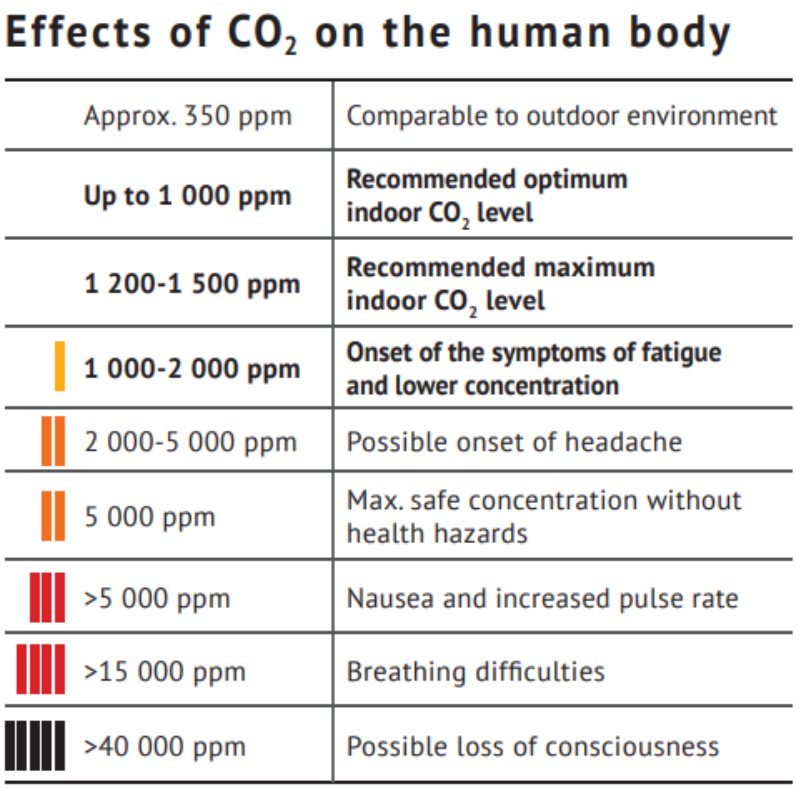
Effective ventilation of school classrooms with energy and financial savings

Saving energy and financial resources spent on building heating is current topic. Effective ventilation of school classrooms **can save up to 82% of heat loss** caused by ventilation. **Thus, up to 82% of the costs spent on ventilation can be saved.** Czech manufacturer of ventilation units, company Xvent s.r.o. brings solutions tailored to the needs of schools.

The effect of ventilation on the human organism

A substantial amount of heat is lost through the ventilation of indoor spaces, in the case of schools, classrooms. However, ventilation of classrooms (any indoor space occupied by people for a long time) is absolutely necessary. Nowadays, when most buildings are insulated with almost airtight facades and equipped with tight windows, ventilation, or in some other way, is a must. If the interior spaces are not ventilated, there is an excessive concentration of exhaled air with a high value of CO2 content. Through several independent measurements of CO2 concentration during classes, it was found that **the value of CO2 concentration in the air in school classrooms several times exceeds the recommended hygiene minimum**, set at 1,500ppm for the Czech Republic (even 800ppm in some EU states). The measured value in classrooms exceeded 5,000ppm in many cases. Such a value of CO2 concentration in the air has a direct negative effect on human health, performance, concentration and fatigue. The figure below shows the effect of CO2 concentration in the air on the human body.

Figure no. 1 Effect of CO2 concentration in the air on the human organism



A solution for effective ventilation of a school classroom with heat recovery from the company Xvent s.r.o. – heating unit with fresh air supply Xroom

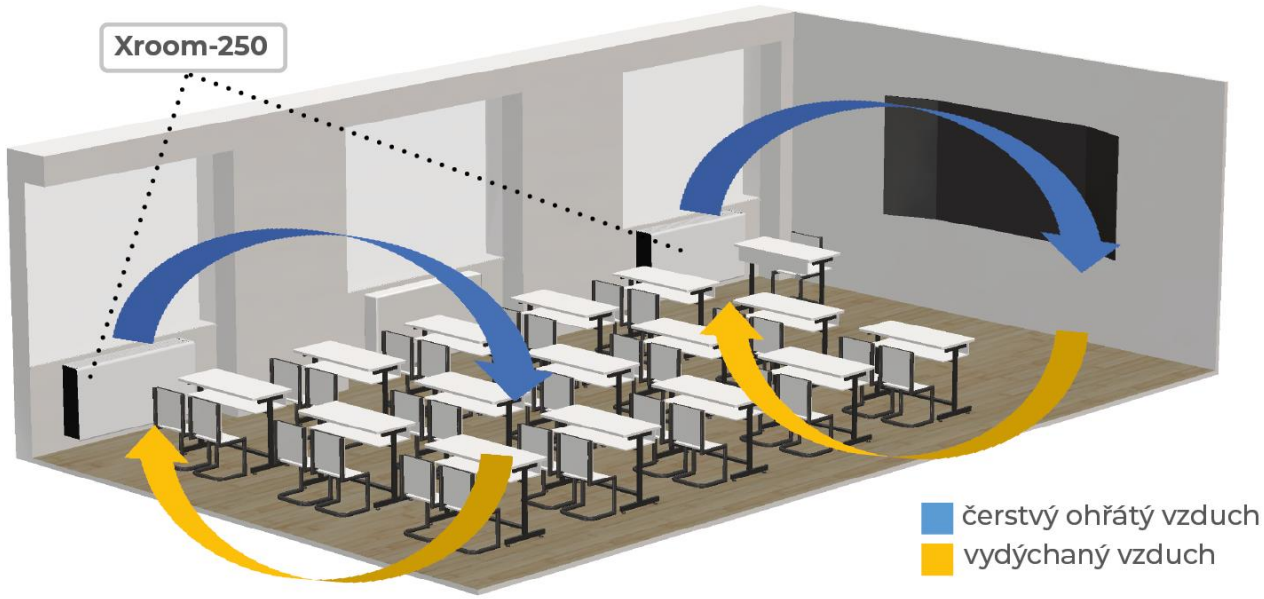
The **Xroom** heating unit with fresh air supply and heat recovery is a wall-mounted unit that does not require the installation of fresh air distribution. It is mounted on the perimeter wall of the building and through two holes drilled in the perimeter wall of the building it brings fresh and exhaled air from the room. The heating power of the unit roughly corresponds to a two-row plate radiator. Its ideal location is under the window in place of the original radiator. This saves space in the classroom.

Ventilation function

It is possible to install several such units in one classroom, thereby increasing the volume of fresh air supplied. The offer includes two sizes of units with a nominal output of 100m3/h (in boost mode up to 215m3/h) and 250m3/h (in boost mode up to 350 m3/h). For sufficient ventilation of a classroom with approx. 30 pupils and a teacher, it is necessary to install at least two units of size 250m3/h (so nominal air output 500m3/h), alternatively (for reasons of space) four units of size 100m3/h (nominal air output 400 m3/h). Better operating parameters (thermal efficiency, noise, etc.) can be achieved by slightly oversizing the system and installing three units of 250m3/h (nominal output 750m3/h). Thanks to the distribution of more units in the space, a better distribution of fresh air is achieved inside the classroom, which is one of the advantages compared to competing products.

Heating and cooling

Xroom can be connected to the heating water system and used to heat the classroom. In the case of an ice water source (heat pump and other equipment), the unit can also be used to cool classrooms in the summer months. The Xroom unit can also be equipped with an electric heating coil (instead of a water exchanger) and can be used as an independent heater or as a backup device in the event of a failure of the heating water system (according to local conditions). The Xroom unit can also be used as a purely ventilation unit with heat recovery and it is not necessary to fit it with any heating element. (Water exchanger or heating coil).

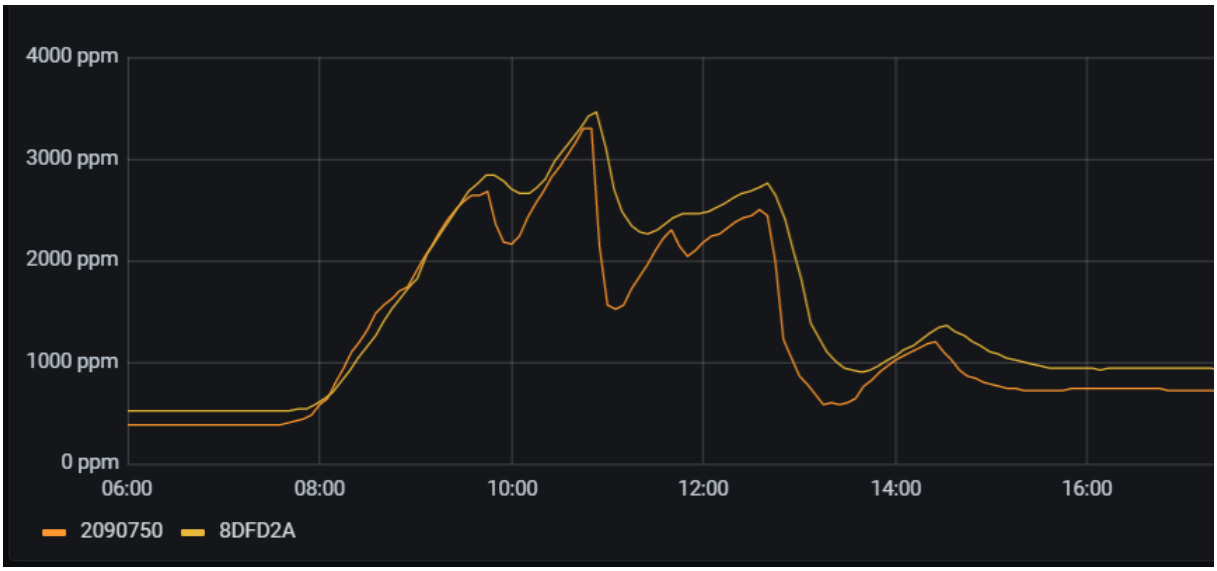


Case study –High School of building constructions – Vysoké Mýto

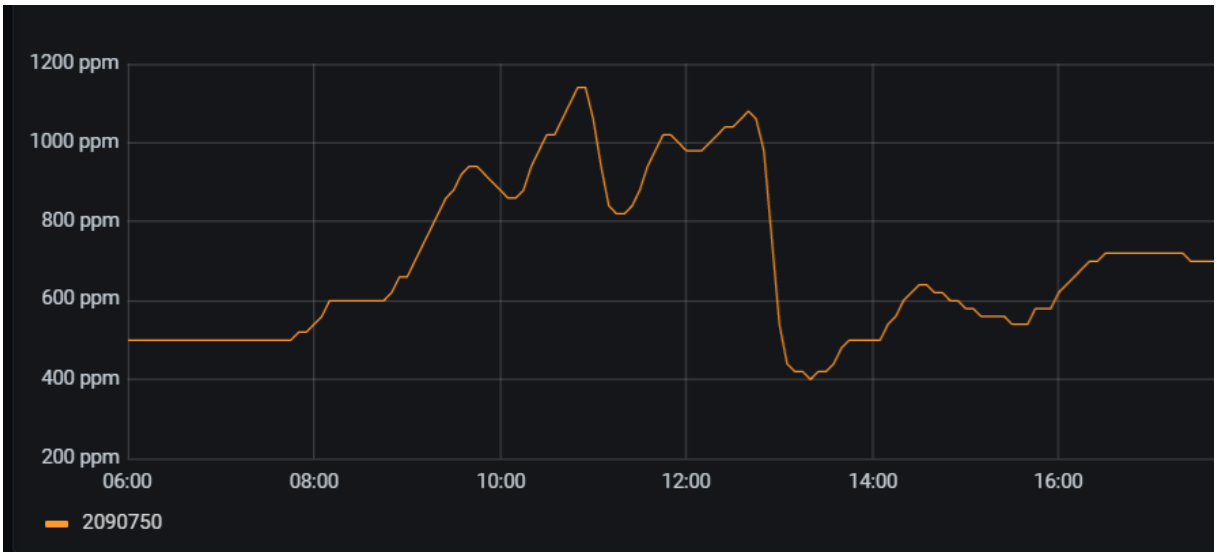
In the autumn of 2022, a sample installation of Xroom units in one classroom at the Secondary School of building construction in Vysoké Mýto was arranged in cooperation with the Pardubice Region. In order to be able to compare the indoor climate in the classroom before and after the installation of the Xroom units, the classroom was equipped with sensors measuring temperature, relative humidity, CO2 concentration and eCO2 concentration (vapours from plastic materials, etc.). in the air. The classroom is normally occupied by 30 students aged 15 and over and one teacher. The area of the classroom is approximately 35 m2.

In the images below, you can view a recording of a real air quality measurement during classes from 21.11.2022 before the installation of Xroom units. It is worth noting the concentration of CO2, which reaches almost 3500ppm and therefore more than doubles the hygienic limit of 1500ppm. There are two CO2 sensors in the classroom, so there are two curves in the graph.

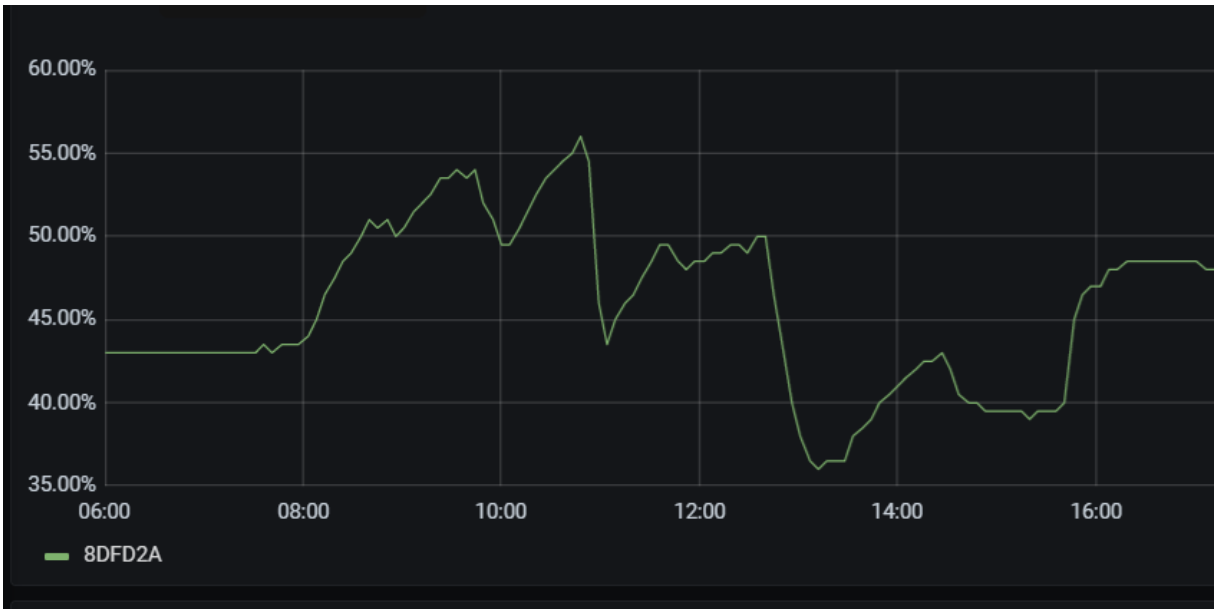
CO2 concentration



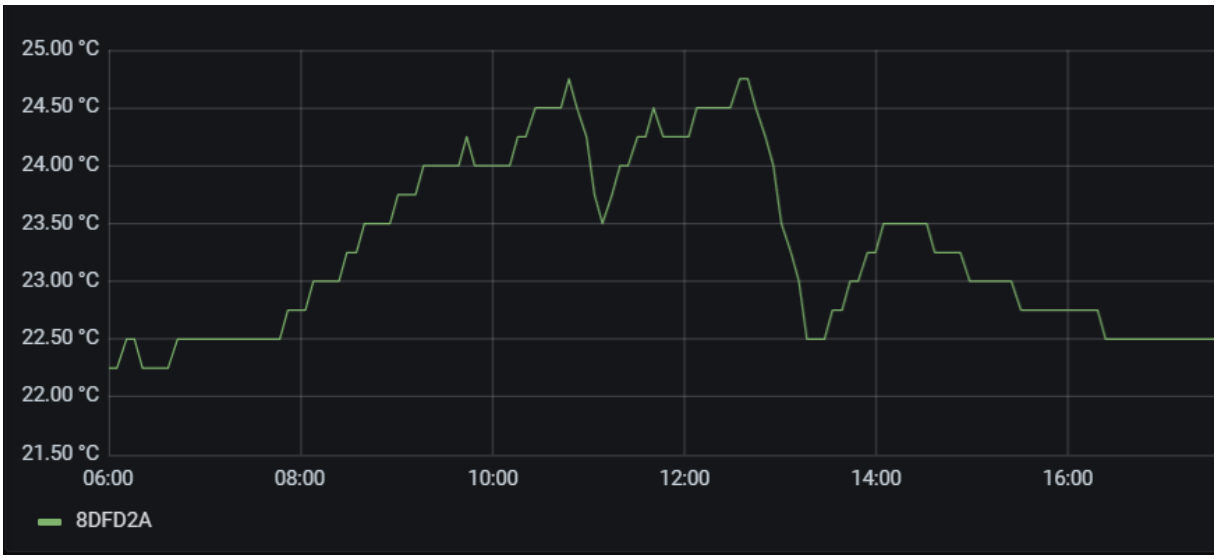
eCO2 concentration (vapors from plastic materials, etc.).



Relative humidity



Air temperature



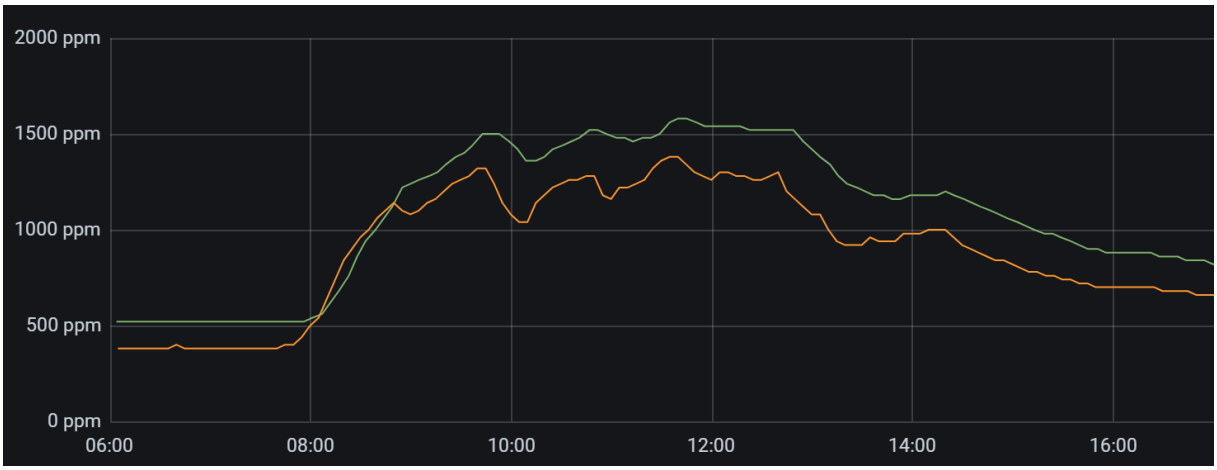
During December (9/12/2022), 2 cast-iron radiators out of 3 were dismantled in the classroom and replaced by two Xroom 250 units, which were connected to the heating water system. The school is using 50/40 degC water gradient.

This was followed by the measurement of the CO2 concentration during the lesson. In this particular case, the unit's common "switching concentration" of 800ppm was used. In practice, this means that the ventilation unit starts to ventilate the school classroom at the moment when the CO2 concentration exceeds 800ppm. ("Switching concentration" of the unit can be set to a different level of CO2 concentration according to local conditions). The operating range of the unit is also regulated by the CO2 "maximum concentration" limit. If the concentration of CO2 in the air approaches this value (in our case it was set to 1500ppm), the unit works at maximum operating power, i.e. supplies the maximum amount of fresh air in normal operating mode. In this particular installation, the maximum output of the unit was limited to half the nominal output, i.e. approximately 125m3/h

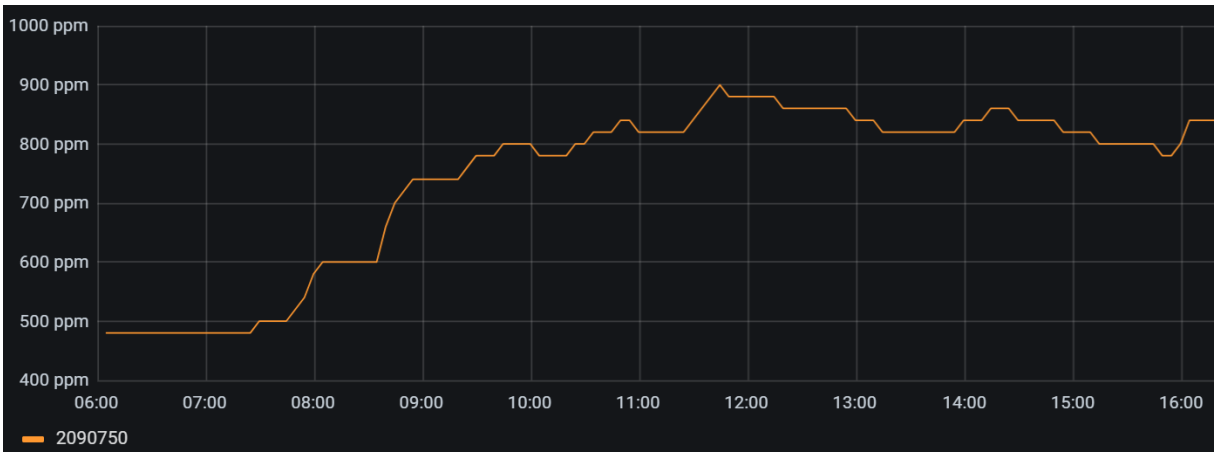
supply by one unit. (In addition to the normal operating mode, the unit also enables operation in the so-called Boost mode, in which it supplies up to twice the amount of air than in the normal operating mode, but at the cost of higher noise. The Boost mode can be used, for example, for intensive ventilation during breaks between classes). The working range of the unit between the "switching concentration" and the "maximum concentration" of CO2 ensures smooth operation of the unit without sudden increases and decreases in the volume of supplied air.

In the images below, you can view a recording of a real measurement of air quality during classes from 12/19/2022 after the installation of Xroom units.

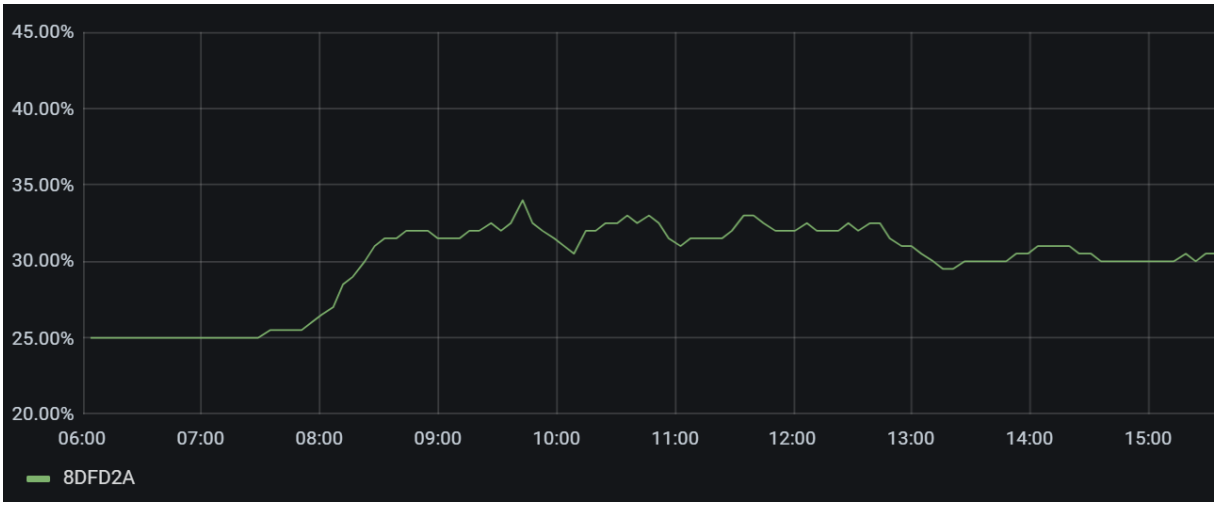
CO2 concertation



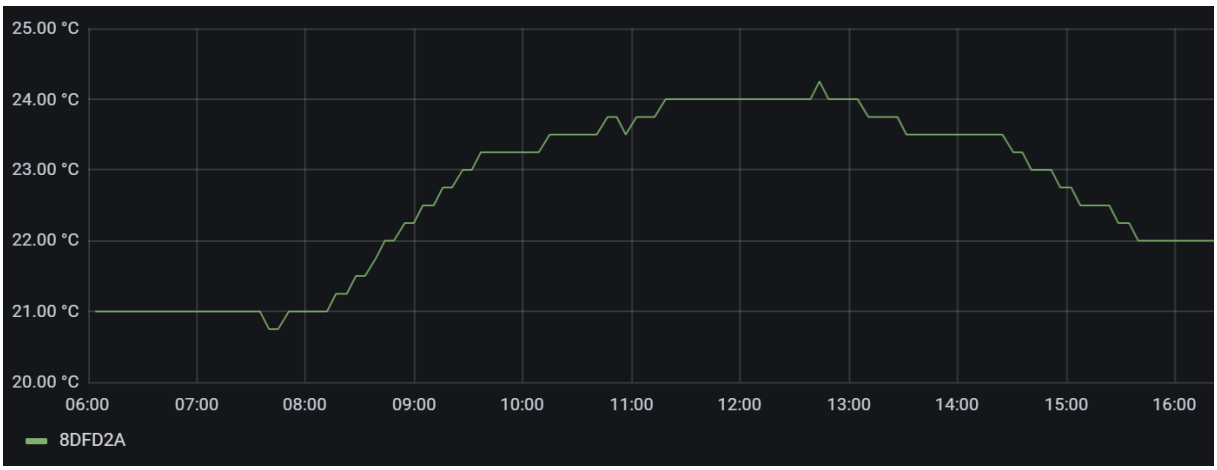
eCO2 concentration (vapors from plastic materials, etc.).



Relative humidity



Air temperature



Measurements in practice have shown that the level of CO2 concentration when using a ventilation unit with heat recovery is lower than half. In the most critical period of time, the unit maintained the CO2 concentration at the limit of 1,500ppm – i.e. at the level of hygienically permissible CO2 concentration. The internal climate inside the classroom has subjectively (emotionally) significantly improved.

Conclusion

Measurements in practice have shown that the level of CO2 concentration when using a ventilation unit with heat recovery is less than half. In the most critical time period, the unit maintained the CO2 concentration at the limit of 1,500ppm – i.e. at the level of hygienically permissible CO2 concentration in the school classroom during classes. The heating power of the unit is sufficient even in the critical winter months with minus temperatures. Note: The building is not insulated. The internal climate inside the classroom has subjectively (emotionally) significantly improved. The XROOM decentralized ventilation unit is the ideal solution for mechanical ventilation with heat recovery. Its advantage is easy assembly. The unit is light and does not need to be lifted. It does not take up additional space in the space and enables heating and cooling. Its autonomous operation does not require further intervention by the operator. The operation of the unit can also be controlled by a superior building management system (BMS/ModBus). Through a questionnaire survey among students and teachers, it was found that the unit does not interfere with teaching due to its quiet operation.

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Pictures from the installation of the units:


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