How to prevent and adapt to the effects of climate change

EXAMPLES OF SUCCESSFUL MEASURES FROM THE CZECH REPUBLIC

Funded by the European Union

ARNIKA

TRANSITION
Ministry of Foreign Affairs of the Czech Republic

PRAGUE – KARAGANDA
2024

How to prevent and adapt to the effects of climate change.
Examples of successful measures from the Czech Republic

Prague – Karaganda, 2024

Authors: Markéta Kolatková, Martin Skalský, Davina Vačkářová, Anna Andreychuk
English proofreading: Simon Gill
ISBN: 978-80-88508-48-9
Graphic design: Jakub Němeček, www.typonaut.cz
Photos: Nadace Partnerství – Adapterra Awards (Vojta Herout, Lenka Mitrenga)
Published: 2024

This publication was published in English and Russian language versions.

The measures described in this brochure are illustrated by photographs created and published in the framework of the Adapterra awards competition. The photographs were provided free of charge by the non-governmental organisation Partnership Foundation. For this we would like to express our sincere thanks to them.

This brochure was produced with the financial support of the European Union and the Transition Promotion Programme of the Ministry of Foreign Affairs of the Czech Republic. Its contents are the sole responsibility of the authors and do not necessarily reflect the views of the donors.

Funded by the European Union

ARNIKA

TRANSITION
Ministry of Foreign Affairs of the Czech Republic

Contents

The opening words

In the time of climate change, our world needs nature-based solutions

Human society is facing urgent and interdependent global crises of climate change and biodiversity loss, which are causing and will continue to cause further impacts worldwide. Anthropogenic climate change, including more frequent and intense extreme events, has already caused widespread adverse impacts and related losses and damage to nature and people, beyond natural climate variability. While some development and adaptation efforts have reduced vulnerability, without transformative adaptation action, the future impacts will cause considerable harm.

Climate change, though a monumental challenge, also presents us with an unprecedented opportunity. It urges us to reinvent our relationship with the planet, innovate, and adapt in ways that mitigate the impacts of the crisis and propel us towards a sustainable and equitable future. Living in harmony with nature, as reiterated in global sustainability and conservation targets, is the future we strive for. The interdependence of human and ecosystem vulnerability is echoed in various policy goals, highlighting the synergies between climate change adaptation, disaster risk reduction, and nature restoration.

The impacts of climate change are both global and personal, and affect every aspect of our lives. Rising temperatures, shifting weather patterns, and extreme weather events are not just abstract phenomena; they have tangible, immediate effects on our health, our homes, our food, and our security. It's crucial to acknowledge that climate change is not just an isolated crisis but a catalyst, accelerating the urgency of numerous interconnected challenges humanity faces today. From biodiversity loss to socio-economic disparities, the impacts of climate change reverberate across every facet of our existence.

The valuable contributions and services provided by nature have been degraded by both human economic activities and changing environments and climate. Protecting and restoring these essential ecosystem services requires coordinated action across diverse communities, institutions, and sectors. Working with nature and enhancing crucial ecosystem services is at the centre of nature-based solutions to climate change adaptation and disaster risk reduction. Such solutions reduce social and environmental vulnerabilities and can bring multiple co-benefits such as mitigating climate change, improving human health and well-being, and providing jobs and business opportunities. Moreover, climate change adaptation possesses high synergies with biodiversity conservation, sustainable ecosystem management, carbon-neutral energy utilisation, and cultural services such as recreation, learning, inspiration, and supporting identities.

These solutions, rooted in the restoration, preservation, and sustainable management of our natural ecosystems, offer a way to mitigate the harshest effects of climate change while providing numerous co-benefits. Forests, wetlands, and urban green spaces act as natural carbon sinks, reduce flooding, improve air and water quality, and offer refuges for biodiversity. Nature-based solutions are being increasingly co-designed by novel technologies which mainstream the benefits provided in urban environments as well as in broader landscapes. These measures support economic activities and cultural practices that sustain millions of lives worldwide.

The examples of nature-based and adaptation measures gathered in this brochure not only present examples of good practice, but several of them also integrate sustainable solutions for the future. Implementing measures to restore natural river flow patterns, enhancing floodplains, and improving water quality not only support biodiversity but also serve as a natural flood management system, reducing the impact of extreme weather events. Adopting innovative rainwater harvesting techniques and green infrastructure such as permeable pavements and green roofs reduces urban runoff, mitigates flood risks, and replenishes groundwater, demonstrating how adaptation can integrate seamlessly into urban planning. Promoting energy efficiency in buildings, transportation, and industry can significantly reduce carbon footprints. Incorporating smart technologies and improving insulation and lighting are practical steps that contribute to reducing overall energy demand. Expanding the use of solar energy through photovoltaic systems is key to achieving carbon-neutral energy utilisation. Integrating panels into urban landscapes supports sustainable energy production, reducing dependence on fossil fuels, and mitigating climate change impacts.

Adaptation planning and implementation have been increasing across all regions. Growing public and political awareness of climate impacts and risks has resulted in including adaptation in the climate policies and planning processes of countries and cities. However, most observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks, and focused more on planning rather than implementation. It is hoped that initiatives such as those presented in this brochure will contribute to upscaling nature-based adaptation and transformative action which would better align multiple benefits of adaptation.

Adaptation efforts must be mindful of the distribution of impacts and the solutions we pursue. Not all communities are affected equally by climate change, nor do they benefit uniformly from adaptation measures. The risk of inadvertently exacerbating inequalities or imposing solutions that do not align with local needs and contexts is real. Thus, inclusive, participatory approaches that respect and integrate local knowledge and preferences are essential. Adaptation is not a one-size-fits-all approach; it requires careful consideration of the diverse landscapes and livelihoods it seeks to protect.

Another potential challenge lies in the implementation and monitoring of nature-based adaptation measures. While further research is greatly needed, we also need a systemic evaluation of the benefits provided by natural solutions, monitoring of the effectiveness of these measures, and mechanisms for upscaling to achieve transformative impact in our landscapes. The successful adaptation measures presented as examples of good practice in this brochure can assist in the sharing of knowledge across regions and countries and navigate adaptation measures towards inclusive action that provides multiple benefits to local communities and society as a whole.

We still need to learn from nature and be inspired by manifold natural solutions to changing environments. We also need to revisit our relationship to nature and recognise that our livelihoods are dependent on healthy ecosystems. As we embrace the potential for transformative change, let us commit to adaptation strategies that are as diverse as the ecosystems they protect and the communities they serve. By integrating specific measures such as river revitalisation, rainwater management, energy savings, and photovoltaics into our adaptation efforts, we can navigate the challenges of climate change, guided by the principles of equity and sustainability. Together, we can create a more just, verdant, and thriving world.

Mgr. Davina Vačkářová, Ph.D.,
an expert at CzechGlobe – Global Change
Research Institute of the Czech Academy of Sciences

Introduction

We need measures that will really help us to solve the problems

In the Czech Republic, climate change is accompanied by three main manifestations – extreme temperatures, drought, and extreme precipitation (with associated floods) – which affect virtually all spheres of human activity.

Drought and extreme precipitation particularly threaten **agricultural production**, in both ways –directly and indirectly – by causing an increase in soil erosion. **The water sector** is facing several problems. As a result of the drying up of surface water sources and a decline in groundwater sources, but also of a lack of snow, there is a decline in water supplies in general, including drinking water. It is also necessary to deal with the overloading of sewage networks and wastewater treatment plants because of flash floods, then with the deterioration of surface water quality (because of overloaded sewers, run-off from cultivated fields, or drought) and, last but not least, with the conflict of interests between the protection of aquatic ecosystems and water users. Of course, floods are also a big risk for **built-up areas**. In addition, cities are particularly in danger because of **heat islands**, i.e. overheating, which poses health risks and essentially makes towns uninhabitable for part of the year. Moreover, extreme temperatures in cities are closely linked to poor air quality (ground-level ozone). Air conditioning is not a wise solution, as it makes the situation worse. It produces waste heat and increases energy consumption, which causes a rise of temperatures in the vicinity of air-conditioned buildings and produces more greenhouse gases, while reducing energy consumption and the production of greenhouse gases are the key measures for mitigating the effects of climate change…

This is not an exhaustive list of the risks, but rather a brief overview of the problems that (not only) the Czech Republic is facing in relation to climate change. What is important to say is that the **solutions are very often interlinked**. For example, well-implemented erosion control measures on agricultural land protect us from the loss of fertile soil, but at the same time allow water to soak into the ground. This helps to refill groundwater reserves and prevents the flooding of low-lying villages and the pollution of watercourses by runoff from fields. Similarly, blue-green infrastructure in cities plays a multifunctional role. It also allows gradual soaking-in of the rainwater at the point of its impact and it captures air pollutants and increases air humidity. Simultaneously, via evapotranspiration and shading, it regulates the temperature of the environment (including the interior of adjoining buildings), creates facilities for relaxation, and, if designed systematically, it may also encourage people to walk and cycle, which means reduced greenhouse gas emissions from transport. By regulating the ambient temperature, it also reduces the heating and cooling demand in buildings.

Biodiversity is a separate chapter. Climate change is linked to species extinction and the collapse of ecosystems. It is easy to imagine that the proper introduction of overgrown swale in agricultural land or blue-green infrastructure in cities (e.g. parks and water bodies) can have a positive effect on species and ecosystem diversity. And the more species and habitats there are, the greater the chance is that at least some will survive, in other words, the greater the resilience.

Despite the size of the problems, it is important and, most importantly, also possible to seek effective solutions. Here we see the possibility of using the knowledge gained in the Czech Republic as an inspiration for similar situations elsewhere, in other countries and regions of the world. By sharing these experiences with the implementation of specific measures, we want to contribute to the global effort to cope with the impacts of climate change. In doing this, it should be remembered that cities, municipalities, and public authorities have a key role to play in the implementation of measures. In some cases, homeowners, private farmers, etc. also play an important role, but the state should help them. There are a number of national and international subsidy programmes for this in EU countries (which we mention in this brochure too), because after decades of devastation of the natural environment and the landscape, it is not possible to leave the financial responsibility solely to the current owners of land and buildings.

LANDSCAPE

1. Changing the way agricultural land is used

A varied landscape with a productive as well as
a recreational function replaced an agricultural desert

Place: Prague, the capital city of the Czech Republic (1.35 million inhabitants)

As a result of unsustainable farming over vast areas, agricultural land is losing its ability to absorb water, so it's drying out, turning into sand and dust, and forming hard crusts inside and on the surface. When strong rains come, streams of water with mud run off the fields, carrying away the fertile soil. In the worst case, the mudflow then reaches a nearby village and floods the streets and house cellars there. In addition, the wide agricultural fields overheat and have an extremely negative impact on biodiversity, which brings a whole range of further problems.

With this in mind, the City Council decided to end intensive conventional farming and lease out 12 hectares of land to responsible local farmers. In cooperation with experts from scientific institutes and universities and with local communities, they implemented several optimisation measures in the field. For example, they planted avenues of trees and windbreaks along local roads and at the edges of particular fields. Using drones, the experts mapped the area to identify a historic network of drainage pipes. After that they restored a drying wetland by installing dykes on the drainage channel. Thanks to this wetland, the subsurface water table has now increased in the wider area. Around the wetland they created a flowering meadow which further encourages its expansion. On one of the plots, they established a permaculture orchard that is open to the public. It is home to over 120 different fruit trees and shrubs. The local school has taken on the maintenance of the orchard and uses it for teaching.

Before the revitalisation, the storm water and mudflow from two plots often flooded adjoining streets. Because of that, one plot is now used to grow forage crops and produce hay for a local farm that keeps horses. Along the edge of this field an 8-m-wide and 300-m-long strip of trees, shrubs, and grasses has been planted. On the second plot an agroforest was established. Within the entire territory nearly 300 fruit trees and 1,000 shrubs with grass between them were planted. The plantings were carried out along contour lines.

In order to make everything work well, the city hall allocated personal capacities for activities related to maintenance of the territory. This job (e.g. long-term cooperation with soil conservation and agricultural experts) falls under the environment and property management departments.

The total cost of the locality transformation reached 3 million EUR and from land leases, the city hall receives "only" 40,000 CZK (1,600 EUR) per year. The return on the investment may thus appear to be 75 years. However, two things should be remembered at this point. The money saved by preventing the consequences of floods can be estimated at hundreds of thousands of crowns per year, and the careful management (without the use of chemicals) leads to improvement of the quality of the soil and whole landscape. These benefits are of virtually incalculable value.

THE ESSENCE OF AGROFORESTRY is the growing of trees together with agricultural crops or livestock farming on the same plot of land. In the case of arable land, trees are planted in rows with agricultural crops grown between them. In the case of grassland, the planting of trees is scattered so that the grassland can be treated in the standard manner. The trees can also be planted in groups to provide shade for grazing animals. The aim is to diversify large blocks of land, which has a number of positive impacts – water retention, the prevention of water and wind erosion, and the above-mentioned shade for grazing animals, while providing shelter and food for species linked to the agricultural landscape (pollinators, birds, small mammals). Woody plants on arable land also increase the proportion of organic matter in the soil and reduce greenhouse gas emissions by absorbing CO_2. So, it is actually a very intensive but at the same time environment-friendly approach to agricultural production.

The city council in cooperation with local farmers and primary school introduced and now maintain sustainable practices on it‘s agricultural land, like avenues of trees and windbreaks, permaculture orchard or wetland restoration, to combat soil degradation and prevent flooding caused by unsustainable farming.

2. Big river revitalisation

A journey from a concrete canal back to a wide living river landscape

Place: The River Bečva, the largest gravel-carrying river in the Czech Republic, the total length of which is 61.5 km

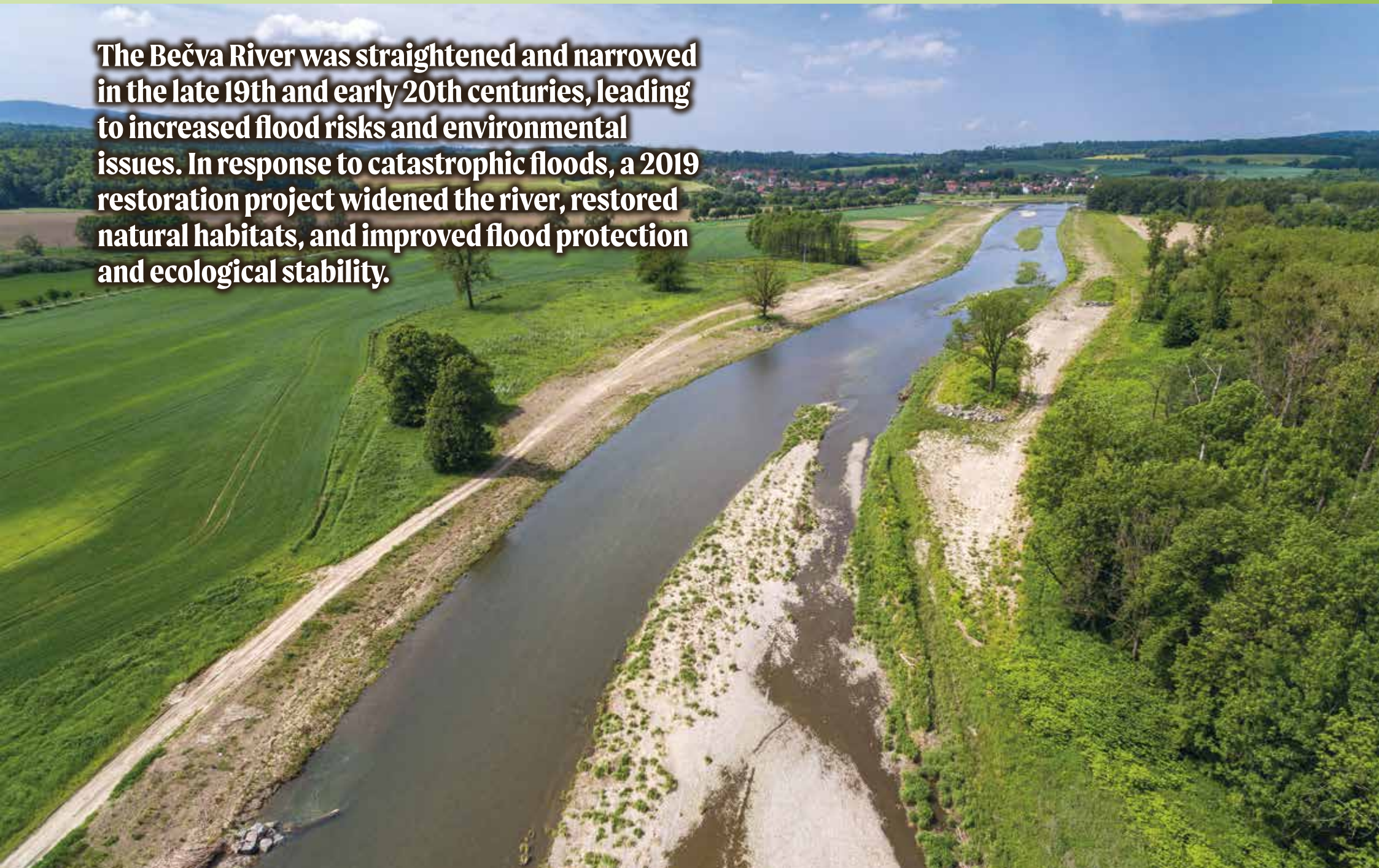
The Bečva, like any other gravel-carrying river, needs a wide channel full of gravel for its dynamic stability because it uses the huge energy of its flowing water to move the gravel. According to historical sources, in the past the channel was up to 300 m wide. At the turn of the 19th and 20th centuries, it was straightened, technically stabilised, deepened, and narrowed to just 30-70 m. Later, it became apparent that this intervention, together with the intensification of land use in the original river floodplain (agricultural areas and buildings in the previously periodically flooded part of the river landscape) made the Bečva river basin the most flood-prone area in the whole country, even in winter (because of ice congestion). In recent years, the surrounding villages were flooded even during less intense rainfalls. In addition, further spontaneous deepening of the channel has led to a decrease in bank stability. Those consequences increased maintenance costs and posed an untenable risk to the surrounding buildings and technical infrastructure. In addition to this we can also easily imagine the environmental impacts of the regulation (e.g. a drop in groundwater levels and the impact on biodiversity or water quality).

A key moment was the catastrophic floods at the end of the 20th century, which initiated the intention to renature the riverbed (restore it to its close to natural state) for two main reasons. Firstly, it was necessary to prevent similar massive damage in the future, and secondly, the flood doubled the channel width and segmented it vertically and horizontally in some sections, thus pointing to a possible solution.

After years of preparation, in 2019, the state enterprise that manages the basin started with fieldwork. The main objective was flood protection, but another was the restoration of other eco-stabilising functions, such as the water's self-cleaning capacity. The essence was to eliminate erosion in the riverbanks and at the bottom and solve the problem with ice flow (the narrowed profile of the channel conditions ice congestions, which then form barriers behind which the water level rises). This is related to restoration of the link between the channel and the river floodplain, in particular to allow water to spread into the adjacent landscape, which means slower down runoff and lower flood waves. It is all also linked to an increase in the diversity of aquatic habitats.

The renovated part of the river is 3.4 km long. In this section, the builders excavated more than 400,000 m3 of soil, thus widening the channel by 70-150 m. They sorted out coarse gravel from the material to stabilise the newly created berms (higher-positioned platforms along the riverbed that flood with higher water flows). In some places within the riverbed, they left overgrown islands from the original terrain. Elsewhere they also added dead wood and groups of stones. All those components (which they also stabilised using gravel) now provide habitats for many plants and animals, but they also influence the flow of the water and thus naturally condition the further development of the stream's shape diversity. Next to the riverbed, in an area of waterlogged soil without vegetation, they also created two pools with different shapes and depths.

Thanks to this intervention, during flood times, the water gradually spreads over a wide channel and its surroundings, more slowly and without destructive impacts. It also allows gradual water seepage and the refilling of groundwater sources. The landscape is supplied with water for subsequent dry periods. The positive ecological impact is demonstrated, for example, by the presence of many common or even endangered bird species. The site is now also much more attractive and accessible for people; the low gravel banks and islands bring a welcome recreational potential. Visitors often also use a new cycle path with a bridge over the river, from which there is a good view of the renovated section. The reduced maintenance costs represent an unforgettable advantage. Maintenance is ensured via natural processes. The artificial restoration cost almost 3.5 billion CZK (EUR 140 million). The condition after the renovation work was initial, and the river is free to shape and change it. Good renaturation should always initiate the processes of natural development of the riverbed and its immediate surroundings. As this affects the surrounding land, it is essential that these processes (as long as they are kept within reasonable limits and do not damage personal property or even endanger health and life) are accepted as desirable and thus tolerated.



The Bečva River was straightened and narrowed in the late 19th and early 20th centuries, leading to increased flood risks and environmental issues. In response to catastrophic floods, a 2019 restoration project widened the river, restored natural habitats, and improved flood protection and ecological stability.

BUILT-UP AREAS

1. Park at the request of residents

A park with a pond which is filled with rainwater coming from the roofs of apartment buildings.

Place: Brno, the second largest city in the Czech Republic (400 thousand inhabitants)

The Brno city administration followed up on an earlier reconstruction of prefabricated buildings from the 1980s with a similarly bold project. It decided to accommodate the residents of a housing estate who objected to a plan to use the adjacent brownfield site to build more prefabricated houses and a school. The residents, lacking space for recreation, were interested in building a park on the site, ideally with a water area. In 2000, the city organised a two-day workshop entitled "How to Turn a Housing Estate into a Home", which was attended by the general public and produced many stimulating ideas. Since there was no natural water source on the site, the idea of building a pond fed by rainwater from the roofs of the apartment buildings was conceived. Today, the park with the pond created on the original brownfield site is not only used for recreation, but also positively affects biodiversity. And in the context of climate change, the park regulates the temperature of the environment and helps solve both drought and flood problems by protecting the lower parts of the city from the effects of torrential rains.

The park was implemented in several phases and was fully completed in 2013. Over the following year, the pond filled with water and was colonised by various organisms. The implementers promoted biodiversity by planting aquatic plants and stocking the pond with predatory fish.

The fact that the housing estate is situated on a hill was an advantage in the implementation, as water could be brought in by gravity. However, the dense network of utilities posed a complication. As the project was ahead of its time, it was met with scepticism, and negotiating the various permits was not easy. The preparatory administrative work took several years, during which time even the residents of the housing estate got used to the overgrown area and many did not agree with its improvement, fearing, for example, the occurrence of mosquitoes or the removal of the beaten paths. The district management therefore approached the implementation sensitively, ensuring the new draft pavements followed the original paths. People do not complain about mosquitoes, as mosquito larvae serve as food for fish, which successfully reduce their numbers.

The total investment cost for the park with the pond was CZK 11 million (EUR 440,000), of which CZK 6.1 million (EUR 244,000) was spent on constructing the pond with a small bridge and a system for draining water from the roofs of the houses. The maintenance of the park includes mowing the grass, sediment removal, the removal of leaves from the shallow parts of the pond once a year, weeding (especially of the dam and the open part of the tributary to the pond), trimming planted trees, and tending or cutting down mature trees.

UTILITIES ARE THE INFRASTRUCTURE that provides essential services for the functioning of cities and towns. These include, for example, water mains and sewerage systems, power lines, gas pipelines, telecommunications networks, and others. They are usually located underground, often without an overall design, and therefore often take up unnecessary space, which makes it virtually impossible to plant trees. Moreover, some administrators believe that utilities always take precedence and trees can only be planted where there is space left. The utilities have legal protection zones in the Czech Republic, within which trees cannot be planted without the consent of the administrators. The administrators also have the right to cut down trees in these protection zones if necessary (on the basis of their own discretion). New planting may be discussed with the administrators and supplemented with a technical solution to prevent root ingrowth. At the time of writing of this brochure, an amendment to the Nature Protection Act was being discussed in the Czech Republic. It should now ensure better protection of trees by allocating similar protection zones as utilities have to trees in cities. It would mean that when felling trees, it will be necessary to consult the Department of the Environment, so that an administrator of utilities would lose the right to cut down trees solely on the basis of their decision. From the perspective of nature conservation and adaptation to climate change, this is certainly a desirable development.

The Brno city administration transformed a brownfield site into a park with a rainwater-fed pond. The project, completed in 2013, faced initial skepticism but now addresses both drought and flood issues while maintaining the area's natural and recreational value.

2. Invitation of a stream to the town

Multi-purpose revitalisation of a small watercourse and its floodplain in the central area of a town.

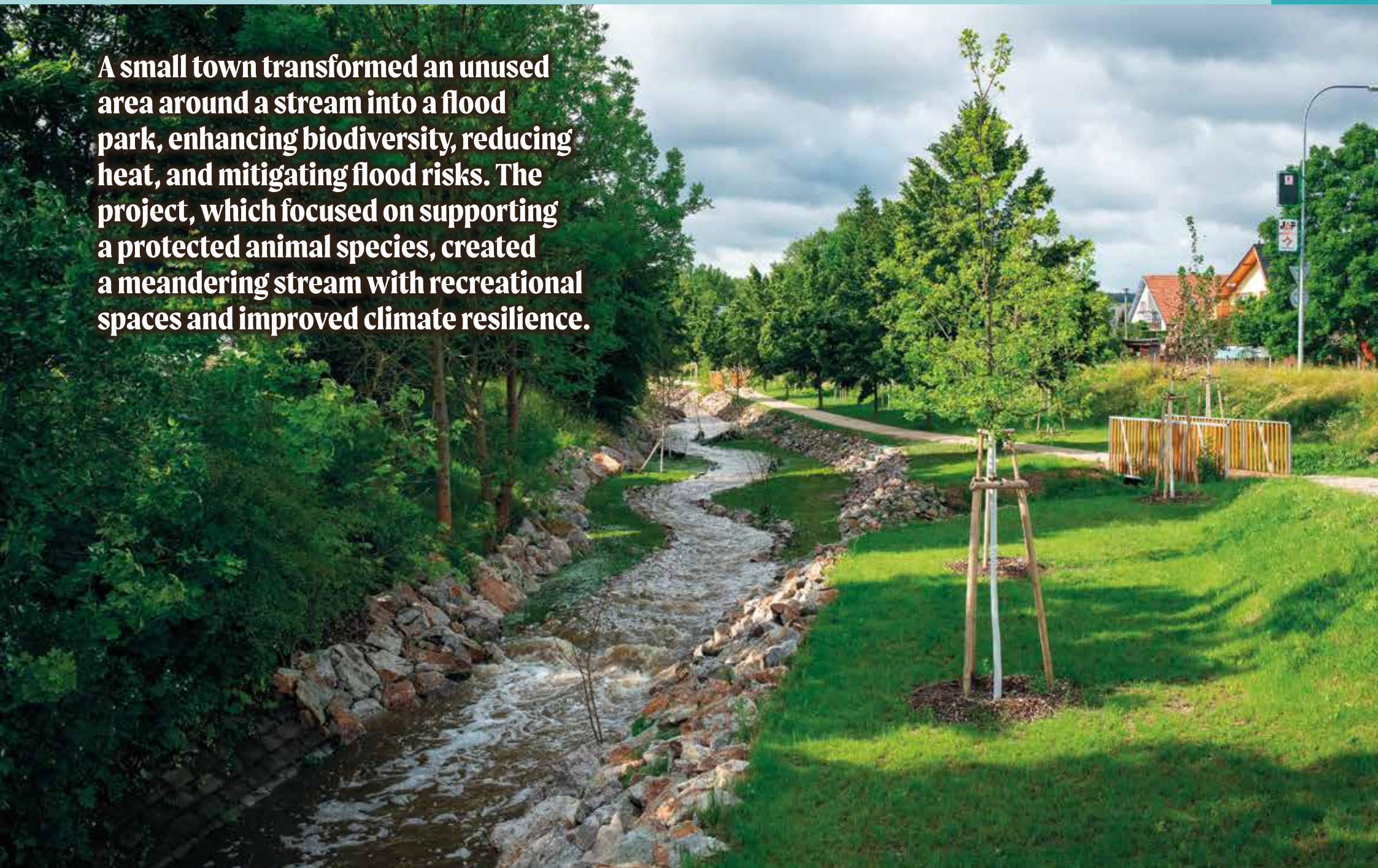
Place: The town of Rokycany (14 thousand inhabitants)

A small stream flows through the central part of this small town. The town decided to use its presence to eliminate the heat island, promote biodiversity, and create a pleasant space for leisure. At the same time, by redeveloping the site, the town has eliminated the risk of flooding and drought in the wider area. Uniquely, the project was carried out in close cooperation with the State Agency for Nature and Landscape Conservation of the Czech Republic. That is because the implementation was based on the needs of a specially protected species, the stone crayfish, which was already present here, and it was therefore desirable to stabilise its population.

The area of about 3 hectares, located on the town's land, was impenetrable and without use. There were small illegal dumps and homeless people lived there. The town council decided to change the character of the site – to clean up the area around the stream, make it more accessible, use its potential to eliminate hazards related to climate change, and build a flood park there. The stream itself had a classic, straight, trapezoid, sunken channel with steep concrete banks. Using a nature-based approach, they transformed it into a wide and meandering stream. It consists of a lowered part, through which there is a regular water flow (the river channel), and an elevated part, which takes the form of flowery meadows and is ready to accommodate higher flood flows if necessary (the berm). The transition between the two is gradual, with the berm being up to 40 m wide in places. The banks and bottom of the channel are rocky and planted with deeply rooting plants. The rocks, which have been selected and placed to maximise opportunities for the crayfish to hide, also offer good access to the stream for people. The meanders have slightly lengthened the stream from its original 520 m to 538 m. The character of the park is enhanced by ponds and accompanying landscape design, which includes more than 170 planted trees and few pathways. The non-flooded parts of the park are designed for short-time recreation. There are benches, fireplaces with seating, and play areas with mainly wooden elements. The main trail is gravel and others are made from a drainage material seeded with a resistant grass mix. Stream crossings created from rocks are an important part of the pathways. The park's attractiveness is also enhanced by a slope for winter bobsledding.

The total cost of building the park amounted to approximately CZK 33 million (EUR 1.3 million) and the investment was made in two phases. Almost 14 million (EUR 0.6 million) was covered by a state subsidy. In addition, a European subsidy largely financed the second phase of the revitalisation of the stream. The town's budget mainly financed tree planting, park furniture, pathways, and a footbridge over the stream. The maintenance costs of the park amount to about CZK 170,000 (EUR 7,000) per year. This includes garbage collection, grass cutting, maintenance of the furniture and pathways, and care for the trees. However, in the first few years, the town invested about 100,000 CZK (4,000 EUR) per year in the developmental care of planted trees alone.

WHEN REVITALISING SMALL WATERCOURSES, it is advisable to follow several basic principles. These include the removal of fortifications, changes to the slope of the banks, and the overall loosening of the watercourse flow. Placing stones and deadwood in the channel slows and diversifies water flow and provides shelters for organisms. Implementing low drop structures to diversify depths (and create pools in the channel) is also beneficial. More radical measures include relocating the watercourse to an entirely new path. It is also important to monitor the quality of water and sediments, as polluted water and excessive sediment deposition can undermine the entire revitalisation effort.



A small town transformed an unused area around a stream into a flood park, enhancing biodiversity, reducing heat, and mitigating flood risks. The project, which focused on supporting a protected animal species, created a meandering stream with recreational spaces and improved climate resilience.

3. Park as protector of a housing estate

Gradual transition of the town into the surrounding landscape in the form of a protection, retention, and recreation area.

Place: The town of Uherský Brod (13 thousand inhabitants)

On the outskirts of the town, close to a housing estate with approximately 800 inhabitants, there was an unmaintained, overgrown area with small illegal dumps of soil in the bushes, etc. This area, three-quarters of a hectare in size, separates the housing estate from intensively farmed agricultural fields and a highway. The aim was therefore to create a gradual transition from the built-up urban area to the surrounding countryside, to isolate the housing estate from noise and dust from intensive traffic, to use the site to eliminate the threats associated with climate change (heat island, drought, flooding, loss of biodiversity), and to offer people a place to spend their leisure time, and not only during hot periods. A flowery park was thus created on the site.

The first step was the reduction of woody vegetation and modelling of the terrain for maximum retention of torrential rainfall. This involved the excavation of four shallow, seasonally drying pools. On the stream (originally a mill race) which flows through the area located below the urban buildup, this helps to slow down a potential flood wave. Instead of draining away, the water gradually infiltrates and evaporates in this park. The pools alone can hold up to 500 cubic metres of water. The retention capacity within the site is otherwise very limited.

After the self-seeded trees had been cleared, new trees (cherry, oak, alder, and willow), as well as various shrubs and ornamental grasses, were planted. The woody plants complement the remnants of the old headed willows that line the former millrace. Flowery meadows have also been planted and are maintained in a way that allows the species to seed before mowing. Natural footpaths criss-cross the whole park and a cycle path is connected to it. Part of the area has been left to develop freely, with people blazing their own trails where they are comfortable. The original concrete bridge over the mill race was renovated with wooden facing, so now it is a large sunbathing bench, which is particularly popular among cyclists and rollerbladers.

The park also includes a beetle loggery and amphibian breeding and wintering area, which were created from logs from felled trees. There are wetland species of plants and animals, such as dragonflies and grass frogs.

The park was not easy to create, as the area has been demarcated for future buildings. Discussions over the change of the master plan took almost ten years. The essential argument was that this was a stream floodplain and therefore development would not be a good pick, because of the risk of flooding and the unsuitable subsoil.

The implementation was fully financed by the town and cost CZK 820,000 (EUR 33,000). The subsequent care of the trees is estimated at approx. 20 thousand crowns (800 EUR) in total. As the site retains water well, the plantings do not need to be watered as much.

THIS MEASURE FITS IN with the concept of so-called green belts. These are defined as areas of green space that surround a continuous urban development and serve as a transition zone between the town and the surrounding countryside. These can be suburban forests or parks, but also allotments and the like. Such green belts bring ecological and social benefits. They regulate the temperature and mitigate the heat island of the town, increase air quality, promote biodiversity, and can help with flood control. However, they also offer recreational space for residents, potentially promoting physical activity and mental wellbeing. When designed and implemented appropriately, they insulate cities from noise and pollution from e.g. traffic or industrial areas and improve the overall quality of life.

A neglected area near a housing estate was transformed into a flood park designed to mitigate the impact of torrential rainfall, reduce noise, and provide recreational space. The park includes seasonally drying pools, meadows with trees, and natural paths, enhancing biodiversity and flood resilience while creating a smoother transition between urban and agricultural areas.

4. Accessible cycling and pedestrian transport

Street space which allows retention of precipitation and motivates residents to use “alternative” forms of transport.

Town of Roudnice nad Labem (13 thousand inhabitants)

There is a consensus that motor traffic (or, better to say, its hazardous effects on health and the environment) should be reduced in densely populated areas by introducing mixed land use. That is why, in this case, the town council decided to demonstrate that a town does not have to be dominated by cars, but can be full of cycle paths and pedestrian zones lined with trees and flower beds and that it can also provide ample areas for parking and be efficient with water management. In practice, this vision was achieved when several of the town’s roadways and pavements needed to be reconstructed and there was a wish to increase the number of parking spaces. Since it is already evident from the above that this is a multidisciplinary “problem”, the town invited not only traffic engineers but also landscape architects to collaborate. At the same time, it accepted the higher initial costs necessary to achieve the aim. Thus three streets with a total length of 1,150 m were reconstructed. These were mostly typical asphalt roads with pavements, with remnants of green spaces in between, without trees or other functional and aesthetic elements of urban greenery. An exception was an avenue lining one street with houses.

Before the commencement of the works, the utilities were reconstructed by their administrators. As part of the revitalisation of the area, the town then increased the number of parking spaces as planned and repaired all paved surfaces. According to the architects’ design, a series of rain gardens (planted with ornamental grasses and perennial plants) and extensive gravel beds complete the space. The rain gardens fulfil not only an aesthetic function, but above all a regulatory one. Rainwater is channelled from the paved surfaces into them, and then gradually soaks into the subsoil. For this purpose, the rain gardens are adequately dimensioned. The biggest advantage of the extensive gravel beds is that it can stand the extreme conditions of the urban environment and are low-maintenance. They are designed in such a way that it’s only necessary to weed them for the first two years. After that, they should be fully engaged, and maintenance will be minimal. They only need watering on tropical days.

A BIG SUCCESS OF THIS PROJECT is the preservation of the existing mature avenue of maple trees, which was advocated by the landscape architects in particular. At the public hearing, the townspeople also expressed their desire to preserve the avenue rather than replace it with a new one. Therefore, only seven trees (that were in poor condition) were cut down. Subsequently, however, it was necessary to level the terrain, as the road level was 30 cm higher than the surrounding green areas. Simply backfilling with soil would have led to the gradual death of the mature trees. Therefore, the height difference was made up only in the area of the trees’ main root system (i.e. a 2-m-wide strip) with a mixture of gravel (90%) and horticultural substrate (10%). Low-maintenance groundcover flowers were planted in this mixture. In other green areas, flowering lawns attractive to wild pollinators (e.g. butterflies) were created. These particularly need to be mown and cleared of litter from time to time, and also mulch needs to be added locally.

Of course, the renovation also included the planting of trees and tree lines; circular benches were installed around some of them for seating. On a street where there are usually very high temperatures during summer, the town created a three-row avenue. In all, 101 trees, 430 shrubs, and nearly 7,000 flowers and grasses were planted. The biggest problem for the implementation of the measures was the utilities, which in some places prevented the construction of rain gardens. Shallow gravel beds were therefore implemented in these places.

The total cost of implementation reached CZK 49.2 million (about EUR 2 million), of which CZK 4.25 million (EUR 170,000) was invested in landscaping. The cost of building the largest rain garden was just under CZK 200,000 (EUR 8,000). The cost of maintaining this rain garden is around CZK 8,000 (EUR 320) per year, which includes waste removal, occasional weeding, and removal of dead plant parts and watering or fertilising if necessary.

As the residents of the town evaluate the non-traditional concept of the streets very positively, the town hall has the intention to expand the concept on its territory.

A town transformed several streets by adding cycle paths, pedestrian zones, rain gardens, and tree lines to promote walking and cycling while improving water management. This project enhanced urban aesthetics and functionality and received positive feedback from residents.

5. Residential district as a model for rainwater management

From a brownfield to a modern densely populated district with systematic rainwater management

Location: Prague, the capital city of the Czech Republic (1.35 million inhabitants)

The residential area called Suomi is a development project which was built on a brownfield site overgrown with self-seeded trees. There was also an illegal dump and the site was inhabited by homeless people. A neglected, regulated stream with steep concrete banks flowed here. The locality overall was simply in poor condition. Today, the same location represents a modern residential area with nice greenery, facilities for short-term recreation, and at the same time an inspiring example of rainwater management in a built-up area.

The total area of the site is over nine hectares and we can find here 23 apartment buildings with a total of 850 apartments and local public amenities. Between the buildings (especially along the pavements and roads), there is a cascading system of trenches, ditches, and swales – i.e. linear, interconnected elements whose main role is to divert water (and partially also absorb it) into the so-called polders. Polders are alternately dry or waterlogged depressions with a maximised retention capacity. Their purpose is primarily to retain water and allow it to gradually soak into the ground. When the capacity of these polders is exceeded, the water is diverted to a pond. After the pond is filled, the water is diverted through an overflow into the stream, which was also revitalised as a part of this project.

Most buildings have retention tanks that collect water from roofs, terraces, and adjacent pavements. If needed, water is pumped from these reservoirs and used for watering trees and greenery. When the capacity of a tank is exceeded, the water is diverted to the drainage system described above.

From public roads, pavements, and small squares, water flows through cut-outs in the kerbs into liner depressions planted with trees, which are thus supplied with water. If possible, these depressions are interconnected by gravel drainage, tubes, or troughs, and thus the water overflows from one to another, again from the highest one to the pond and then to the watercourse.

This method of rainwater management leads to maximum retention and use of water at the site of its impact. During the rainy season it means maximal slowing down of runoff and reduced demands on the sewerage system and a reduced risk of floods. At the same time, it enables the use of rainwater to regulate the microclimatic conditions in the given locality and reduces the costs of taking care of greenery and the watering requirements. The return on the total investment of 15 million crowns (600 thousand EUR) is estimated at 30 years. Maintenance consists of regular care of green surfaces and cleaning of filter fabrics once every ten years.

THE PROJECT WAS REALISED ENTIRELY at the investor's expense and without the use of subsidies. It is a large construction company operating in several countries (Finland, Sweden, Poland, the Czech Republic, Slovakia, Estonia, Latvia, and Lithuania) that, in addition to ethical principles and economic goals, has also included environmental responsibility in its strategy. In this direction, it focuses mainly on the sustainable development of cities, the efficient use of resources, and the reduction of the impacts of climate change. The company stands by the opinion that environmentally friendly construction is a way to save nature and the environment that at the same time brings more comfortable and healthier living for residents. The company uses brownfield sites for its projects and strives for minimal CO2 emissions from its buildings and construction activities. So it uses environmentally friendly materials, pays attention to the low energy consumption of its buildings, implements elements of smart management of rainwater, and, in addition to playgrounds and similar equipment, the buildings are always supplemented by trees, shrubs, and flowers. In the future the company also wants to add birdhouses and beetle loggeries.

A residential area was developed on a brownfield site, transforming it into 23 apartment buildings with green spaces that effectively manage rainwater. The project features a cascading system of trenches and polders for water retention and irrigation of greenery, reducing runoff and flood risks while enhancing the local microclimate.

ENERGETICS

1. Photovoltaics

Photovoltaics (PV) can be installed in various forms, from small, decentralised power plants on the roofs of individual buildings to large-scale PV farms. The efficiency then depends on regional conditions and the design of the PV plant. Therefore, the Ministry of Environment of the Czech Republic (CZ MoE) has issued a leaflet with recommendations on how to proceed when choosing a PV plant, so that the resulting efficiency is as high as possible, but also so that people can prevent unfair business practices. According to these recommendations, there are several key questions that should be answered before making a choice:

- The first question is, of course, **why am I buying photovoltaic?** Am I motivated by energy savings, energy independence, or do I wish to provide only hot water with PV? On the basis of these requirements, the supplier can then propose an optimal solution.

- A crucial parameter for the selection of a PV system is the **quality of the panels** supplied. Panels should be assembled from high-quality components by trained personnel. Very cheap panels made from poor-quality components come with a number of complications, additional costs, and much lower durability and longevity. For example, cheap panels can crack under a weather event (especially hail) or simply stop working after a few years and need to be replaced. Simultaneously, suppliers of poor-quality PV panels often do not offer the necessary additional service or may not even be on the market any more.

- **Batteries** can maximise the use of the energy produced and ensure supply in the event of blackouts. However, they are not essential and depend on the purpose of the PV plant. When choosing them, it is also true that good-quality batteries are more likely to pay off than cheap competitors are.

- When selecting **a supply company**, it is advisable to find out about the company's history and references from previous customers and also to enquire whether the company will provide a connection to the distribution network and what service it offers after installation. It is common for companies to offer a 25-year warranty on panels and a shorter warranty on other components. It is also usual to have a time-limited guarantee on the efficiency of the panels, which can also vary from company to company.

- When talking about a PV **performance**, the contractor should design a solution corresponding to the (current) consumption, and it is important to clarify whether the consumption will change in some way, for example, whether you will get an air conditioner or an electric car, or whether the consumption will rather decrease.

- **Location** is also related to performance. The ideal orientation is east or west or south. Sometimes it may be more advantageous to place the panels on the roof of a garage instead of the roof of a house. It is also important to consider architectural and landscape aesthetics.

- **Financing** should ideally be spread over two advances and a top-up payment. The first advance should be paid after the contract is signed and its amount should be around 10-40% of the total price. The second advance of 50-70% of the total price is mostly paid after the contract for connection to the network has been obtained and installation has begun. The remaining amount is then paid after the acceptance of the finished work with the inspection report and handover report.

Examples of PV installations

Photovoltaics shading a car park

The largest and perhaps the most effective example of PV in the Czech Republic can be found at the Dukovany Nuclear Power Plant. It has been there in operation since 2021 as a so-called carport, i.e. PV shading a car park. Specifically, 322 parking spaces are shielded by 2,598 double-sided (bifacial) photovoltaic panels, which can use the underside to harness light rays reflected from parked cars. The total output of this PV plant is 831 kWp and in the year since its installation (thanks to the favourable geographical and meteorological conditions of that year) it has produced 877,823 kWh. With this amount of energy, it has been able to cover the consumption of almost 300 households. Moreover, thanks to the comfort for the drivers and the protection of the cars from external influences, it has become the most used parking area of the plant.

Photovoltaics on waterworks buildings

Another example of the smart use of photovoltaics can be seen in the project of the municipal joint-stock company the Prague water management company. This project aims to build nine pilot PV plants on the roofs of waterworks buildings and on the grassy roofs of underground water tanks managed by the company. PV plants with a total capacity of 1,507 MWp will be installed at nine sites. Annual energy production of 1,470.1 MWh is expected, along with a reduction in CO_2 emissions of 1,264.5 t, as a result of reduced consumption of non-renewable primary energy. The project will be co-financed from the state subsidy fund with over EUR 15 million. The estimated total cost is just under CZK 53 million.

THE DISTRIBUTION NETWORK for delivering electricity is a system that transmits power from power plants to homes, businesses, and other end users. This system includes high-voltage power lines, transformers that reduce the voltage to a safer level, and low-voltage lines that carry electricity directly into buildings. The distribution network is designed to be reliable and efficient, ensuring a continuous supply of electricity and being able to cope with variable demand. It is a crucial part of the infrastructure that enables us to use electrical appliances and technologies in our daily lives. When installing a photovoltaic power system, connecting to the distribution network is essential for several reasons. It allows for the sale of excess electricity generated by the solar panels back to the grid, ensuring that no energy is wasted. Additionally, the connection provides a backup power source from the grid during times when solar production is insufficient, such as at night or during cloudy weather. This integration helps maintain a consistent and reliable power supply, maximising the benefits of renewable energy.

The condition for the subsidy is that at least 80% of the electricity produced will be consumed on-site, i.e. in the selected waterworks.

Community photovoltaic power plant

Photovoltaics is now a relatively well-known and available technology, which can be found, for example, on the roofs of family homes or apartment buildings, schools, office buildings, or halls. In the capital city of the Czech Republic, the use of photovoltaics for community energy is currently being developed on a large scale, in the context of apartment buildings, where the energy is shared between individual housing units. To give an idea, 40 PV panels with a total output of about 20 kWp can be installed on the roof of an apartment building with a width of 10–15 m. This PV will then produce approximately 20 MWh per year. If there were 20 apartments in this apartment building with an annual electricity consumption of all units of up to 40 MWh per year, the PV could cover 30–50% of the household consumption, with a lifetime of 30 years or more.

2. Open Garden education and counselling centre

Brownfield regenerated into an energy-efficient, working, educational, and recreational environment.

Location: Brno, the second largest city in the Czech Republic (400,000 inhabitants)

A truly comprehensive approach to climate change adaptation is represented by a site at the foot of a hill with the most famous historical landmark of the city of Brno – Špilberk Castle. The owner is a Czech environmental foundation which in 2006 purchased there a historic building with a garden as a profitable investment of its basic assets. The gardens here were once used to supply the kitchen of the local monastery, which disappeared as a result of bombing in 1944. The building was neglected and the gardens derelict. Therefore, the foundation, in cooperation with the city and the local church congregation, began to work on its reconstruction. The goal was to build a model example of the ecological development of a city.

Today, on less than 3,000 m^2, we can find there two administrative buildings that conform to the passive energy standard (i.e. fully energy self-sufficient) and an educational garden. The original historical building, which was reconstructed, is used for offices. A photovoltaic power plant with an output of approx. 19 kWh per year is located on its roof and can thus cover half of the building's annual consumption. The second building, which is newly built, serves as a seminar centre and a facility for non-profit organisations and educational events. It is connected to the aforementioned Špilberk hill through its green walkable roof and climbing plants grow on its façade.

The total floor area of the buildings is 2,000 m^2; they are heated by eight deep wells and a system of four heat pumps with an output of 68 kW. The system consumes up to 20 MWh per year for its own operation, but thanks to a number of measures it can multiply the energy that is received by up to six times. Cooling and heating in the new building are helped by an active concrete core (concrete pipes embedded in the ceiling, through which the cooling or heating liquid passes) and a rotary exchanger, which either cools or heats the fresh air flowing into the building, depending on the time of year. The total energy consumption in the new building is minimised by the intelligent control system of the regulation, which coordinates elements such as lighting, outdoor blinds, or the recuperation system automatically. Small measures are also very important. In both buildings, all water taps are equipped with aerators – water savers that mix the water with air bubbles.

The buildings' consumption is monitored by hundreds of sensors and dozens of measuring devices. The data is available to the public on the foundation's website.

Grey water from the kitchen and all sinks is purified by a root wastewater treatment plant filled with gravel and planted with moisture-loving perennials. Rainwater is collected in containers and retained by green roofs. The above-mentioned intensive walkable vegetation roof has a substrate height of 30 cm.

In the garden, there are flower beds that can be rented by the public, places to rest, works of art that demonstrate physical phenomena within the themes of the Sun, Earth, water, and air, and a number of environmentally educational play elements. The entire garden is interwoven with an educational trail. The adjoining garden remained the property of the church congregation. With joined forces, the organisations restored it to a small urban farm where they grow herbs and keep bees, chickens, sheep, and rabbits. They also restored a meditation place here.

Interpreted walks, suburban camps, courses (e.g. tree care), exhibitions, and conferences, but also private events, e.g. weddings or company parties, are organised in the area. The garden is seasonally open to the public and thus fulfils the function of a city park. The result of the above-mentioned measures is an area with almost carbon-neutral operation, which at the same time has an effect on the regulation of the urban heat island and social life.

The reconstruction of the historical building and the construction of the new building and the garden cost a total of 104 million CZK (almost 4.2 million EUR). The payback for the individual technologies varies between seven and ten years, while their expected lifetime is 20 (photovoltaic) and more years. The lifetime of a new passive building is estimated at 40–80 years.

A Czech environmental foundation has transformed a brownfield site into a model of ecological urban development, featuring two energy- and water-efficient buildings and an educational garden. This center now offers various educational programs and community engagement opportunities.

3. Reconstruction of a municipal school

Transformation of a building in disrepair into an environment-friendly municipal school with a natural garden.

Place: Ostopovice, a small village (approximately 1.7 thousand inhabitants)

The school in Ostopovice is housed in a building dating from 1985. Until a few years ago, the management had to deal not only with the high energy consumption of the building, but also with numerous structural defects. As a result, the school was threatened with closure for safety reasons. In 2010–2011, however, the school was completely renovated. This transformed it into a safe and comfortable space for children's education and an inspiring example of municipal building management.

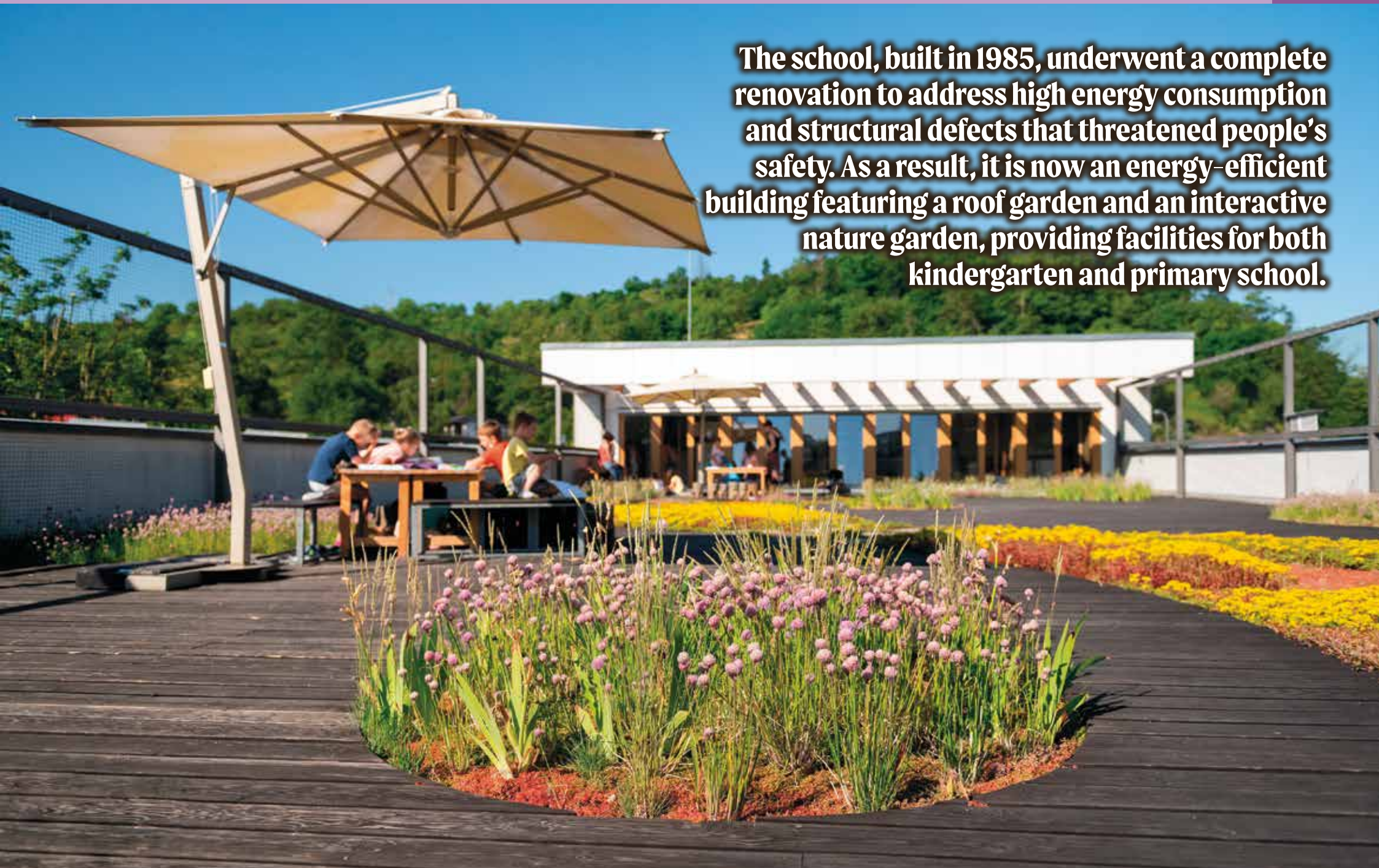
The school building was designed as an energy-efficient building in preparation for the renovation. This means that the energy performance (heat loss) is in the range of 50–75 kWh/m^2/year.

The envelope consists of an insulating block lining and 20–23-cm-thick insulation. The roof is insulated with a layer with a thickness of 25–50 cm and is designed as an extensive green roof. The internal partitions and floors on the upper floors are lightweight, prefabricated, and acoustically insulated. The windows are wooden, with double glazing.

In the basement there are the technical facilities of the school. On the ground floor of the building there is a kindergarten with three classes with a total capacity of 73 children and a space for an art club with a separate entrance. On the first floor there is a primary school with a total capacity of 135 children, i.e. two large and two smaller classrooms and a computer room. On the second floor, above the level of the original roof, there is another classroom with access to the roof garden, which is used mainly for teaching and afterschool care. Other notable features are an interactive nature garden with terraces, play equipment (including a water element), and a practice garden for hands-on learning within the nursery and primary school.

Heating and domestic hot water is provided by a 33.8-kW system consisting of an electric boiler and a ground-source heat pump, specifically five ground boreholes 120 m long. Heat is distributed by underfloor heating on the ground floor and radiators on the upper floors. Rainwater from a storage tank is used to flush the toilets. When the capacity of the tank is exceeded, the water is collected in the school grounds.

A HEAT PUMP extracts heat from the surrounding environment (ground, water, or air), converts it to a higher temperature level, and allows it to be used for heating or hot water. It consists of two basic parts. The indoor part provides heat transfer to the heating system and looks like a conventional gas boiler, while the outdoor part provides heat extraction from the environment; its shape and size depend on the chosen heat source (ground, water, air). The heat pump is usually able to heat the heating water to a maximum of 50–55 °C, so its use is more suitable for underfloor and wall heating than for radiator heating.



The school, built in 1985, underwent a complete renovation to address high energy consumption and structural defects that threatened people's safety. As a result, it is now an energy-efficient building featuring a roof garden and an interactive nature garden, providing facilities for both kindergarten and primary school.

4. Regeneration of municipal apartment buildings

A participatory approach to the regeneration and management of city-owned apartment buildings.

Place: Brno, the second largest city in the Czech Republic (400 thousand inhabitants)

In 1994, a law on the ownership of flats was adopted in the Czech Republic. The consequence was the transfer of state-owned flats from the socialist era, when there was no private ownership in Czechoslovakia, to management and maintenance by cities, municipalities, and, consequently, city districts.

Since 1994, one municipal district of Brno (Nový Lískovec), which has over 13,000 inhabitants, has taken over a total of 1,100 formerly state flats (17 prefabricated buildings). For the most part, these were housing estates built shortly after 1975. Thanks to the initiative of citizens and some councillors, the district began work on their reconstruction in 1999. The municipal council created a diverse working group to which they invited architects, experts from universities and NGOs who focus on sustainable energy management, and active tenants who initiated the whole project. The result was a proposal for the comprehensive regeneration of selected prefabricated buildings, including a financing model.

The subsequent implementation in 2001 was thorough and the project was in many ways ahead of its time. Insulation with a (then significantly above-average) thickness of 14–18 cm was used, which was in addition embedded below ground level. In order to minimise the thermal bridges, the window frames were also covered with external insulation and the apartments were fitted with new balconies. They also modernised the heat transfer station, reconstructed the electrical wiring, and fitted the radiators with thermostatic valves. A solution to the ventilation of the flats was essential, as air exchange is crucial for ensuring a good and healthy environment in the flats, in terms of both human health and the lifetime of the buildings. However, at the same time it is necessary to avoid unnecessary heat loss (for mostly economic and ecological reasons). Before the renovation, air exchange was mainly provided by leaks in the windows, which was uncomfortable for the occupants and led to overheating and excessive air drying in winter seasons. Therefore, central heat recovery units were built in some houses with distribution of preheated air to individual rooms. Elsewhere, small extractor fans have been installed in individual flats, with the air supply provided by micro-ventilation in the windows. In the second case, ventilation (opening the windows and switching on the fan) is entirely in the hands of the tenants.

NORMAL WINDOW VENTILATION CAUSES significant heat loss in winter seasons. Inside a waste heat recovery ventilation unit, waste warm air and fresh cold air flow against each other in ducts separated by a special wall through which heat is transferred without reducing the quality of the incoming air. This ensures both high air quality and minimal heat loss. The air flow velocity is minimal, so there are no draughts or noise. In addition, operation is virtually maintenance-free and efficiency ranges from 60-80%.

The energy and financial savings, tenant satisfaction, and the positive impact on the environment motivated the municipality to continue to perform similar renovations and since 2011 all the municipal buildings in Nový Lískovec have met the low-energy standards. Other modernised buildings already have insulation with a thickness of 20 cm and are fitted with the now proven triple-glazed windows.

Energy monitoring shows heating consumption has fallen by about a third, from 135 kWh/m²/year to 40 kWh/m²/year. The most recent renovations achieve just 26 kWh/m²/year, saving 20–35 kg of CO_2 per m² per year, with financial savings of 6–33 EUR/m²/year, depending on heating material.

Citizens and councillors initiated the housing estate reconstruction. A diverse working group of architects, university and NGO experts in sustainable energy, and active tenants created a proposal for comprehensive regeneration. As a result, municipal buildings now meet low-energy standards, reducing energy consumption, CO2 emissions, and saving tenants money.

5. Energy self-sufficient village

A small village produces more electricity than it consumes.

Place: Kněžice, a small village (410 inhabitants)

In 2004, the municipality of Kněžice used support from European and state subsidy funds and two years later started operating a central heating plant and a biogas plant. By the end of the year, it had gradually put into operation a system for distributing heat to individual households. In total, 149 houses in Kněžice are connected to this central heating system, a figure which represents more than 90% of the permanent population or 95% of the total heat consumption in the municipality. The annual heat consumption of the connected houses is approximately 2,000 MWh (7200 GJ).

A biogas plant with one combined heat and power unit which generates an electrical output of 330 kW and a thermal output of 405 kW is in continuous operation. It produces biogas (from agricultural, food, and other materials and waste), heat for heating homes, and electricity for sale to the electricity network, as well as biomass heating pellets and high-quality fertiliser for use in agriculture. Straw, maize, clover, and other biomass (surplus or grown for this purpose) are mainly processed at the plant.

The biomass boiler plant with two hot-water boilers with a total heat output of 1,200 kW is only in operation as needed during the heating season and thus supplies heat at times when the surplus heat from the biogas plant would not be sufficient to heat the village. The boiler house and the biogas plant are connected to each other by a heat pipe and information cabling. The ductless heat distribution throughout the village and automatic heat transfer stations in the houses ensure that heat from the boiler house and the biogas plant is continuously transferred to all the connected buildings all year round.

Contrary to this, the electricity generated by the biogas plant is not directly fed to the individual houses. Households and local businesses continue to receive their electricity from a distribution company operating nationwide. The municipal biogas plant produces about 2,600 MWh/year and thus supplies more electricity to the network than the entire village consumes (about 2,200 MWh/year). The remaining part (approximately 15% of the electricity produced) is used for the actual operation of the biogas plant and the biomass boiler house. Thus, Kněžice, with its 410 inhabitants, produces an average of 6 MWh of electricity per inhabitant a year and supplies an average of 5 MWh of electricity to the electricity network for each of villager. The municipality invests the profits from the sale of electricity mainly in the maintenance of the biogas plant and boiler house and in the further development of the municipality.

IN THE CZECH REPUBLIC, a legislative framework is emerging for sharing energy produced from renewable sources between individual households or buildings. This is the concept of so-called community energetics. The aim is to decentralise the energy sector and increase the share of renewables in the national energy mix. It is also a means of preventing energy poverty. In practice, this means that unused energy will no longer be sold primarily to commercial distributors, but can be shared through the distribution network within a predefined community (a so-called energy community). The difference is that if the energy supplied to the network is consumed within 15 minutes by a member of the community, the community will need to pay a fee for using the distribution network, but there will be no trade in the energy itself through a commercial supplier who would otherwise buy the energy cheaply and then sell it for a higher amount.

The municipality established a central heating and biogas plant, along with a heating system that now serves over 90% of the population. The biogas plant generates both electricity and heat, producing more electricity than the village consumes, with the profits reinvested in local development.

6. Public transport buses powered by renewable energy

The biogas produced on a nearby farm replaced the conventional natural gas used to power the buses

Place: the town of Jihlava (54 thousand inhabitants)

The transport company of the town of Jihlava has teamed up with a nearby regional agricultural enterprise to operate two local buses powered by biogas from a biogas plant. This has replaced the compressed natural gas (CNG) previously used to power the local buses. Biomethane is produced by a farm from compressed biomass. It can be said that these buses now run on straw and grass haylage residues or apple residues from the local fruit drying plant, animal feed remains, or manure. The passengers and bus drivers do not feel a difference. The town started using this fuel in mid-2023. For the transport company, the change mainly brings a guaranteed supply of natural gas in an uncertain time, while it is also an environmentally friendly and sustainable source. The agricultural company came up with the offer and the town company agreed. Compared to natural gas, biogas contains fewer impurities – thanks to membrane separation. So it is a high-quality gas with a methane content of at least 90%. The price and the method of refuelling the buses are comparable. The technology belongs to the supplier, BioCNG.

The buses were purchased by the town with support from European subsidies, under which it has committed to operate them for at least the next ten years. The biogas filling station consists of a refuelling stand, a compressor station, and a container in which the biogas is delivered from a village about 20 km away. The volume of the biogas container is 1.6 t and corresponds to the daily fuel requirement for 15 buses. The consumption of the vehicles is similar to that of conventional CNG. The municipal transport company has a total of 40 buses and 45 trolleybuses. In 2022, the trolleybuses travelled over 1.1 million kilometres and the buses 1.67 million kilometres. In the future, it is expected that 65–100% of the buses' consumption will be covered by biogas from the farm. The farm operates under a regenerative farming regime and has been operating the biogas plant since 2012. Initially producing heat and electricity, the farm decided to expand production to include biomethane in 2022. The unit processes between 105 and 210 Nm^3 of biogas per hour. This is then compressed into mobile storage tanks and distributed.

The transport company has partnered with a local agricultural enterprise and now operates buses powered by biogas, which is derived from agricultural residues and provides a reliable supply.

IN THE CZECH REPUBLIC, European and state subsidy funds operate as financing instruments for various projects that support infrastructure development, entrepreneurship, innovation, education, the environment, and other areas. European subsidy funds are provided by the European Union to Member States. The funds are divided into several categories, such as the European Regional Development Fund, the European Social Fund, or the European Agricultural Fund for Rural Development. State subsidy funds are funds provided by the Czech government and its institutions also to support various areas of development. These funds can be complementary to European subsidies or operate independently.
Within each fund, specific European and state subsidy programmes (periodically) announce calls for applications, which specify the conditions and objectives of the projects to be financed. Applicants must prepare the required documents, such as a detailed project plan or financial budget, and complete a subsidy application. The projects that are submitted are evaluated according to predetermined criteria. If a project is approved for funding, its implementation is regularly monitored and evaluated by the responsible institution. European and national grant funds therefore operate on the principle of calls, evaluation, and follow-up checking and are key instruments for promoting development and innovation.

Subsidy programmes as an element of a large-scale transformation

Available funding is crucial for the implementation of adaptation measures. In the Czech Republic, the vast majority of such investments are co-financed by state or European institutions in the form of subsidy programmes. The longest-lasting (since 2009), most accessible, and therefore most effective and best-known subsidy programme is the New Green Savings (NGS), which is a state subsidy programme aimed at energy savings in buildings (especially family and apartment buildings). The programme has undergone a number of changes since the first call for proposals was announced – for example, the investments that are supported have been extended to include adaptation measures, and recently there has been an increased emphasis on the introduction of renewable energy sources. However, the essence of the programme remains the same. It is to support the general public in implementing energy-saving measures in the renovation and/or construction of residential buildings, thereby reducing emissions of greenhouse gases and other air pollutants. In addition to the social benefits of reduced energy consumption, financial savings, and increased quality of housing for citizens, the Czech government is contributing to the implementation of the Paris Agreement and to the achievement of some of the goals to which the Czech Republic has committed itself under the European Green Deal.

A major advantage of the NGS programme is the wide range of possible applicants. Both municipalities and cities or their contributory organisations, as well as individual citizens (owners of family homes or apartment buildings) can apply for financial support. A new sub-component of the programme is a call specifically aimed at low-income households and the elderly. Another key advantage is the relative simplicity and friendliness of the programme. The applicant must submit a completed application form and attach a professional report about the condition of the building, provided by an authorised person (energy specialist, designer certified by the Ministry of the Environment of the Czech Republic). Free consultation experts are available to potential applicants from the elderly and low-income households. Their work is funded by the Ministry of the Environment and consists of clarifying the subsidy conditions and recommending specific measures, as well as a suitable expert for the drawing-up of the report.

THE PASSIVE HOUSE STANDARD for buildings is an internationally recognised standard for energy-efficient buildings that have very low energy consumption for heating and cooling. The aim is to minimise energy losses and maximise energy gains, resulting in a significant reduction in energy consumption and increased occupant comfort.

The list of subsidised investments is also wide. It includes total or partial insulation of buildings, the

replacement of windows and doors, the purchase and installation of solar thermal systems and photovoltaic systems, the replacement of heat sources with more environmentally friendly options (e.g. the replacement of coal-fired boilers with heat pumps or biomass sources), and the purchase and installation of controlled ventilation systems with heat recovery or systems for the use of waste heat, but also the construction of family homes or apartment buildings that conform to the so-called passive house standard, the purchase of houses and apartments with very low energy consumption, the implementation of green roofs, the installation of outdoor shading technology, the construction of storage tanks for rainwater, the construction of charging stations for personal electric vehicles, or even the planting of trees for apartment buildings on lands which are accessible to the public.

The administration, including the mediation of funding from this grant programme, is provided by the State Environmental Fund of the Czech Republic (SEF). It is a state institution under the administration of the Ministry of the Environment, which was established specifically to implement strategies and international conventions aimed at environmental protection. The basic revenues of the SEF are defined by legislation and are generated on the one hand by subsidies from the state budget or European funds and on the other hand by payments for the use of natural resources or for environmental pollution (e.g. emission trading, fines imposed by the Czech Environmental Inspectorate), but also by repayments of loans granted from this fund. In the case of the NGS programme, emission trading is the key source of finance.

Between 2014 and 2021, the SEF received over 90,000 applications under this programme, approved almost 76,000 of them, and paid out more than 60,000 of them in this period, which represented CZK 11.63 billion (EUR 465.2 million). Another great advantage of this programme is the fact that the implementation of individual measures covers basically the entire territory of the state evenly.

Energy audit – research first, then implementation

An energy audit is a systematic assessment of energy consumption in buildings or industrial plants. In an energy audit, an expert examines how energy (electricity, gas, heat, etc.) is used in a given building, identifies inefficient consumption, and proposes measures that will lead to energy savings and reduced financial costs, and, at the same time, reduce greenhouse gas emissions and protect the environment. Measures often also improve the indoor environment of buildings (heat, light, ventilation), which can improve the comfort and health of occupants or employees.

The energy audit process starts with data collection, where the auditor collects energy consumption data from bills, measurements, and records. Next, it examines the technical equipment (boilers, lighting, air conditioning) and operating practices. This is followed by a physical inspection of the building or facility, during which the auditor determines how the various systems are set up and how they work in practice. On the basis of the data collected and the inspection, the auditor analyses the energy consumption and identifies the areas of greatest energy loss or inefficient use. The auditor then prepares a report proposing specific measures to reduce energy consumption. These measures may include, for example, insulating the building to reduce heat loss, replacing old windows with energy-efficient ones, upgrading heating or cooling systems, installing LED lighting, or using renewable energy sources (solar panels, heat pumps). The report also includes an economic evaluation of the proposed measures, i.e. how much they will cost and how long it will take them to pay back in savings.

The result of the audit is a detailed report that includes an overview of current energy consumption, identified inefficient areas, proposals for specific improvement measures, estimated costs of implementing these measures, estimated energy and money savings, and return on investment. An energy audit is a valuable tool for households, businesses, and public institutions that want to better manage energy, reduce their costs, and contribute to environmental protection.

Competition as a motivation tool

Motivating the public, sharing information, and inspiring examples are extremely important for any systemic change. In the Czech Republic, a competition called Adapterra Awards was created for this purpose in 2019. It recognises implemented adaptation measures in four main categories: landscape, habitats, buildings, and industry, and then in several other categories, such as the Sympathy Award, in which the public votes, or the Responsible Energy Award, which assesses the impact on energy self-sufficiency. Other prizes are awarded in selected regions that are most vulnerable to the impacts of climate change or are affected by heavy industry. The competition essentially runs all year round and is divided into several phases. The organiser is a non-profit organisation, Partnership Foundation. In 2024, the sixth year of the competition was under way.

How the competition runs

From January to March, individuals, associations, municipalities, or various organisations (simply anyone who has in any way been involved in the implementation of a suitable project) have the opportunity to enter their project into the competition free of charge. In April, the submitted projects are then published on the organiser's website and the evaluation phase begins. Between April and July, an expert jury selects the projects that will go forward in the competition. The jury is made up of researchers and practitioners with a focus on climate, (landscape) architecture, energy, flood control, and so on. The jury then also selects the winners of each category described above. From August to October, the general public votes in the aforementioned Sympathy Award. The competition then ends with a conference, usually in November, which is always themed around a topical issue related to climate change (e.g. drought, urban green spaces, renewable energy sources, etc.). At the end of the conference, the winners are announced and are presented with prizes and financial gifts provided by the sponsors of the competition. The funds received by the winners must be used to develop new or existing adaptation measures. The successful projects are described on the competition website, where they are easily traceable and serve as a source of inspiration for anyone interested in the topic of sustainable development.

IN THE CZECH REPUBLIC, an energy audit is usually necessary when applying for subsidies from energy-saving programmes, such as the New Green Savings programme. It is a key document that demonstrates the justification and effectiveness of the proposed measures to be financed by the subsidy programme. Without an energy audit, it is not possible to obtain accurate information on energy consumption and potential savings, which is essential for the approval of the grant application.

Reading

Recommended additional reading

Landscape

The UN Decade on Ecosystem Restoration 2021-2030 project website provide information about ecosystem restoration. On the website, you'll find educational articles and videos, interesting publications available for free download, as well as documentary films.
https://www.decadeonrestoration.org/restore-films-frontiers-hope
https://www.decadeonrestoration.org/przewalskis-horses-return-central-kazakhstan-after-nearly-200-year-absence

Agriculture

Source of sustainable agriculture information is e.g. ATTRA (Appropriate Technology Transfer for Rural Areas) which maintains a knowledge base of practical multimedia resources for farmers or educators. Most of the publications are free and available as a digital download or audio reader.
https://attra.ncat.org/publication-library/
Association of Private Farming of the Czech Republic offers on its website a number of study materials about agroforestry, including illustrative videos in English which are based on the collection of a number of case studies and good agroforestry practices from several countries.
https://www.agroforestrysystems.eu/en/education-system/

River revitalisation

Detailed description of an urban river restoration project on the River Isar:
ARZET Klaus, JOVEN Stefan. The Isar Experience – Urban River Restoration in Munich.
https://www.wwa-m.bayern.de/fluesse_seen/massnahmen/isarplan/doc/the_isar_experience.pdf
A video about climate change adaptation measures in Isar River Basin:
NGI – Norges Geotekniske Institutt. PHUSICOS Isar River Concept case Look&Learn 2019.
https://youtu.be/lQd2k4Y9URg?si=QpORU3xb0gRDERYd

Urban green spaces

Practical information on designing green spaces and maintaining urban greenery:
PAYSALIA. Your ultimate guide about designing public green spaces!
https://www.paysalia.com/en/blog/maintenance/ultimate-guide-design-public-green-space

Pedestrian and cycling infrastructure

A website that outlines the principles, processes, and specific elements needed to design streets in cities to make them greener, safer, and more accommodating for pedestrians and cyclists:
NACTO – National Association of City Transportation Officials. The Urban Street Design Guide.
https://nacto.org/publication/urban-street-design-guide/

Urban rainwater management

Government of Ireland, Department of Housing, Local Government and Heritage. Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas. March 2022.
https://www.gov.ie/en/publication/10d7c-nature-based-solutions-to-the-management-of-rainwater-and-surface-water-runoff-in-urban-areas-best-practice-interim-guidance-document/
NRDC – the Natural Resources Defense Council. Green Infrastructure: How to Manage Water in a Sustainable Way.
https://www.nrdc.org/stories/green-infrastructure-how-manage-water-sustainable-way#important

Energy savings and renewable energy sources

The International Passive House Association (iPHA) website provides extensive information and free downloadable publications on highly energy efficient buildings.
https://passivehouse-international.org/index.php?page_id=150
More information about Energy communities is available e.g. on the EU website.
https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities_en

Subsidy programmes

English website of the State Environmental Fund of the Czech Republic, which administers, among other things, the New Green Savings program.
https://www.sfzp.cz/en/administered-programmes/new-green-savings-programme/
On the following website, the EU presents funding programmes focused on climate change.
European Comission. Climate Action. EU funding for climate action.
https://climate.ec.europa.eu/eu-action/eu-funding-climate-action_en
Through the European Green Deal, the EU is committed to becoming climate-neutral by 2050. On its website, the EU presents the tools it uses to achieve this goal as well as general information related to climate change.
European Comission. Climate Action. EU Action.
https://climate.ec.europa.eu/eu-action_en

Adapterra Awards competition

English website of the Adapterra Awards competition:
https://www.adapterraawards.cz/en/Databaze/2020/Park-u-Rakovacku-v-Rokycanech

Sources

Sources are provided in the following format – Title of the article or page or publication. Name of the website. Date of publication (if available). URL

Infographic **Adaptační strategie České republiky**. Fakta o klimatu. Licencováno pod CC BY 4.0. https://faktaoklimatu.cz/infografiky/adaptacni-strategie-cr

Průvodce změnou klimatu. KlimatickáZměna.cz. https://www.klimatickazmena.cz/cs/vse-o-klimaticke-zmene/pruvodce-zmenou-klimatu/

Šetrné zemědělství v Praze 12. Adapterra Awards. https://www.adapterraawards.cz/cs/Setrne-zemedelstvi-v-Praze-12

Šetrné zemědělství. Praha 12. https://www.praha12.cz/setrne-zemedelstvi/d-81084/p1=85980

About Project. AgroForestrySystems. https://www.agroforestrysystems.eu/en/

Rozvolnění koryta štěrkonosné řeky Bečvy. Adapterra Awards. https://www.adapterraawards.cz/cs/Rozvolneni-koryta-sterkonosne-reky-Becvy

Povodí Moravy zahájilo na Bečvě rozsáhlou revitalizaci. Povodí Moravy. http://www.pmo.cz/cz/media/tiskove-zpravy/povodi-moravy-zahajilo-na-becve-rozsahlou-revitalizaci/

Bečva, Černotín. Povodí Moravy OPŽP 2014-2020 projekty v oblasti ochrany životního prostředí. http://opzp2014-2020.pmo.cz/cz/stranka/becva-cernotin/

Protipovodňová ochrana podél Bečvy – revitalizace toku u obcí Skalička a Černotín. Časopis stavebnictví. 2022. https://www.casopisstavebnictvi.cz/clanky-protipovodnova-ochrana-podel-becvy-revitalizace-toku-u-obci-skalicka-a-cernotin.html

Park Pod Plachtami. Městská část Brno – Nový Lískovec. https://www.novy-liskovec.cz/park-pod-plachtami/ds-1140

Park pod Plachtami. Jezírko, zachycující dešťovou vodu ze střech paneláků, přinese během 25 let užitek za půl miliardy korun (Nový Lískovec). Ekolist.cz. 2020. https://ekolist.cz/cz/publicistika/priroda/park-pod-plachtami.jezirko-zachycujici-destovou-vodu-ze-strech-panelaku-prinese-behem-25-let-uzitek-za-pul-miliardy-korun

Znovuoživení Rakovského potoka v Rokycanech. Adapterra Awards. https://www.adapterraawards.cz/cs/Znovuoziveni-Rakovskeho-potoka-v-Rokycanech

Park u Rakováčku v Rokycanech. Adapterra Awards. https://www.adapterraawards.cz/cs/Databaze/2020/Park-u-Rakovacku-v-Rokycanech

Revitalizace Rakovského potoka včetně povodňového parku Šťáhlavská v Rokycanech. Město Rokycany. https://rokycany.cz/revitalizace-rakovskeho-potoka-vcetne-povodnoveho-parku-stahlavska-v-rokycanech-ucs-3/d-905040

Další etapa revitalizace začne stěhováním raků. Město Rokycany. https://www.rokycany.cz/dalsi-etapa-revitalizace-zacne-stehovanim-raku/d-894172

Environmentální park Škrlovec. Adapterra Awards. https://www.adapterraawards.cz/Databaze/2020/Environmentalni-park-Skrlovec

Environmentální park Škrlovec. Uherský Brod. https://ub.pincity.cz/projekty/20-environmentalni-park-skrlovec

Ing. Josef Filip, Ph.D., **Zadržování dešťových vod v městském prostředí a rostlé zástavbě – revitalizace ulic Budovatelů, Stadická a Školní v Roudnici nad Labem.** Voda stavba a voda 2020. https://www.voda2020.cz/files/_start/SEKCE_D.pdf

Rekonstrukce ulic v Roudnici nad Labem. Adapterra Awards. https://www.adapterraawards.cz/cs/Rekonstrukce-ulic-v-Roudnici-nad-Labem

Jan Macháč, Marek Hekrle a kol., **Modro-zelená města. Příklady adaptačních opatření v ČR a jejich ekonomické hodnocení.** 2022. https://www.ieep.cz/wp-content/uploads/2023/04/Machac_Hekrle_Modrozelena.pdf

Otevřená zahrada. Go to Brno. https://www.gotobrno.cz/misto/otevrena-zahrada/

Otevřená zahrada a poradenské centrum NNO. Archiweb. https://www.archiweb.cz/b/otevrena-zahrada-a-poradenske-centrum-nno

Areál Otevřená zahrada v Brně. Adapterra Awards. https://www.adapterraawards.cz/cs/Databaze/2019/Areal-Otevrena-zahrada-v-Brne

Co znamená udržitelnost ve výstavbě? YIT. https://www.yit.cz/aktuality-blog/blog/2022/co-znamena-udrzitelnost-ve-vystavbe

Hospodaření s dešťovkou v SUOMI Hloubětín. Adapterra Awards. https://www.adapterraawards.cz/Databaze/2020/Hospodareni-s-destovkou-SUOMI-Hloubetin

Vyhláška č. 140/2021 Sb. Vyhláška o energetickém auditu. Příloha č. 8. Ekologické hodnocení. https://www.zakonyprolidi.cz/cs/2021-140?text=

Dva regenerované "paneláky" v Novém Lískovci: nejkvalitnější bytové domy v Česku. TZB info. 2005. https://www.tzb-info.cz/2661-dva-regenerovane-panelaky-v-novem-liskovci-nejkvalitnejsi-bytove-domy-v-cesku

Regenerace panelových domů. Městská část Brno – Nový Lískovec. https://www.novy-liskovec.cz/regenerace-panelovych-domu/ds-1147

ARNIKA

2024