Priatelia
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Educational guided visits to places of good energy practice

Locality 1: Czech Republic

This document was created as minutes of the first educational visit for employees of Sustainable Energy Centres (SECs), that took place on 11.-12. of December 2019 in Czech Republic. SECs are pilot structures for coordination and implementation of new regional sustainable energy policy in marginalized regions in Slovakia.

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Kaprál´s Mill

Ecological education center and scout base in the building of an old mill in Moravian Karst Protected Landscape Area, with a capacity of 61 beds and year-round operation of the kitchen. Kaprál´s Mill makes residential programs for schools (ecotechnology, field ecology, biology). The prize of educational programs is affordable, because the organization is making it´s income otherwise, by partly renting the building for commercial activities (various seminars, social and other events).

1. **Clay plasters**: a mixture of common clay sand (usually in a ratio of 1: 3), combined with straw chop. This kind of plasters have excellent hygroscopic properties. This means that they absorb air humidity if it´s high, and release it again when the air is too dry. This maintains ideal room humidity throughout the year. Clay plaster also accumulates heat better than conventional lime-cement plaster. It is a local natural material with low embedded energy - unlike lime or cement, clay plaster has a negligibly low carbon footprint.

2. **Acoustics** in lecture halls: pulp paper recyclate is sprayed on the ceilings (this is commonly used as blown insulation into cavities – one possible application is to add the glue to the recycled material, the mixture is moistened and adhered to the substrate). Once in a few years and when repainting the room, this layer should be removed and replaced, because it keeps the dust. This acoustics solution is also more energy and cost-efficient than conventional solutions.
3. **Insulation** of external walls: the lecture partly under the ground (it is covered with ground from the back), which acts as a natural insulation, similar to a green roof. Partitions and ceilings are made of plasterboard (used similarly to plasterboard, they are panels of seared straw wrapped with 1 x 1.5 m paper). It is self-supporting (it is sufficient to glue the partitions with polyurethane glue, no supporting structure is needed), it is possible to anchor various objects (lamps, boards, shelves) and it has good sound and thermal insulation properties.

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4. **Centralized control** of heating and water: over 200 temperature sensors are installed in the buildings to monitor the air and water temperature as well as the water consumption, and store the data in the central computer. Thus, the organization can accurately assess the effectiveness of individual measures and technologies and their return at any time.
5. **Central temperature control**: exact temperature and heating intervals are programmed in each room, all set online. This saves up to 40 % of energy. Rooms only heat up when in use, room users can add or remove temperature within 2 °C.
6. Windows with **insulating triple-glazing**: the gaps between the glasses are filled with argon, which is heavier than air, so it does not circulate in the window and thus provides better insulation of the window. Solar energy penetrates through the glass with power of 0,5 – 1,0 kW/m^2. A metal filter on the inner side of the glass surface reflects the heat radiation back into the room.
7. **Correct roof overhang**: to prevent the interior from overheating due to the large glazed area (24 m^2) in the south-oriented lecture hall, the roof overhang has an exact length calculated in the way, that in the summer between 10 am - 2 pm the sun doesn´t shine in the interior at all. Therefore, even at outdoor temperatures of 30 °C, the room temperature will not exceed 26 °C (without the use of any air conditioning). On the contrary, in the winter, when the sun is low above the horizon, it shines deep into the interior and warms it up significantly.
8. **Controlled heat recovery ventilation**: the exhaled air blows out through the recuperation system, where it transfers heat to the fresh air that blows into the room, and thus preheats it. The device has an efficiency of 50 – 80 %. It is used mainly in passive houses. Controlled ventilation ensures constant fresh air in the living rooms (keeping the low CO_2 concentration in the interior is also beneficial for health). This system is worth using for insulated buildings with a high load of rooms. The system must be properly dimensioned and requires occasional service and filter replacement.
9. **Water recuperation**: hot water that flows from showers sells its heat to the water that flows into the shower. With an average of 50 liters of water per shower, this system adds significant energy savings.
10. **Heat pumps**: the building is heated by two heat pumps, although initially a single larger one was intended. The power is the same, but if one malfunctions, the other can still work. The power of one pump is 22,5 kW, together they have a power of 45 kW. A heat pump is a technology that we use for heating or

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hot water production. It works on the principle of thermodynamics similar to a refrigerator (the pump contains a medium that, when compressed by a compressor, transfers heat to its surroundings and, when it expands, extracts heat from the surroundings). 2,5 km of tubes are stretched 1 meter under the ground below the unused sunny meadow above the facility. The soil transfers its "low-potential" heat (the soil has about 5 °C in winter) and is transferred to the water, which then circulates in the radiators (there are more radiators in the rooms as usual - but they are lukewarm, not hot). The heated rooms have very low heat losses after reconstruction and therefore can be heated to a sufficient temperature using lukewarm radiators. The heat pumps use electricity only to provide energy transfer. The heating factor given by the manufacturer is 4 (based on the measured data around it is less, from 2,5 to 3,5). It is the ratio of consumed energy to the obtained thermal energy, indicating that we can get up to 4 times the amount of energy consumed. In the Kaprál´s Mill (1700 m^2 of usable area) the measured total energy consumption of the building is about 70 MWh/year, of which 30 - 36 MWh is needed for heating. The return on the pump in this case is about 10 years.

11. **Wood boiler**: consumption of approximately 10 m^3 per year, covering about 25% of the heating energy. The cost of heating per year is about 2 780 EUR (the floor area of the mill is roughly like 10 family houses), which makes it possible to provide accommodation at good prices.
12. **Fireplace** in a small lecture hall: aesthetically well designed both-side fireplace, built into the wall of the room. The fireplace draws air from the exterior, so when it is used, the interior does not deplete oxygen as in conventional fireplaces. It can be used for teaching the correct technique of lump wood heating.
13. **Heat storage**: the heat extracted from the sun is stored in water in two tanks, with the first tank (1500 liters) receiving hot water for showering and cooking, the second (2000 liters) accumulating unused heat. Cold water from the well is preheated here (e.g. to 30 °C or more) and then only reheated to the required temperature. In summer, other water storage tanks are also used to store heat from solar collectors, while in winter this water circulates in radiators and heats the building (the system allows monitoring the water temperature in the storage tanks and solar collectors). On cold days of the year when the hot water consumption is low, the water heated by the collectors is used also for heating.

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14. **Strawboard**: ceilings in the attic are made of strawboard (it is similar to plasterboard, but made of straw). It accumulates heat well (the interior does not overheat), it is durable and can be composted at the end of its life, since it is a natural material. The straw in the panel is so compressed that it achieves excellent fire performance.
15. Kitchen **electrical appliances**: energy efficiency was an important criterion in their choice.
16. **Wood furniture** from local workshop coated with natural linseed oil: local furniture produced using local natural materials has a much lower carbon footprint than furniture purchased in a regular retail chain. The carbon footprint of a product is calculated over its entire life cycle – from logging, processing, transport, furniture, coating, transport to the store, and transport to its destination. In addition, purchasing material from a local manufacturer supports the local economy.
17. **Vacuum solar collectors**: are used to heat hot water. There is a vacuum between the layers of glass, which is an excellent thermal insulation layer. They work with similar effectiveness in winter and summer. Efficiency depends on the exposure, not on the outside temperature - even in winter they can heat up to about 30 °C. Their disadvantage compared to conventional panel collectors is that they freeze up in winter (the layer of icing then reduces the exposure and hence efficiency). Solar collectors are also used in educational programs: their performance can be read on a central computer, which allows students to calculate converted energy, saved money and return.
18. **Photovoltaic panels**: they are used to produce electricity based on the photoelectric effect. Panels with a total output of 3 kW (12 panels in total) are installed on the roof of a straw house for volunteers. The produced electricity is used in the main building (Kaprál´s Mill), where energy consumption is constant throughout the day. In the case of excess, the energy is used for recharging the batteries or heating the water in the house. With low panel performance, the building automatically connects to the public distribution network.
19. **Energy-saving valves** on water taps: are installed on washbasins in the building, reducing water flow and leading to large water savings. Valves are also used for educational purposes: students can precisely calculate water consumption without and with using a valve. One washbasin is left without a valve just for this purpose.

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20. **Straw house** for volunteers:
    - is placed on the feet above the terrain to protect the house from moisture,
    - construction of the house is wooden and the walls are filled with straw (45 cm), plastered with clay plaster (the outside wall is protected from moisture by the roof overhang). Straw walls have excellent thermal insulation properties (they don´t need to be insulated) and straw is a natural material with low carbon footprint. Similarly, the inner walls are filled with straw and in the attic walls are made of strawboard,
    - clay accumulation stove (weight 2 t) provides heating. The stove accumulates heat during wood burning (after one loading into the stove), and then radiates it to the surroundings for a long time. With proper heating, the stove has a much lower wood consumption than light tiled ovens, which need to be loaded more frequently.
21. **Solar tubes**: they illuminate a large common room by leading the sunlight from the exterior into the room (power about 100 W). They are a suitable solution for large rooms with the need of electrical lighting during the day (the condition is green roof above ceiling).
22. **Showers**:
    - used water from showers is used for flushing toilets,
    - the shower faucets are thermostatic with a temperature scale, which allows quick adjustment of the water temperature.
23. **Floors**: are made of **marmoleum** – it is similar to linoleum, but made entirely of natural materials (linseed oil, limestone, wood flour, pine sap, jute and natural coloring),
24. Dug **well**: it serves as a source of drinking water.
25. **Compost** in the garden: is used to compost organic residues from the kitchen and to process green garden waste. It is an excellent element usable for educational purposes.

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Partnership Foundation

The Partnership Foundation is a foundation aimed at supporting environmental projects. They support the development of cycling transport infrastructure and mitigation and adaptation measures for urban climate change. It is located in the center of Brno, where it owns and manages two big buildings, which are used by various organizations and companies for administrative and training purposes. One of the buildings is a newly built passive building, the other is a historic building reconstructed to a passive standard. Both buildings use a combination of modern technologies leading to energy savings. In addition to low operating costs, the use of these technologies has a strong educational dimension – excursions for the public and schools, universities are involved in measuring and evaluating data – demonstrating the practical importance of good engineering design and a sensible combination of efficient technologies. On its grounds, the Partnership Foundation has built an Open Garden with lots of simple educational elements and a community garden, and this space has become the center of community civic activities in the city.

1. **Passive building**: it has extremely low heat losses compared to conventional buildings (due to proper cardinal orientation, minimal segmentation, very good insulation, airtightness of interiors, absence of thermal bridges and heat recovery ventilation) and has passive energy gains (mainly through large glazed areas on the southern facades, further from electrical appliances, human bodies and cooking).
2. Controlled **heat recovery ventilation**: a heat exchanger provides heat transfer from exhaust air to fresh air. **Clay plasters** prevent air from drying. They are painted white to better reflect light (less energy consumption for room lighting).
3. A system of 8 **geothermal heat pumps** around the building: the heat pump receives the heat from pumped groundwater and transfers it via the heating medium to the interior. A ceiling heating built-in the concrete layer is installed in the building, which allows the reverse operation of the heat pump in the summer for cooling the interior – the collected heat is stored back into the underground water in the boreholes. This achieves a high heating factor: the ratio of the energy/heat produced to the heat/energy consumed to run the heat pump – the number that expresses the efficiency of the heat pump. It is 5,6, which means that 1 kW of electricity consumed will produce 5,6 kW of thermal energy.

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4. **Prevention of the interior overheating** in summer is provided by
   - automatic adjustment of the blinds to transmit only part of the thermal radiation from the sun,
   - green roof,
   - ceiling cooling by heat pumps (cold air sinks down, thus naturally distribute cold in the room).
5. **Intelligent control and measurement system**: automatically coordinates all active elements in the building (lighting, ventilation, blinds, heat pumps) to minimize the total energy consumption. Since all energy consumption data is stored, the building manager can evaluate consumption and compare the efficiency of the used technologies in both buildings of the Partnership Foundation,
6. **Active radiators**: window-mounted radiators with active ventilation, used for additional heating in a reconstructed building (where for technical reasons it was not possible to install ceiling concrete layers with built-in heating and cooling),
7. **Photovoltaic power plant** on the roof: generates 13 MWh of electricity per year, covering 4 months of operation of one of the buildings. Solar energy is also used for heating the water using classic **solar collectors**.

8. **Water saving** measures:
   - a rainwater tank built under the terrace collects the water from roofs and drainage – it is used for flushing toilets and watering the garden (this measure saves almost 50 % of total drinking water consumption),
   - a drilled well in the garden serves for the cases when the rain water lacks, it is used for technical purposes,
   - a root wastewater treatment plant with a pond – cleans waste water from washrooms, it is also used as educational habitat. Water from the root wastewater plant is collected in an underground reservoir and is used to water the garden,
   - regulation of tap water with aeration technology (optically the water flow is the same as if there was no energy saving system) – it saves more than 30 % of the water consumption in washbasins.
9. **Green roof**: perfectly insulates the interior and prevents it from overheating, because the soil stores the heat, catches the rainwater and has significant cooling effect also for the surrounding environment, thanks to the evaporation of water from the green plants.

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10. **The facade** is adapted to provide shelter to various species of birds and bats, the climbing plants provide cooling and, together with the trellage, protect the vapor-permeable foil on the facade from UV radiation.
11. **Compost** in the garden serves for the treatment of bio waste and is used in a **community garden**. There are many educational elements in the community garden, from beehives to the outdoor classroom, water cycle imitation, herb beds, to an outdoor kitchen with a green roof (providing a pleasant shade) where people can prepare meals directly from the garden.

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Hostětín

Hostětín is a municipality in the White Carpathians, which has been moving towards energy self-sufficiency for more than 20 years. In co-operation with the Veronica Ecocentre, the Partnership Foundation and various companies that donated different systems in order to promote themselves, the municipality launched several pilot environmental projects in the Czech Republic.

1. Municipal **biomass heating plant**: the wood chip heating plant in Hostětín is owned and managed by the municipality (and thus also determines the price of heat and gains income), has power of 732 kW, wood for wood chips comes from the waste from local sawmills and factories (annual consumption is 500 – 600 tons). The heating plant employs local people to maintain and operate the plant. Its construction was financed by a subsidy from the emissions trading, while the citizens themselves financed the connection of their households – the municipality did not have to take a loan.
2. **Cider house**: it is operated by the company Moštárna Hostětín Ltd., whose partners are the Veronica Foundation (owner of the cider house), the municipality and several non-profit organizations from the White Carpathians. It processes production from local orchards (mainly apples), produces and distributes organic quality cider throughout the country. It employs local people and serves citizens – they can make juice from their own apples. There is also a fruit drying room at the cider house.
3. **Passive building** of the ecological center Veronica: the first passive public building in the Czech Republic, it works as an ecocentre with accommodation capacity of 25 persons. It is insulated with mineral wool and straw bales (40 cm thick), the foundations are thermally separated from the ground by special polystyrene (20 cm thick) and windows have insulating triple glazing (heat transfer coefficient ≤ 0,8 W/m^{2}K). Airtightness was confirmed by special test (blower door test) before the building was put into operation. Exchange of air is provided by heat recovery ventilation, solar collectors heat the water, and heat pumps are heating the building with additional heating provided by the municipal biomass heating plant. The building is made of ecological building

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materials (clay plasters and bricks) has green roof and uses rainwater. Cooling in summer is provided only by opening the roof windows at night, so warm air gets out. Thanks to good insulation, the cool air in the interior warms up just slowly.

4. **Solar collectors** on the roof of the cider house: are built-in the roof (replacing part of the roof covering), and since there is large, but irregular consumption of hot water in cider house and ecocentre (heating, shower, cooking, cider house operation), the collectors are heating the water in a big tank. The tank has 9 000 liters and is insulated with 1 meter thick straw bales. The storage system is designed to store and use the heated water as efficiently as possible (cooler water for low-potential heating, warmer water for showers, etc.). In case of insufficient collector output, the municipal biomass plant is additionally heating the water in the storage tank. The annual energy savings by collectors are 8 500 kWh.
5. **Vertical facade collectors** on the southern wall of the Veronica ecocentre: they are connected to the same tank as the collectors at the cider house, with thermal stratification. Annual heat savings are about 6 000 kWh.
6. **Solar collectors on** family **houses**: they heat the water for households. The savings per year are up to 2 000 kWh per household.

7. **Photovoltaic power plants**:
   - at the cider house: power 8,8 kW, owned by the Veronica Foundation,
   - on the land of the biomass heating plant: power 50,6 kW, owned by the municipality together with three foundations (Veronica, Partnership, Czech Architecture Foundation)
   - on the roof of the house: power 13 kW.
8. **Intelligent public lighting**: is a combination of energy-saving technology (which eliminates the amount of heat radiation and emits only white light), light directed straight down and automatically dimming (depending on the moonlight or night time) and switching off the light.

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9. **Root wastewater and sewage treatment plant**: it was the first of its kind in the region. Previously, there was no sewage treatment plant in the municipality, and a construction closure was declared due to the risk of contamination of the water source. Thanks to the root treatment plant the problem of waste water was solved and the village could continue in development. In the root treatment plant, the waste water passes through a settling tank to a set of gravel filters and a sedimentation tank. The cleaning process is mainly carried out by bacteria on the surfaces of gravel stones and in the roots of plants. Since the research in the field of root treatment plants has progressed significantly since the pilot project in Hostětín, the reconstruction of the treatment plant needed to meet demanding standards is planned.
10. **Composting toilet**: Veronica Ecocentre has, in addition to classic toilets, an external composting toilet. It works on the principle of separation of solid and liquid components. Since the liquid component contains valuable nutrients needed for fruit trees (e.g. phosphorus), it is used to fertilize the orchard after it is diluted with water. The solid component is used as compost – the composting process begins already in the toilet container, so that the finished compost is removed directly from the back of the toilet after some time. Thanks to chimney effect ventilation the toilet does not smell.

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Conclusion

All three sites have several common features.

They show that it is crucial to consider an initial investment in the context of the energy and financial demands of the operation over the entire life of the building.

Energy measures taken in all locations were made with an emphasis on their educational and awareness-raising character. Technologies are not enclosed in technical rooms, but are accessible to the public and schools, they can be "touched", measured, evaluated, recalculated and their functions are demonstrated using various models and visualizations.

The sites are designed in a comprehensive way, the projects respect local conditions and make meaningful use of their surroundings.

Thematic educational programs using the building of an old mill, its surroundings and the specific conditions of the Moravian Karst are held at the Kaprál´s Mill. At the Partnership Foundation, universities use the measurement of parameters and performance of various technologies for their own research, the public uses a community garden, meteorologists use collision data, and so on. The large green roof area contributes significantly to a better microclimate in the urban environment. In the village of Hostětín, there is a continuation of the fruit tradition and waste wood from the surroundings is being used as well. Both measures, in addition to serving citizens, also bring revenues to the municipal budget. The ecocentres in Kaprál´s mill and Hostětín can provide affordable services to schools thanks to low operating costs and accommodation capacity allowing a certain percentage of commercial operation.

All three visited localities show the importance of a well-designed proposal, good implementation of energy measures, a complex view of each project, taking into account local needs, traditions, surroundings and its awareness-raising potential.

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