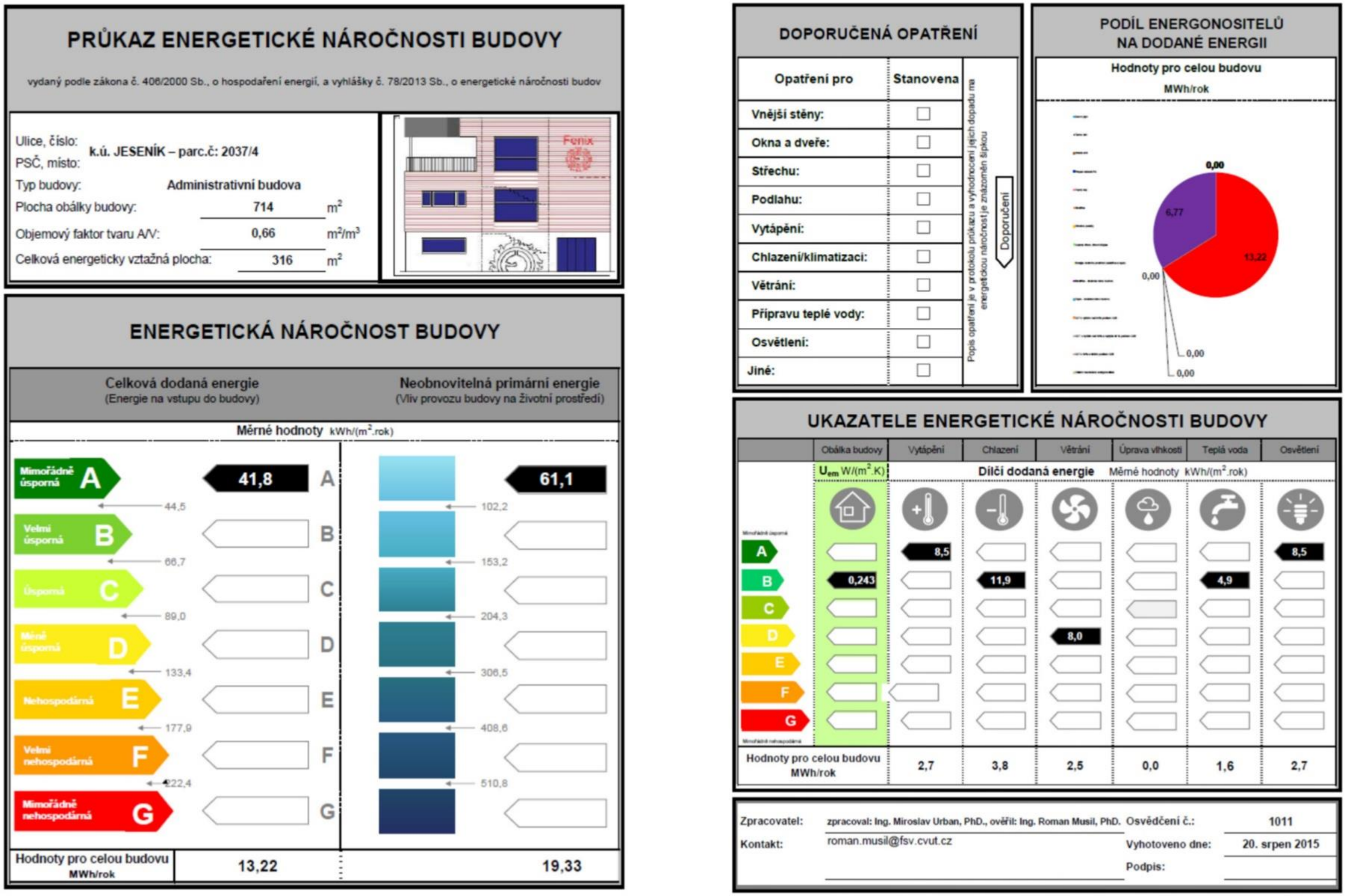
FENIX

An nZEB which is an active element of the energy grid

2 years of operation !

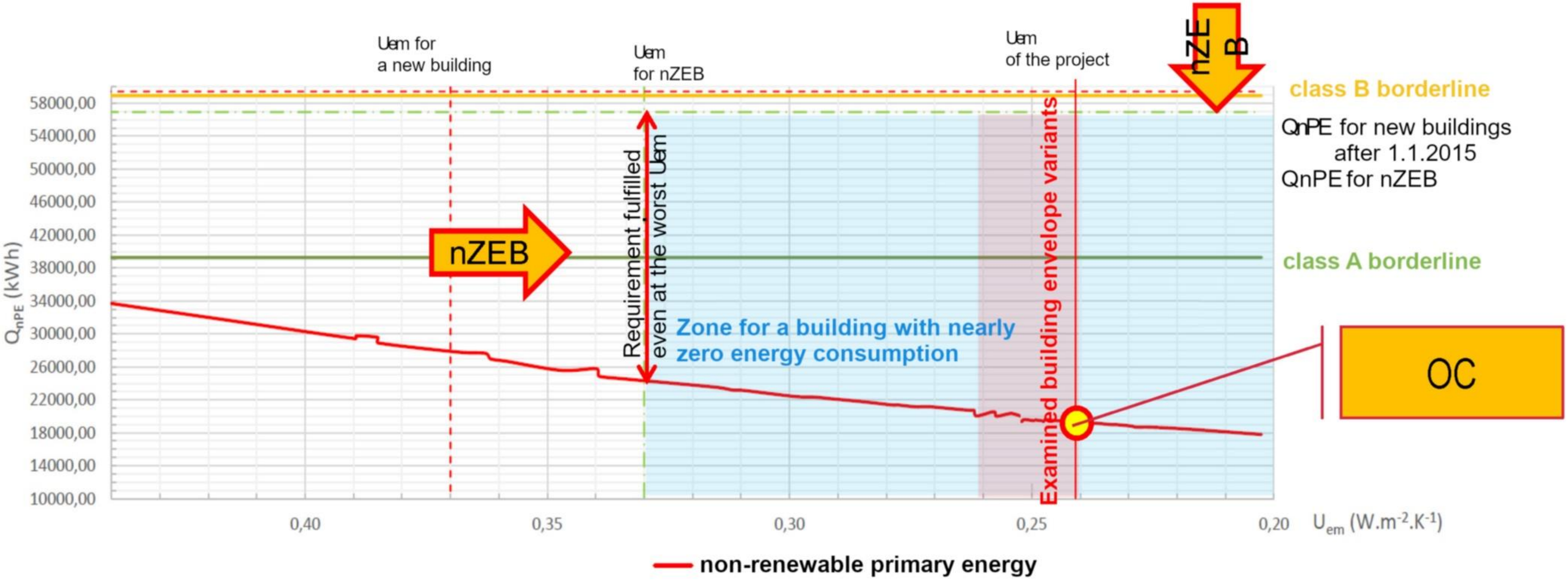
The building’s energy label

calculated according to the 2020 standard



The building is constructed to meet the nZEB standard, is fully electrified, and is equipped with an electric radiant heating system

Achieved NPE level



Office center - a building with nZEB parameters

a fully electrified building which is an active element of the grid

Presentation of the idea of an nZEB which is an active element of the grid - 2014

Design of the building - cooperation with CTU 04 / 2015 -08 / 2015
Construction commenced –10/2015
Construction completed – 05/2016

Cooperation occurs between the building's 7.2 kWp rooftop PV system, its 26kWh home battery and the energy supply grid. The battery is not only used for 100% of the building´s own utilisation of the energy from the PV system, but also for active cooperation with the grid. This means that it is charged during the low tariff period, while in the high tariff period it fully takes over the supply of energy for the building.

The building was designed with the help of the Czech Technical University in Prague's Department of Building Services. It was monitored over two years by a specialized group composed of representatives from the Ministry of Industry and Trade, the Ministry of the Environment of the Czech Republic, the Energy Regulatory Office, ČEZ - ESCO, ČEZ - Distribution, ČEPS and CTU.
The collection of energy consumption data as well as data on the quality of the indoor environment was performed by CTU-UCEEB.

Three surprises from the construction process

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

2) The building has been equipped with flexible electric radiant heating; an evaluation of possible variants estimated that if a warm-water system were installed together with a heat pump, return on investment would only occur after 25 years of operation, i.e. after approximately double the service life of the heat pump. The real energy consumption after 2 years of operation of the building only confirmed this information. If only the heating system was considered (without taking cooling - which sees very little use – into account), it would take up to 40 years to see a return on investment.

3) Monitoring of the number of cycles of operation for the battery storage system confirmed that its lifespan should exceed 25 years.

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Comparison of expected and real results after 24 months of operation:

Expected yearly energy consumption	**UCEEB –**	**27 000 kWh**
Real energy consumption		**26 626 kWh (- 1.4% 2017)**
		27 193 kWh (2018)
Energy consumption from the grid		**21 000 kWh (2017)**
		20 100 kWh (2018)

Energy consumption on heating and warm-water heating: 12 402 kWh (2016/2017)
Energy consumption on heating and warm-water heating: 10 500 kWh (2017/2018) -15.4%

The PV system´s own production	**PV –**	**7 200 kWp**
Real production		**6 050 kWh (2017)**
		7 123 kWh (2018)

It was verified that this model of controlled supply is fully functional and can provide advantages both for the operators of the energy grid and for the users themselves!

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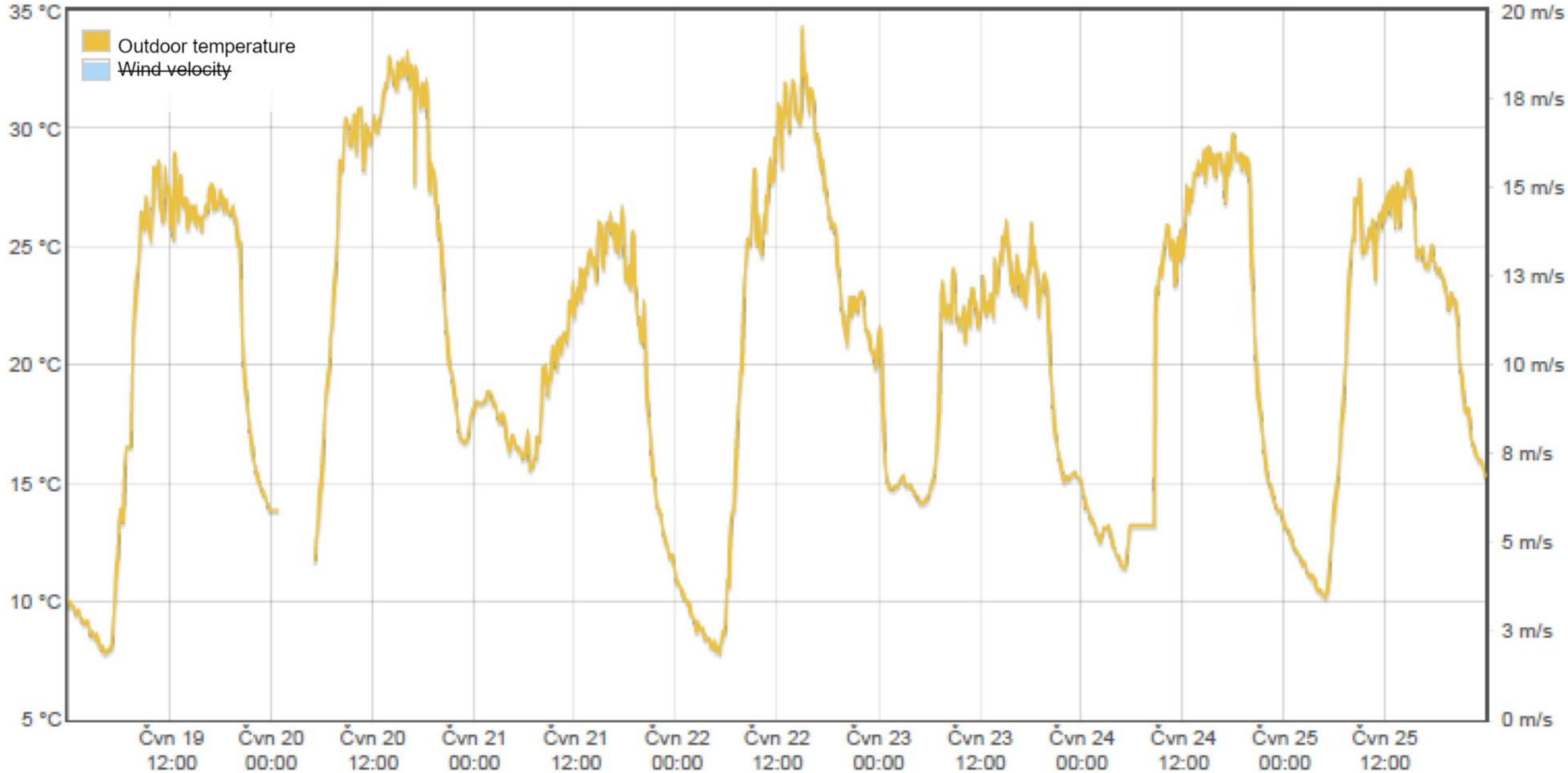
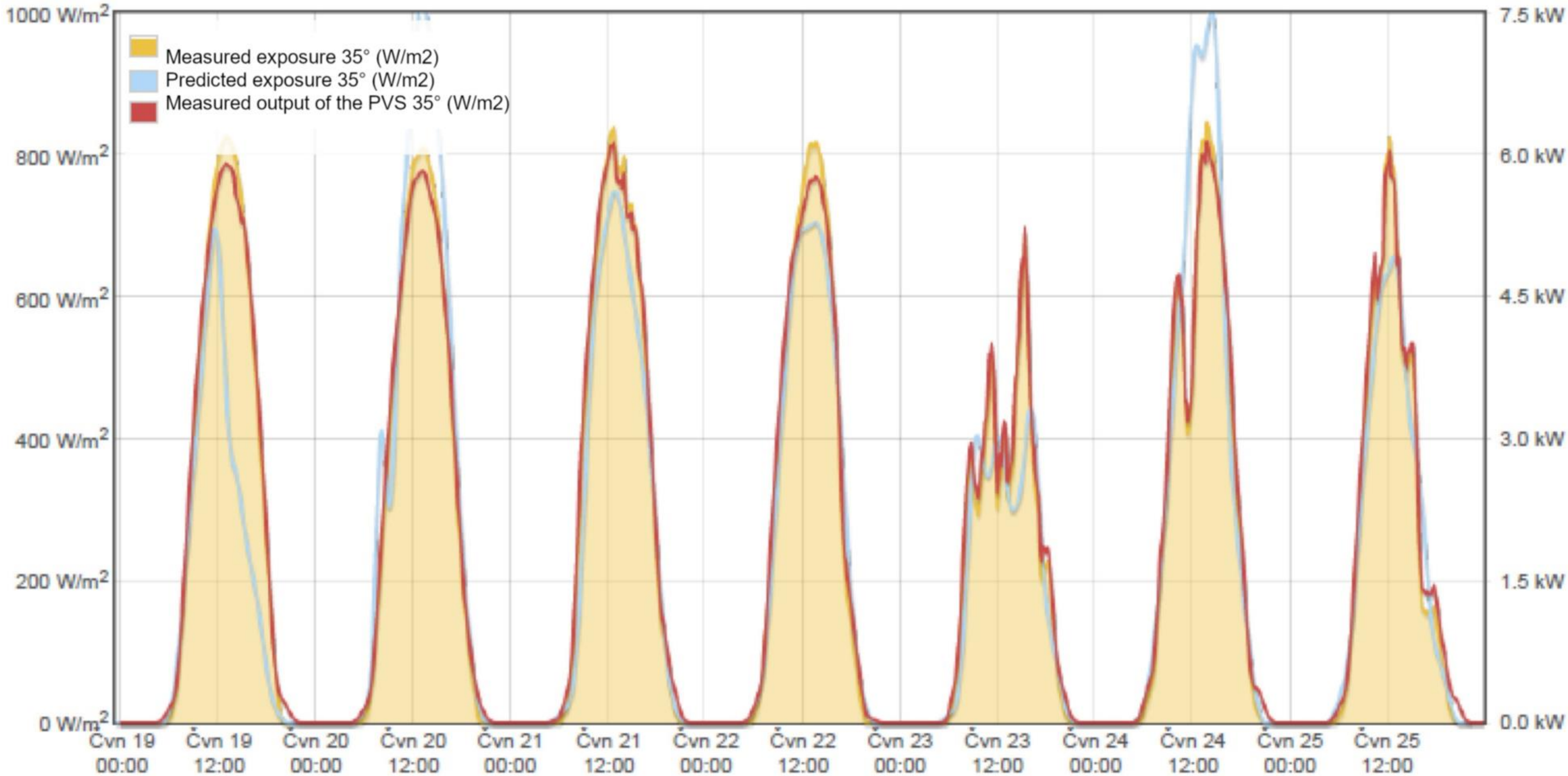
Summer operation - 19. 25.6. 2017

Outdoor environment



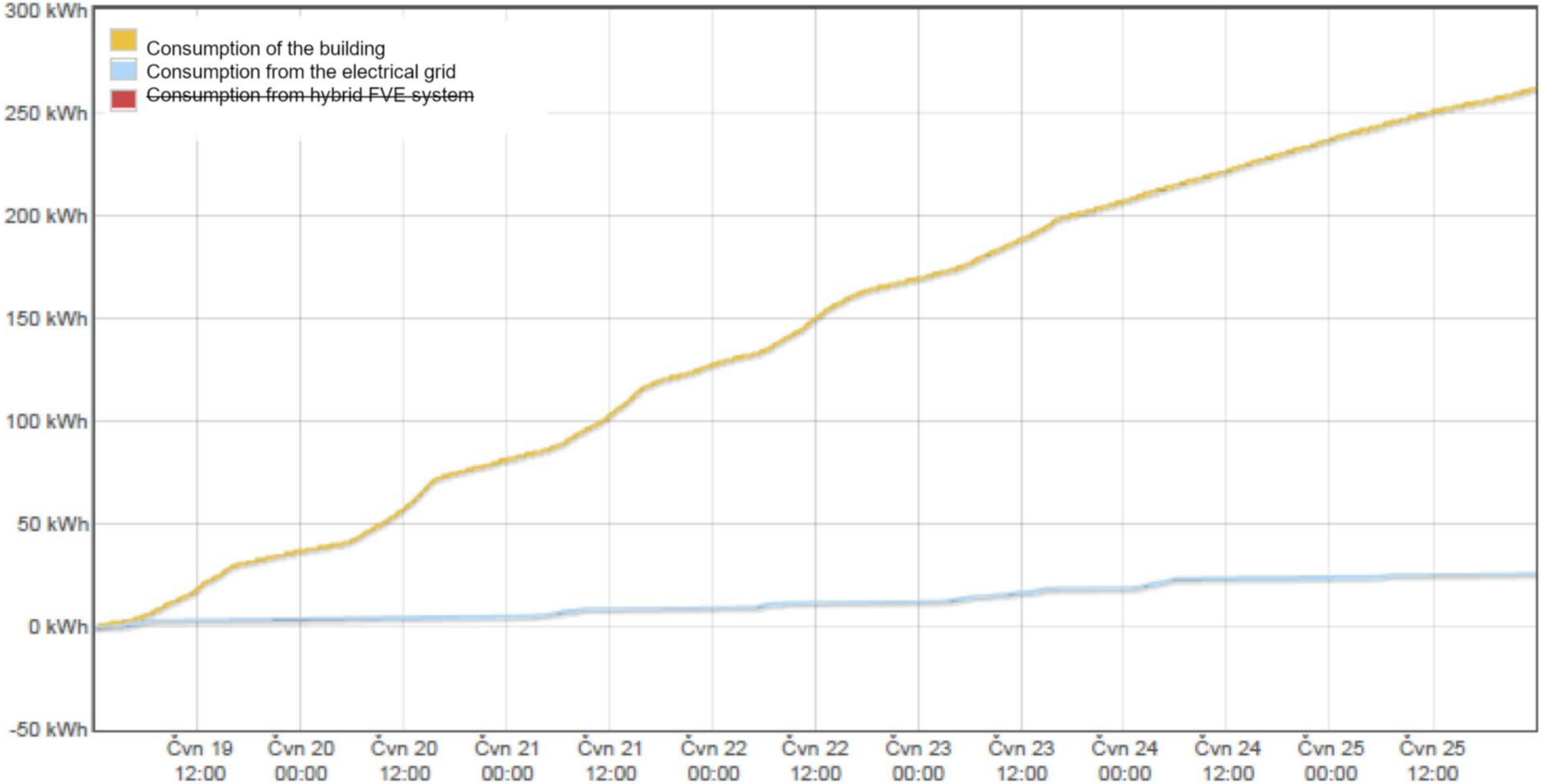
Sunny summer days with daytime temperatures exceeding 30°C

Exposure and produced output – gradient 35°



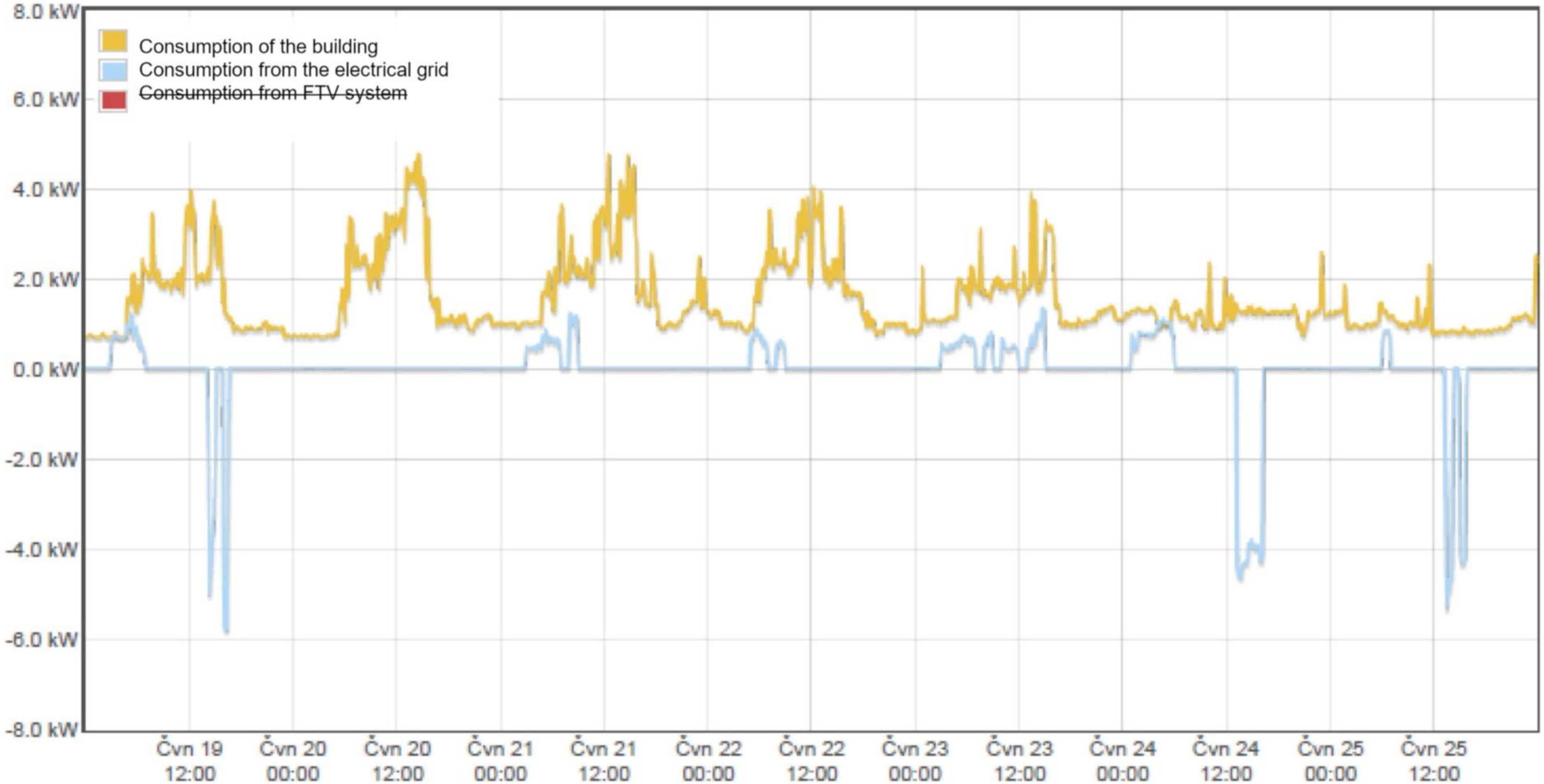
Comparison of the planned and real output of the PVS

Consumption of the building, production and supply (kWh)



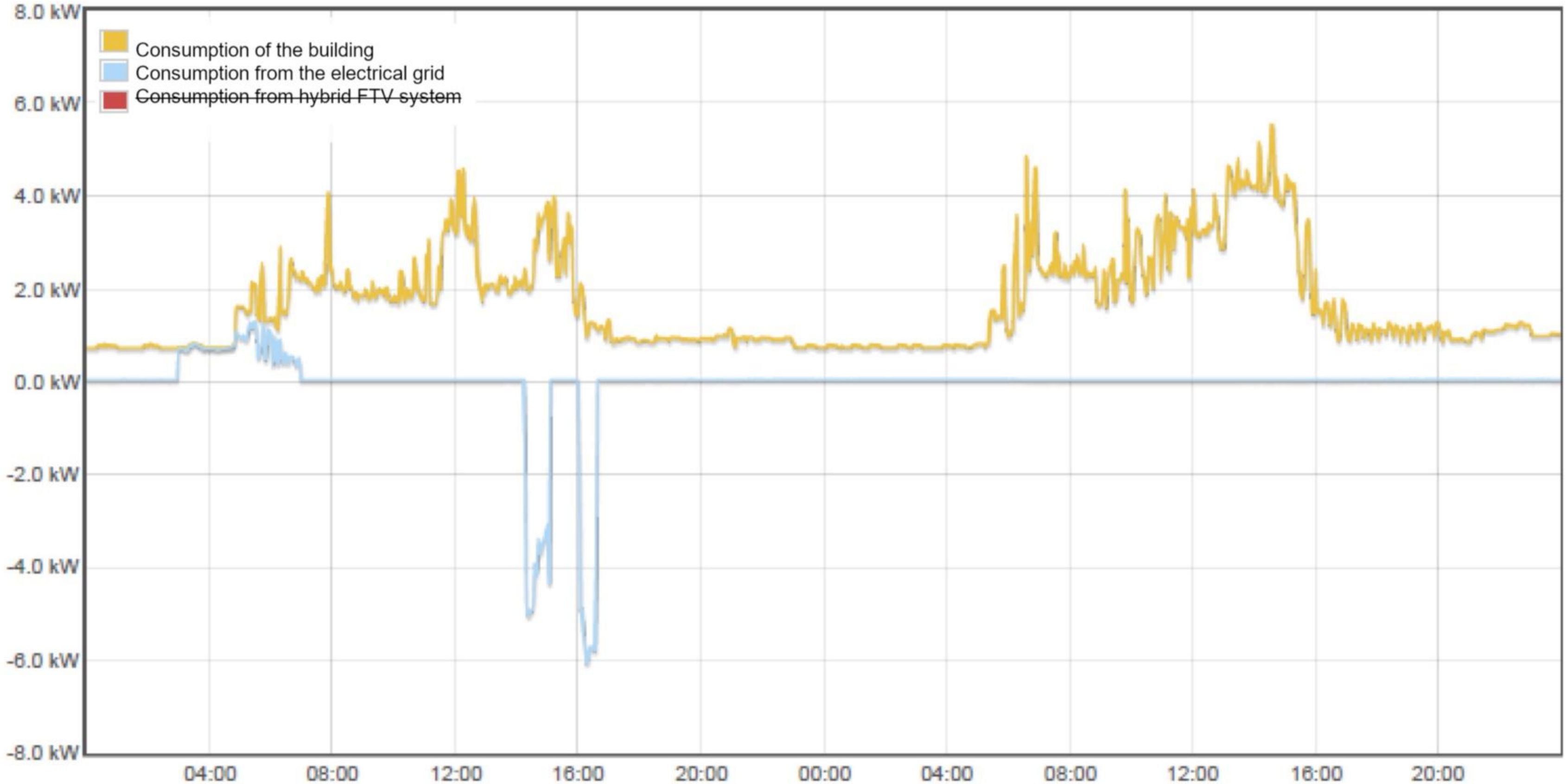
The output of the PVS covered 91% of the energy requirements of the building under these conditions.

Consumption of the building, production and supply (kWh)



Comparison of the real consumption of the building with the consumption from the grid - shows that low, controlled consumption takes place during the night while controlled supply occurs during the day (High Tariff)

Consumption of the building, production and supply (kWh)

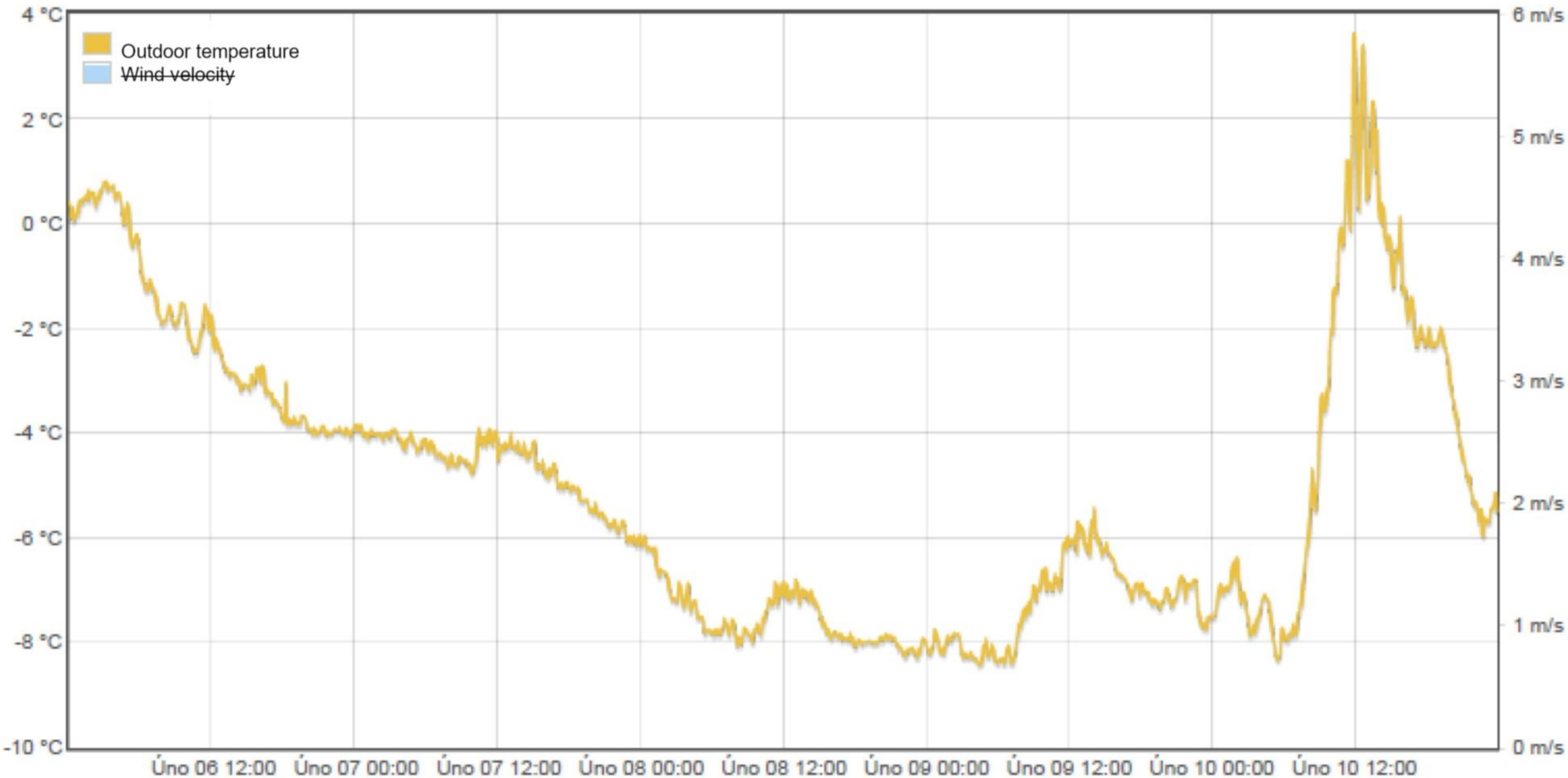


For a more precise overview - a detailed graph for two days from 19.-20.6.2017

Winter days - 6.-10.2.2017

Outdoor environment

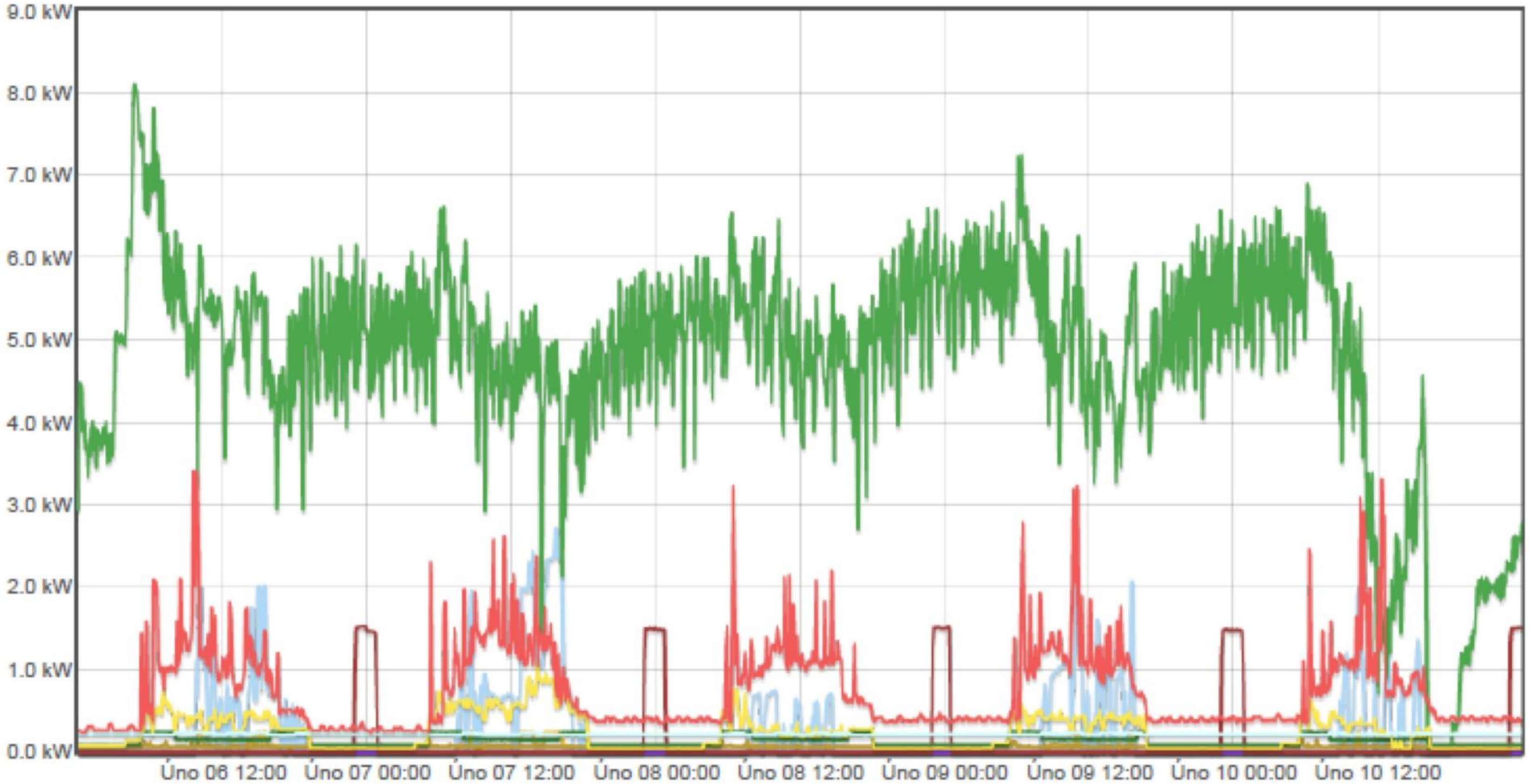
6.-10.2.2017



The day temperatures were below freezing point, with the exception of Friday 10th, when the day temperature rose sharply to +3°C.

Energy consumption (kW) for individual components

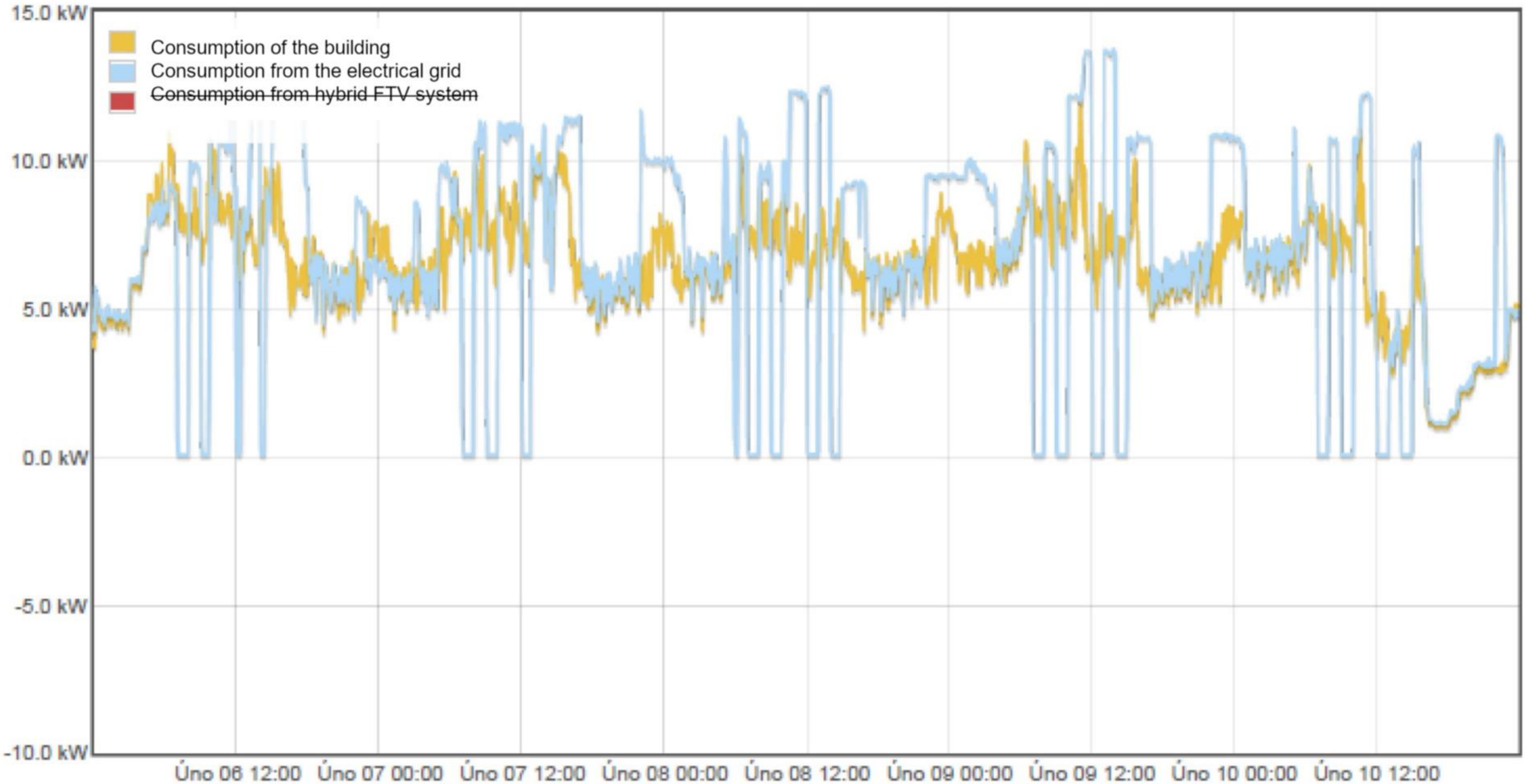
6.-10.2.2017



The energy consumption for heating (green) is influenced by the presence of people and the activity of office equipment (lower daily consumption), and reacts significantly to Friday´s increase in temperatures!

6.-10.2.2017

Consumption of the building, production and supply (kWh)



Comparison of the real consumption of the building with consumption from the grid, showing the ability of the battery storage system to achieve zero consumption from the grid during peak periods (high tariff) and harmonize the consumption of the building over 24 hours.

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Operation of the 26 kWh battery storage system

The battery is charged from the PVS, 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 lower main circuit breaker values was verified. **The building could thus operate with a 3 x 25 A circuit breaker even in the winter period, even though the output would suggest a 3 x 40 A circuit breaker should be used.**

Autonomous operation in the event of a power outage was also verified during the shutdown of a transformer station - the building functioned from **6 a.m. to 8 p.m. completely without limitations** and no technical failure 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 24h cycle. Its ability to work with limited wattage while satisfying every need was demonstrated. A storage system with a three-phase connection also significantly contributes to the balancing of energy consumption during the individual phases of the day !

Heating

Electric radiant heating system with individual control for each area
(9 kW installed)

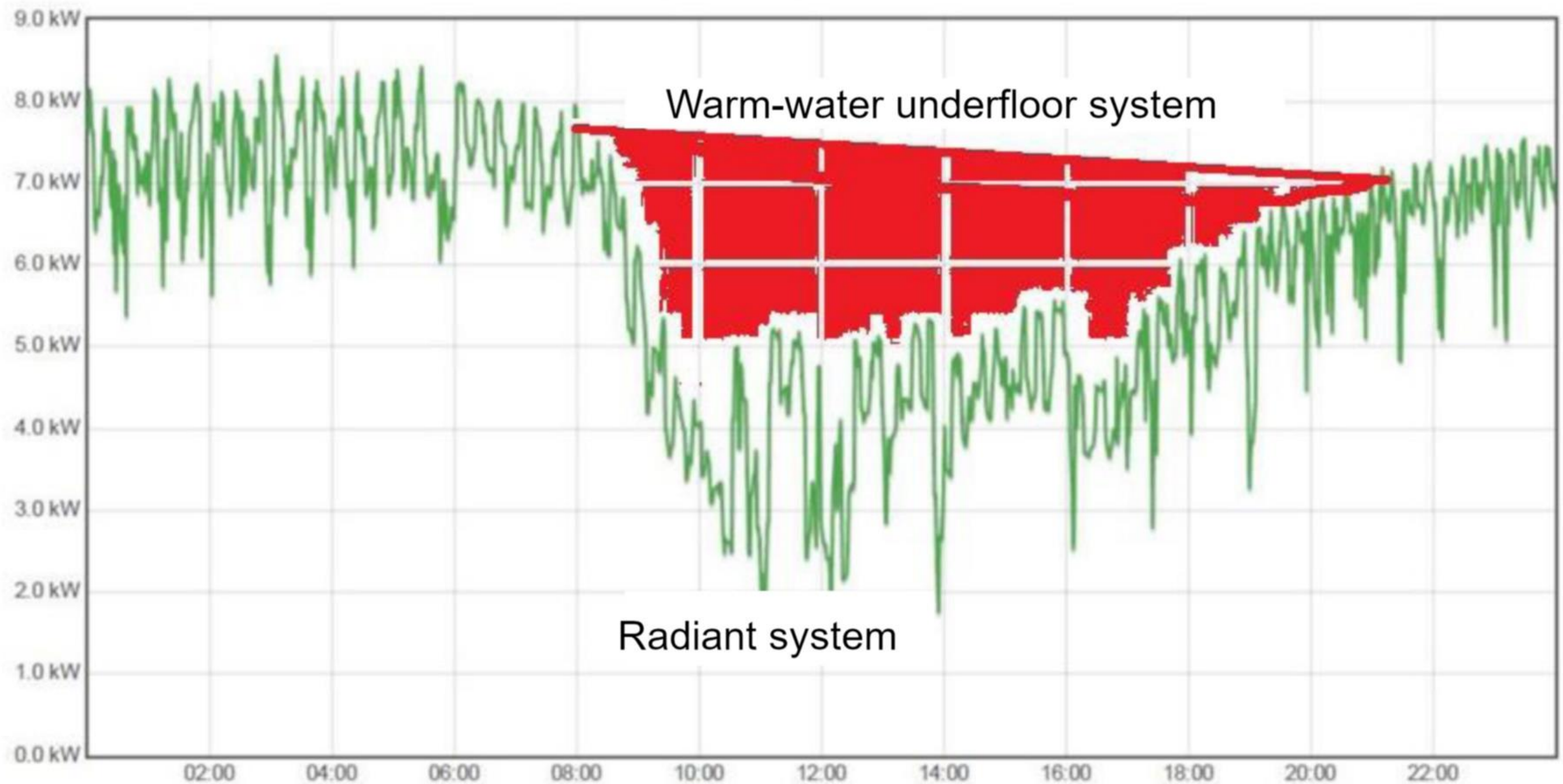
Energy consumption on heating was higher than expected and reached 12 045 kWh in the period from 10/16 – 5/17 and 10 050 kWh in the period from 10/17-05/18.
The consumption in the second year thus very much approximates our expectations - i.e. approx. 1000 kWh per one kW of installed heating wattage. However, it remains significantly higher than the calculated value, so it is questionable whether the calculated values are achievable in reality!

During the test, the advantageousness or disadvantageousness of the “attenuation mode” (- 2°C) was tested, and the established savings were found to be very good (17%). However, it results in large morning consumption peaks, though these can be solved by increasing the capacity of the battery.

In general, the heating system reacted very flexibly both to temperature changes and to the occupation of individual heated zones. It has clearly demonstrated its great advantages over warm-water systems with their large inertia!

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

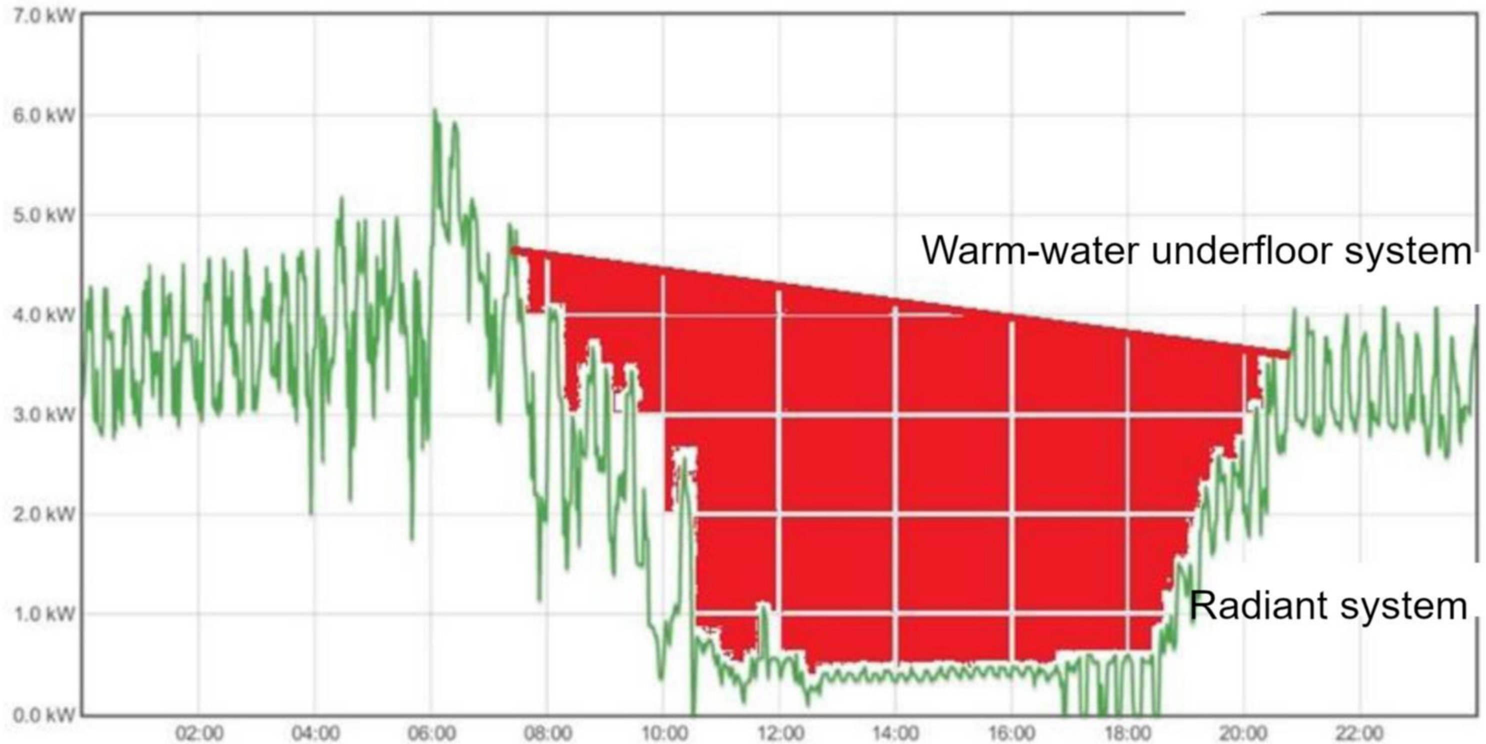
Electric radiant heating in comparison with a warm-water system
Energy supply for the heated area



The energy consumed for heating (by the radiant heating system) reacts flexibly to the change in outdoor temperatures and particularly to random heat gains (people – equipment) In contrast, a warm-water system with its great inertia and slow reaction speed is not capable of reacting quickly, which results in significant energy losses

Sunny day 16.2.2017– average temperature +4.7°C

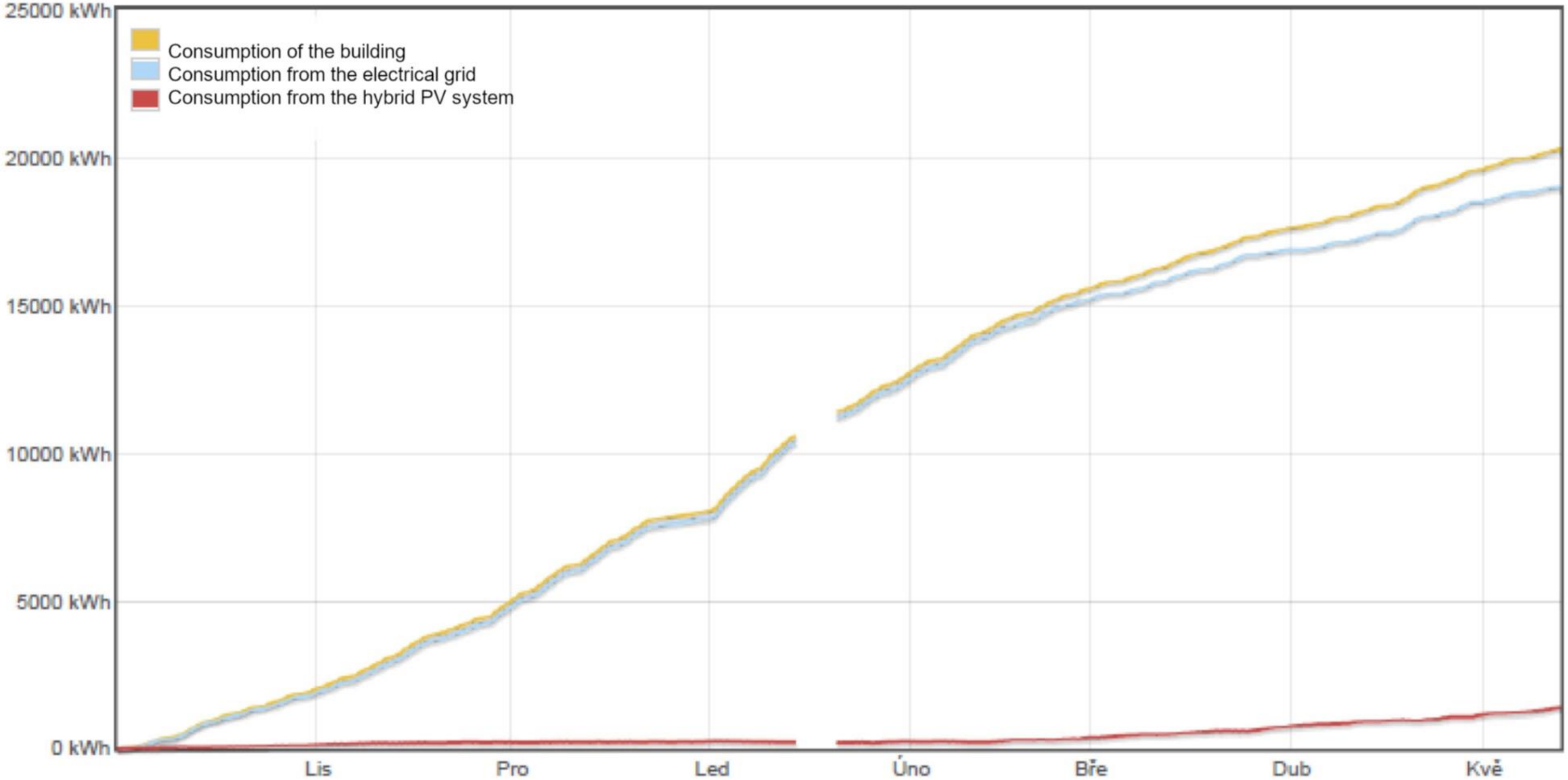
An even greater difference in effectiveness



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 use a flexible heating system capable of reacting swiftly in each individual heated area.

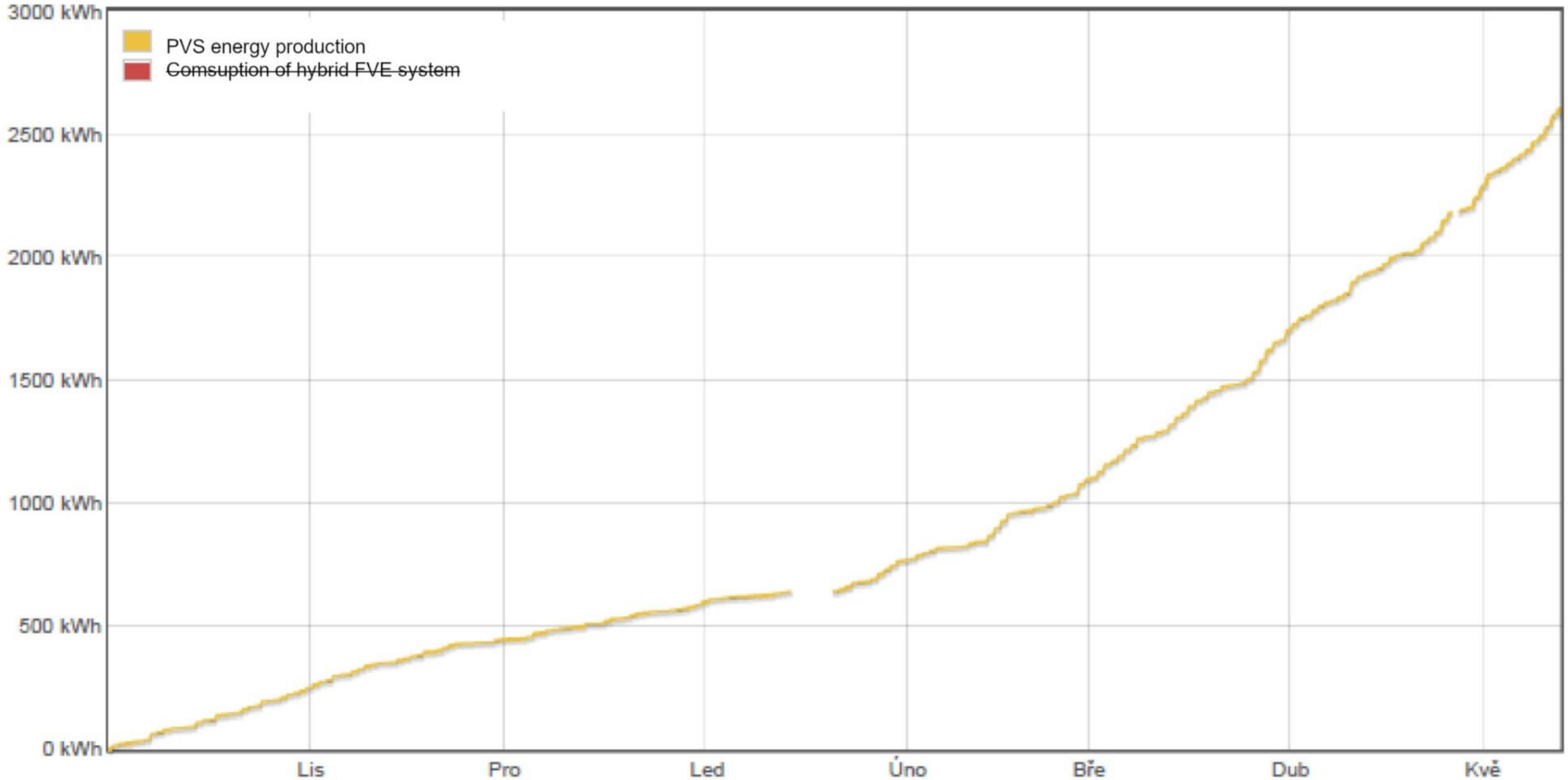
Standard warm-water systems (with any source) do not have this ability in nZEB!

Consumption of the building, production and supply (kWh)



During the heating season, 20 005 kWh were used in the first year and 20 000 kWh in the second year

Production by the hybrid PV system (kWh)



The PV system produced 2 507 kWh in the 2016/17 heating season, i.e. 12.5% of total energy consumption, and in 2017/18 it was 3 500 kWh, i.e. 17.5% of total consumption!

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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 individual rooms + the provision of minimal ventilation - in the summer months, the input air temperature was set to 20°C, while in the winter 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 3 times more energy in the summer months than the cooling of the interior using a multi-split 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 (2017), 650 kWh (2018)**
- multi-split:	**350 kWh (2017), 340 kWh (2018)**

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Quality of the indoor environment

The following parameters were monitored in the individual rooms:

- temperature
- humidity
- CO_2
- VOC

Evaluation was carried out by the Department of Indoor Environmental and Building Services Engineering at the Czech Technical University in Prague - Dr. M. Urban. (extensive independent report)

Conclusion: for all parameters the quality of the indoor environment was Class 1 for the whole period of use.

ČEZ distribution testing modes

“Smoothened” supply point diagram with regard to the distribution grid

- Aim - the longest possible operation in constant mode

Islanding operation balance (with a connection to the grid)

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

The supply of electrical energy to the grid when 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 PVS to the grid to a pre-arranged proportion of the installed PVP output

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

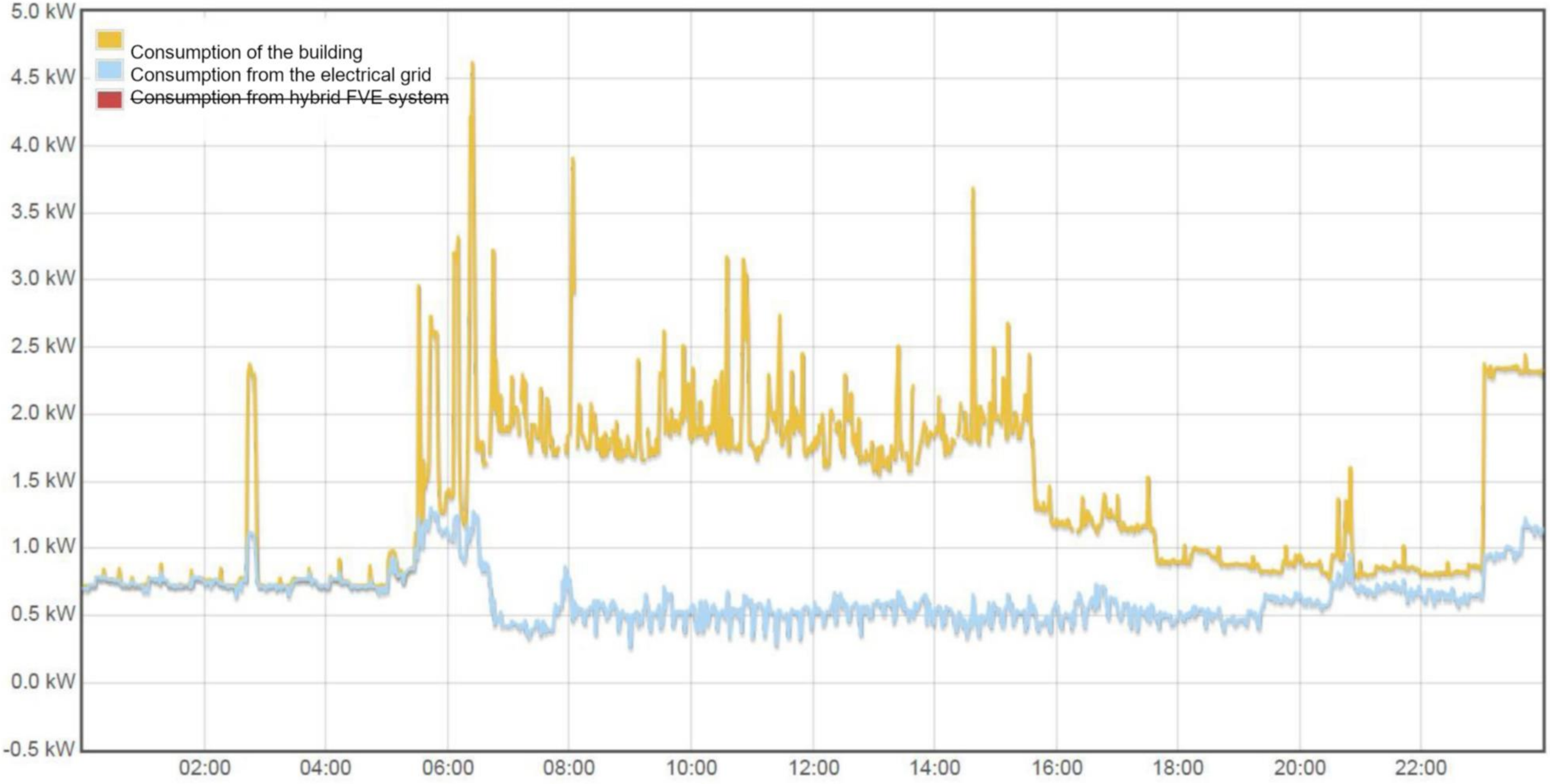
Consumption limited by the Distributor to a pre-arranged level

- Aim - to take - upon the request of the distributor – a lower amount of power (e.g. half) from the grid than was consumed by the consumption site at a given moment

The tests took place from 14. to 28.5.2018

Testing mode - balanced consumption diagram

Consumption of the building, production and supply (kWh)

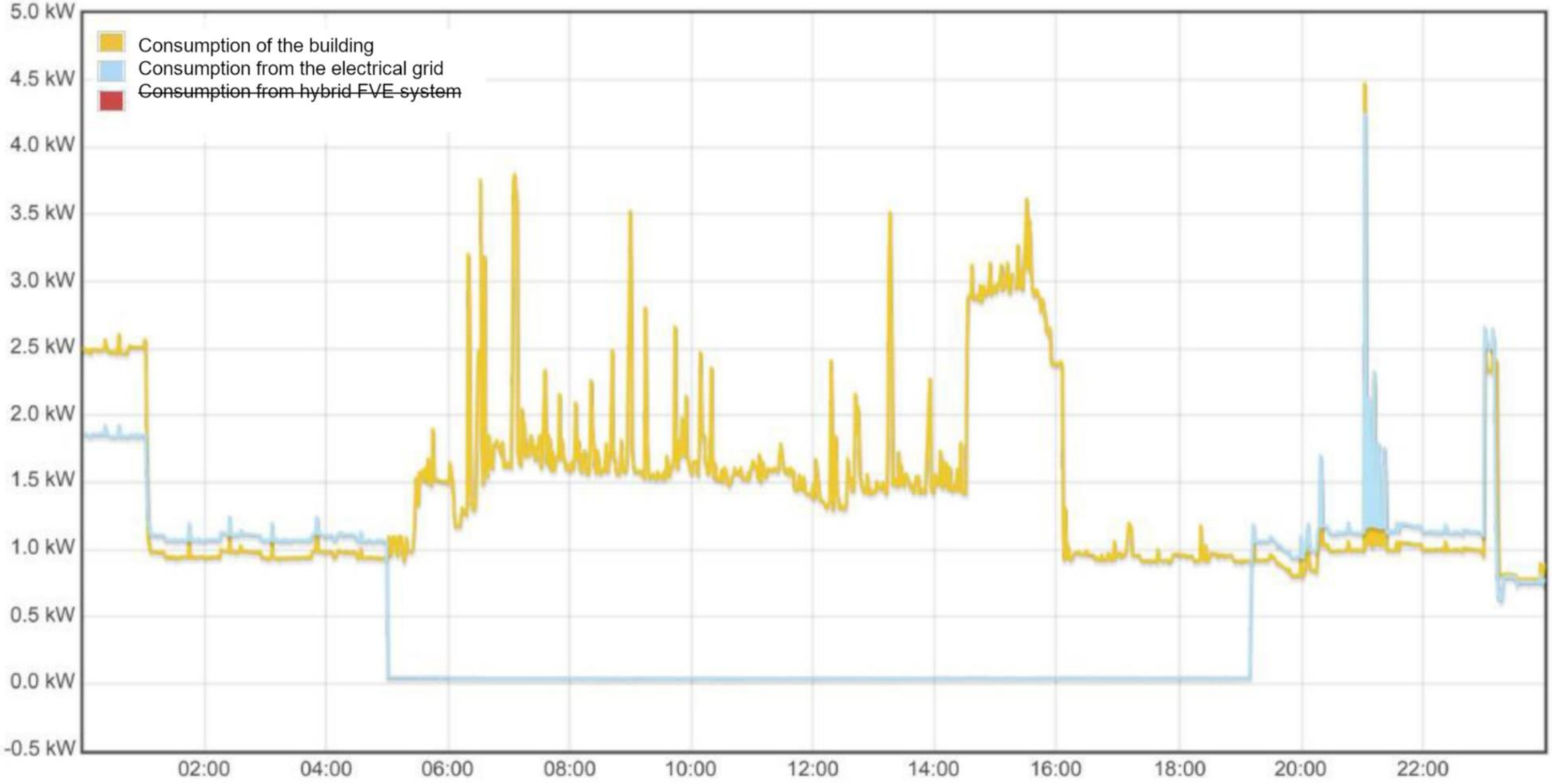


The maximum total electricity consumption of the building was 4.5 kW

The maximum energy consumption from the grid was 1.2 kW

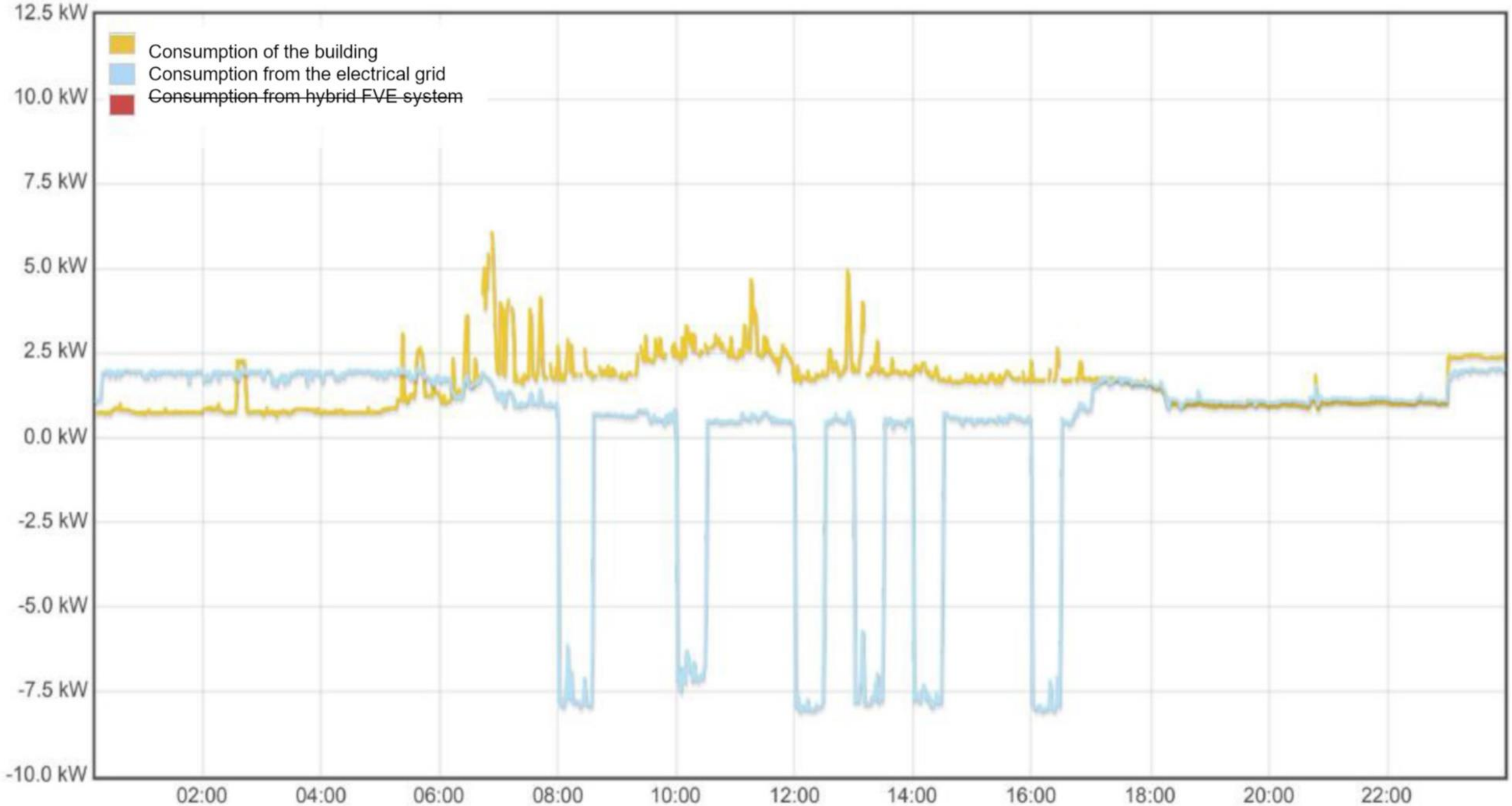
The graph clearly shows the complete separation of the real consumption of electricity from

Consumption of the building, production and supply (kWh)



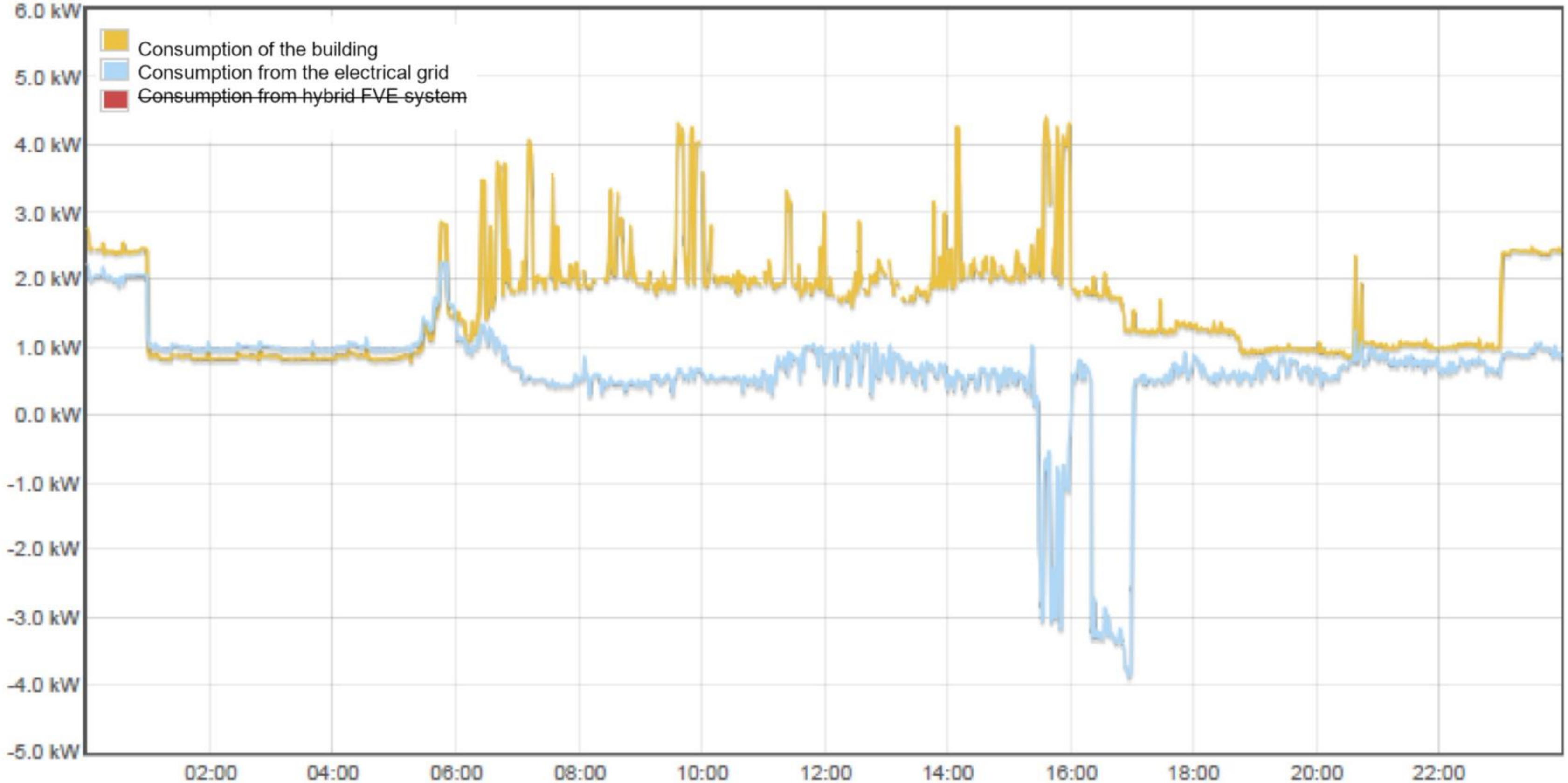
18.5. – experiment: zero consumption from 5 a.m. (maintained for 14 hours till 7 p.m.)

Consumption of the building, production and supply (kWh)



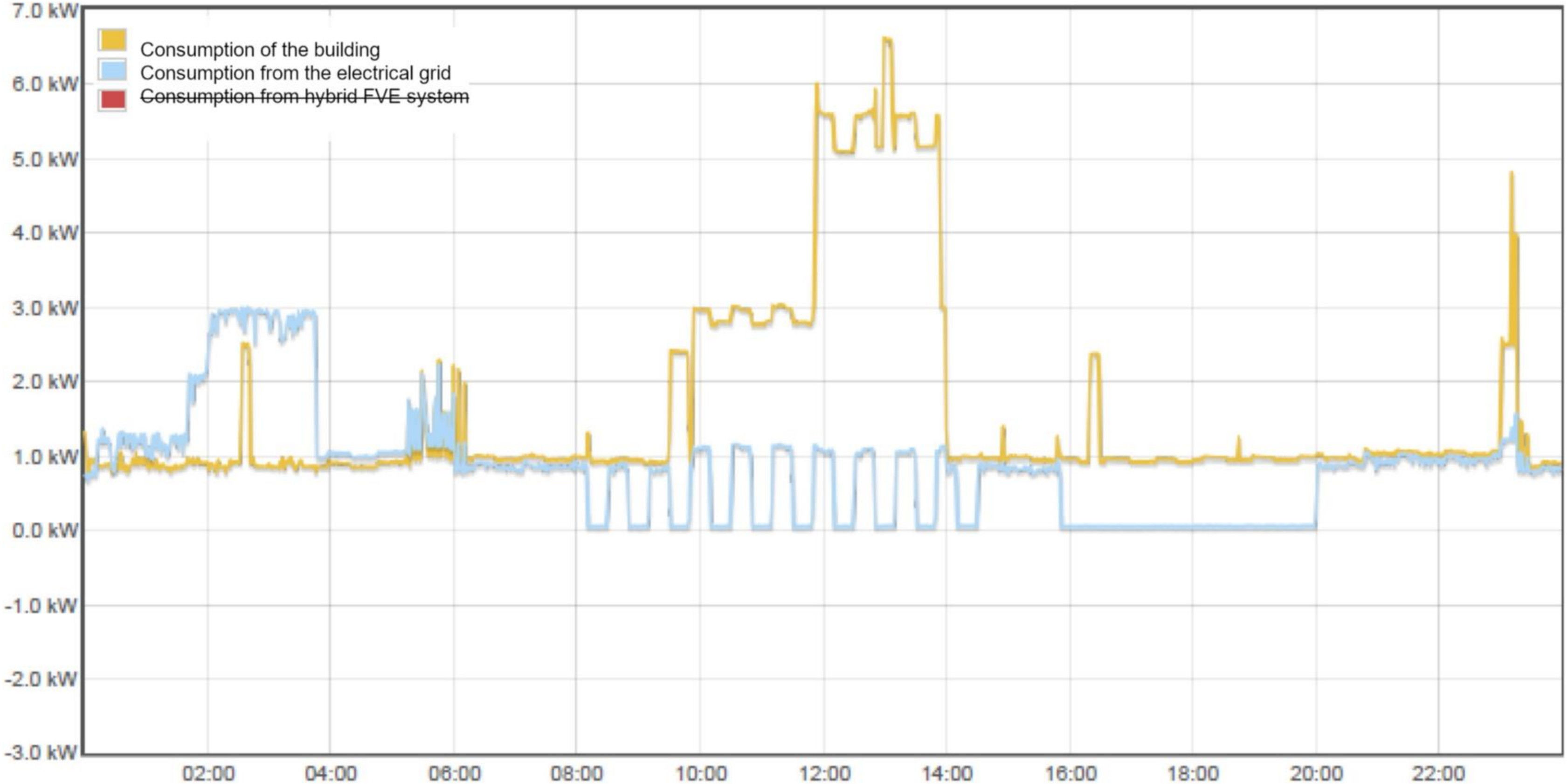
21.5.2018 - even consumption with controlled energy supply to the grid

Consumption of the building, production and supply (kWh)



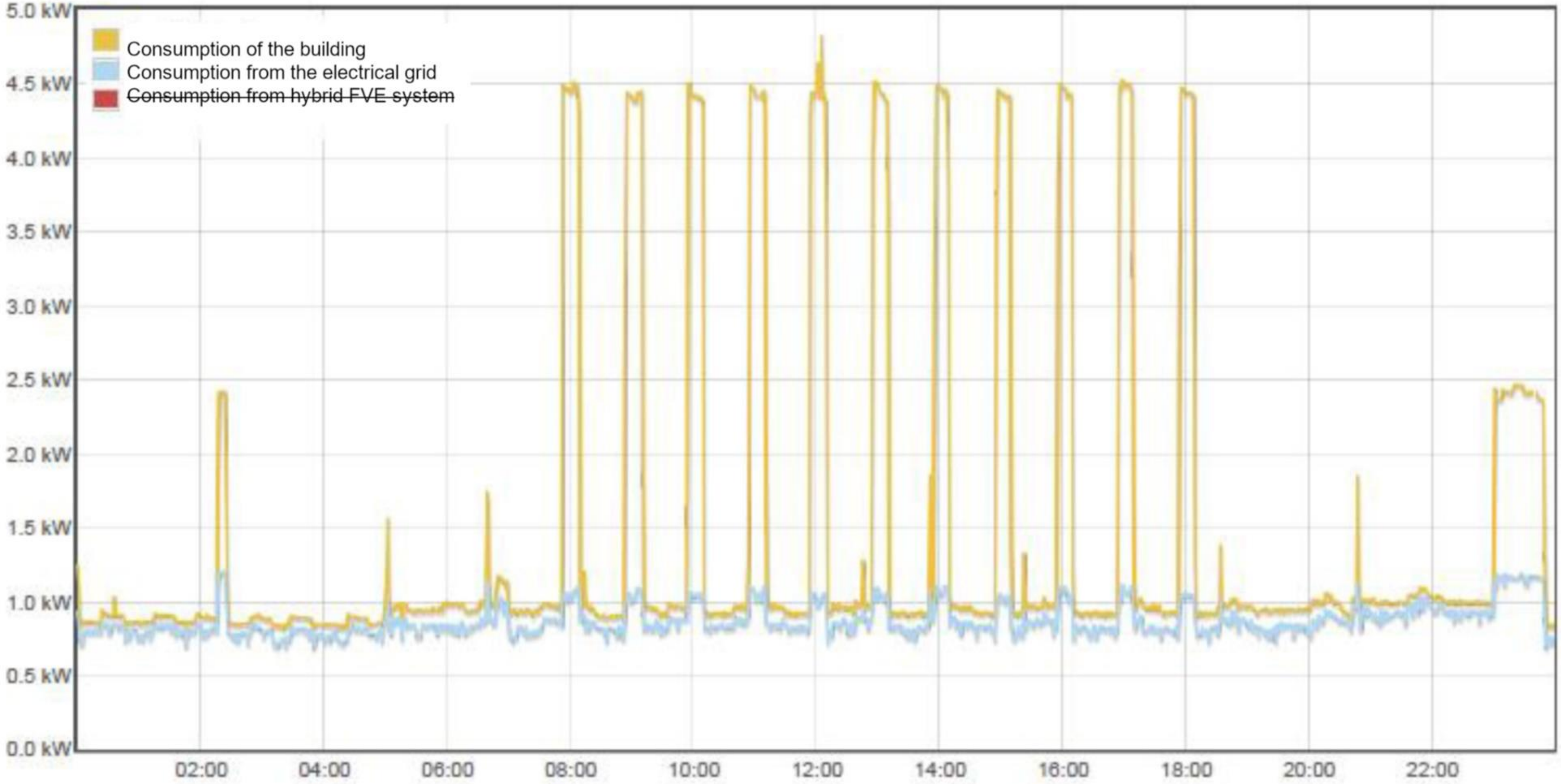
Maintenance of the daily power supply from the grid at a level below 1kW, with possible controlled overflow in the case of PVS overproduction

Consumption of the building, production and supply (kWh)



Regular off-grid mode (30 min intervals) when load increases (up to 6kW)

Consumption of the building, production and supply (kWh)



Maintenance of even consumption from the grid despite a load increase of 4.5 kW at regular intervals

Conclusions:

- It was proved that the presented concept is capable of effective cooperation within future “smart grids” as well as currently operated electrical grids using load management

- ČEZ measurements showed that the impact of individual modes on the grid is completely insignificant. As this minor phenomenon occurred in one phase only, UCEEB and Fenix will carry out tests to identify the causes.

- It seems that it is essential to produce materials for designers that set out the relationship between the wattage of the building, the size of the PVS and the size of the battery storage system

- Cooperation with regard to monitoring and evaluation was arranged with SAS Jeseník for 2018-2019

Further steps

1) The data are collected online in the UCEEB cloud and all participants have access to them.

2) UCEEB will produce a final report by 30.10.2018 which evaluates all aspects of the two years of the building’s operation.

3) A working group will assess the creation of suitable conditions to expand the concept.

4) It was agreed that the group will continue to work on the SAS Jeseník project - 640 kWh battery storage system.

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 and agricultural buildings, and also for the area of services

- - the smallest system, AES 10, will be available from 2/19

- At present we are completing a project involving the cooperation of a battery storage system (640 kWh) with a 24kWp roof PV system.
  The aims are as follows:
  - - to decrease the reserved wattage (distribution of consumption over 24 hours)
  - - management of the ¼ hr maximum
  - - the elimination of short-term failures which can cause significant damage
- Again, the data from this project will be available at the UCEEB server from 09/18

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

- This concept promises an advantageous return on investment even with current storage prices, and we can see great potential for its future development.

Collaborative project Fenix - CTU-UCEEB

as part of the NCK (2019-2020) programmes

Residential buildings:

Development of an algorithm for the optimum management of the indoor environment in a residential building constructed to the nZEB standard, with renewable energy sources and electrical energy storage. The aim is that a building with a PV system should maintain its indoor environment through the optimum operation of electric heating, ventilation and lighting, while making efficient use of locally produced electrical energy via its storage system.

Two-year project - cooperation: UCEEB – Fenix – RD Rýmařov – WAFE – AERS – S-Power
Joint investigation and subsequent commercial collaboration during project implementation

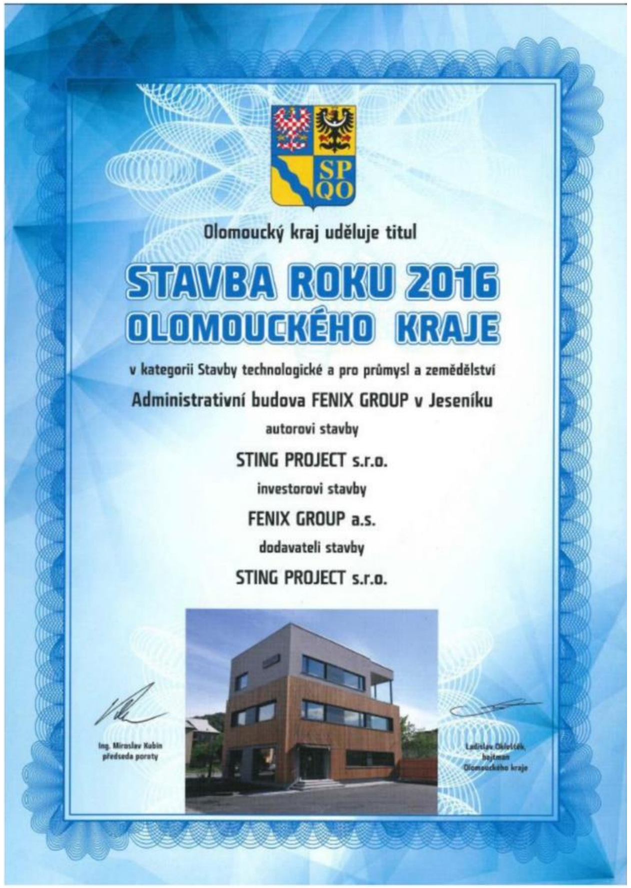
Awards :

1) On 16.6.2016 the concept for a house as an active element of the energy system received a special award as part of the CZECH TOP 100: 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 theme for the whole exhibition. A specialized thematic conference also took place there at which some of the members of the specialized working group actively took part.

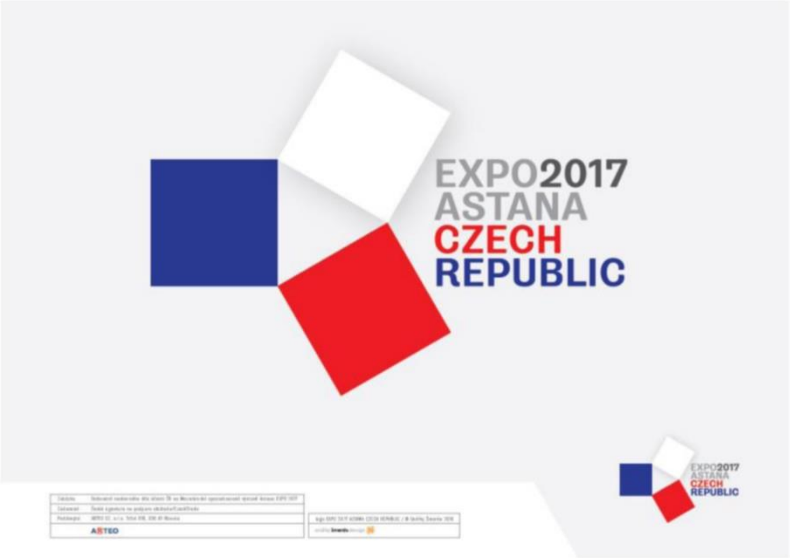
3) On 27.3.2017 the county representative of the Olomouc region awarded the OC project the prize

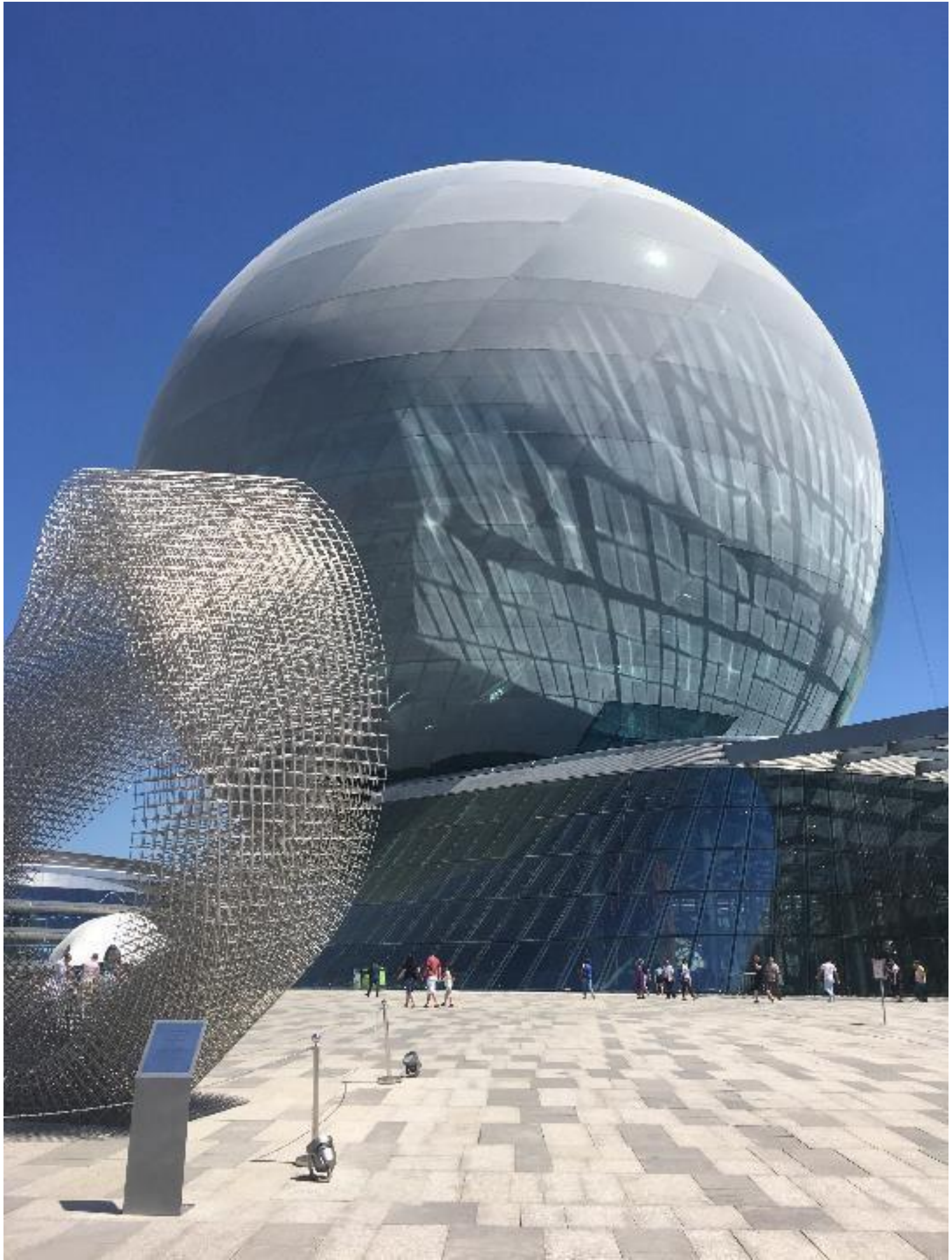
Building of the year 2016

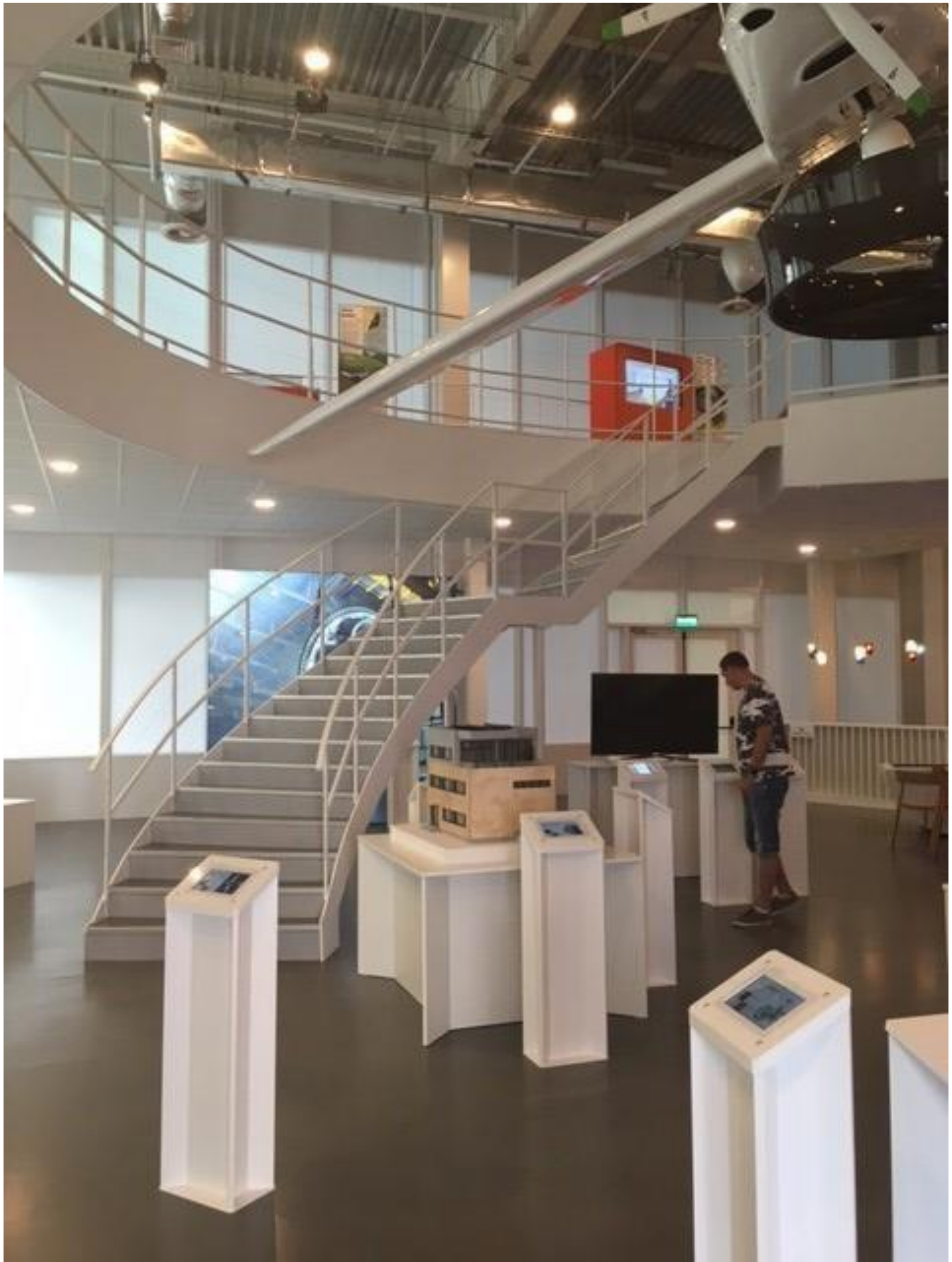


4) We consider the fact that this project was presented at the Czech Republic's display as one of 10 official exhibits at the world exhibition in Astana (06/17-10/17) to be the highest award.

The theme of the exhibition was energy savings and energy efficiency.







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 | 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

EXPO 2020 DUBAI - Pavilion of the Czech Republic, March 2021

Fenix was contacted by the general commissioner for the Czech contingent and its participation in the greatest of world exhibitions was arranged. A model of OC Fenix will be exhibited there with the AES 10 modular battery storage system.