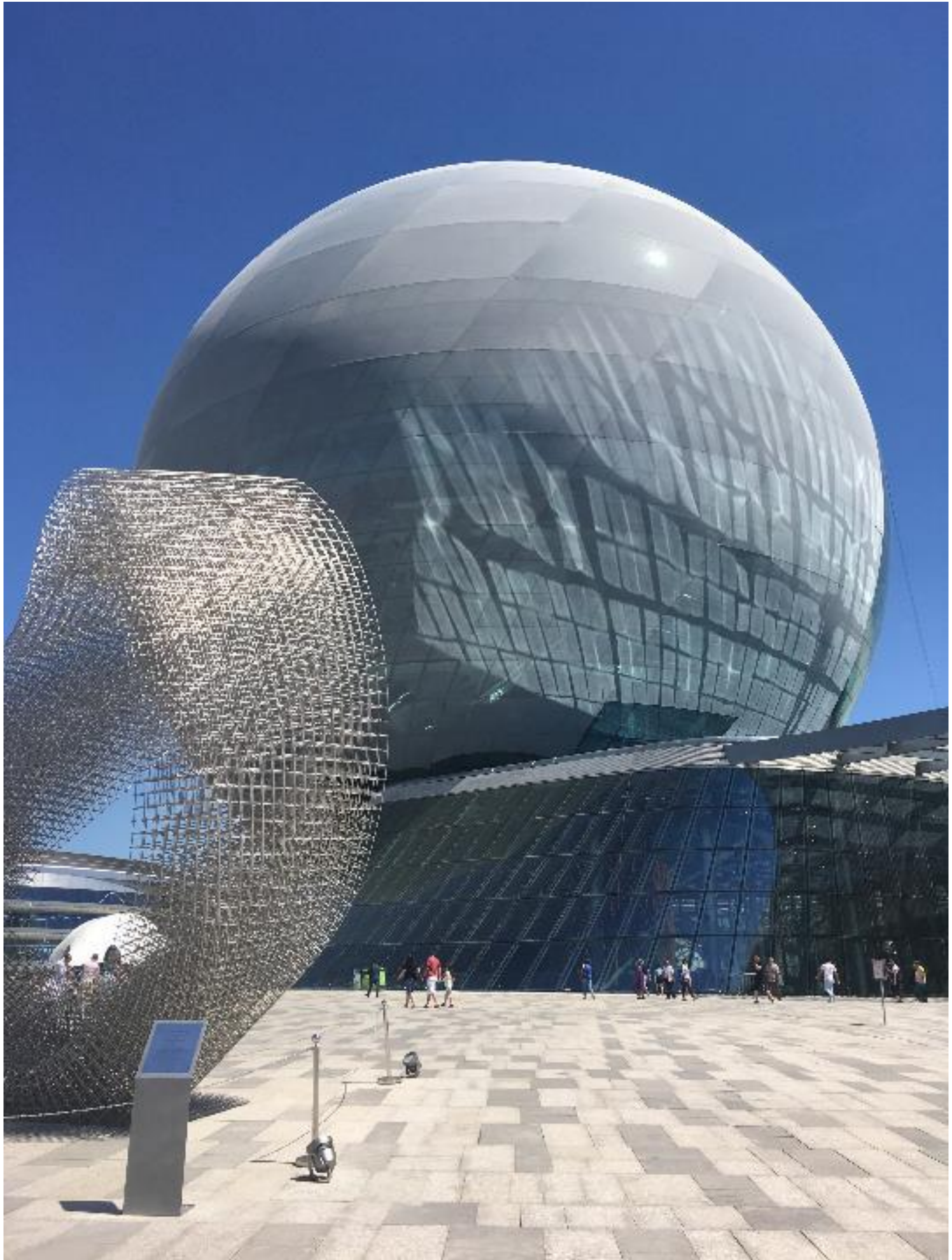
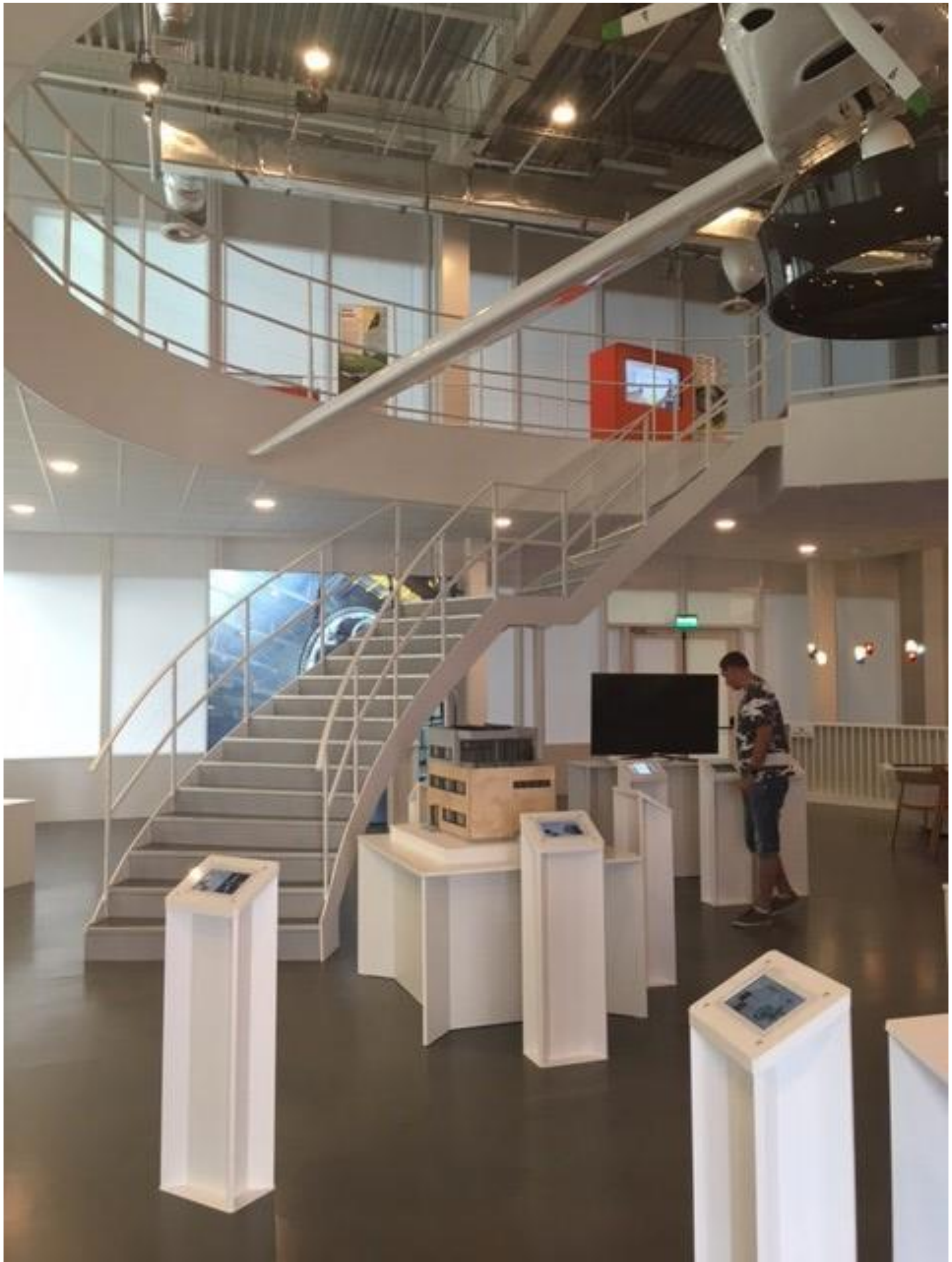
EXPO 2017
• Future Energy •
Astana Kazakhstan





ČEEP 2016

ČESKÝ ENERGETICKÝ A EKOLOGICKÝ PROJEKT | STAVBA | INOVACE ROKU

VYPISOVATELÉ: MINISTERSTVO PRŮMYSLU A OBCHODU · Ministerstvo životního prostředí · MINISTERSTVO PRO MÍSTNÍ ROZVOJ ČR

HLAVNÍ PARTNER: PRE

PARTNEŘI: ČESKÝ INSTITUT INFORMATIKY ROBOTIKY A KYBERNETIKY ČVUT V PRAZE · TA ČR · PRAHA PRAGUE PRAGA PRAG · ČVUT UCEEB · A.e.M · CENTRUM PASIVNÍHO DOMU · TEPLÁRENSKÉ SDRUŽENÍ České republiky · SPS SVAZ PODNIKATELŮ VE STAVEBNICTVÍ V ČR · SP SVAZ PRŮMYSLU A DOPRAVY ČESKÉ REPUBLIKY · CZGBC · ČKAIT · czech smart city cluster · TPUE

TITUL ČEEP 2016

Kategorie: C – TECHNOLOGIE, INOVACE
Chytrý energetický management administrativní budovy Fenix Group

Přihlašovatel: ČVUT UCEEB

Výrok poroty: Za optimalizaci stavebního řešení, která v kombinaci s FV umožnila budovu s elektrickým vytápěním klasifikovat jako A - mimořádně úspornou. Projekt ověřil spolupráci střešních FVE s domovními bateriemi a distribuční „smart grid“ a byla prokázána efektivita tohoto inovačního řešení.

21. LISTOPADU 2017

Ing. Drahomír Ruta, předseda poroty

Ing. Miloslava Veselá, organizátor

TOP EXPO