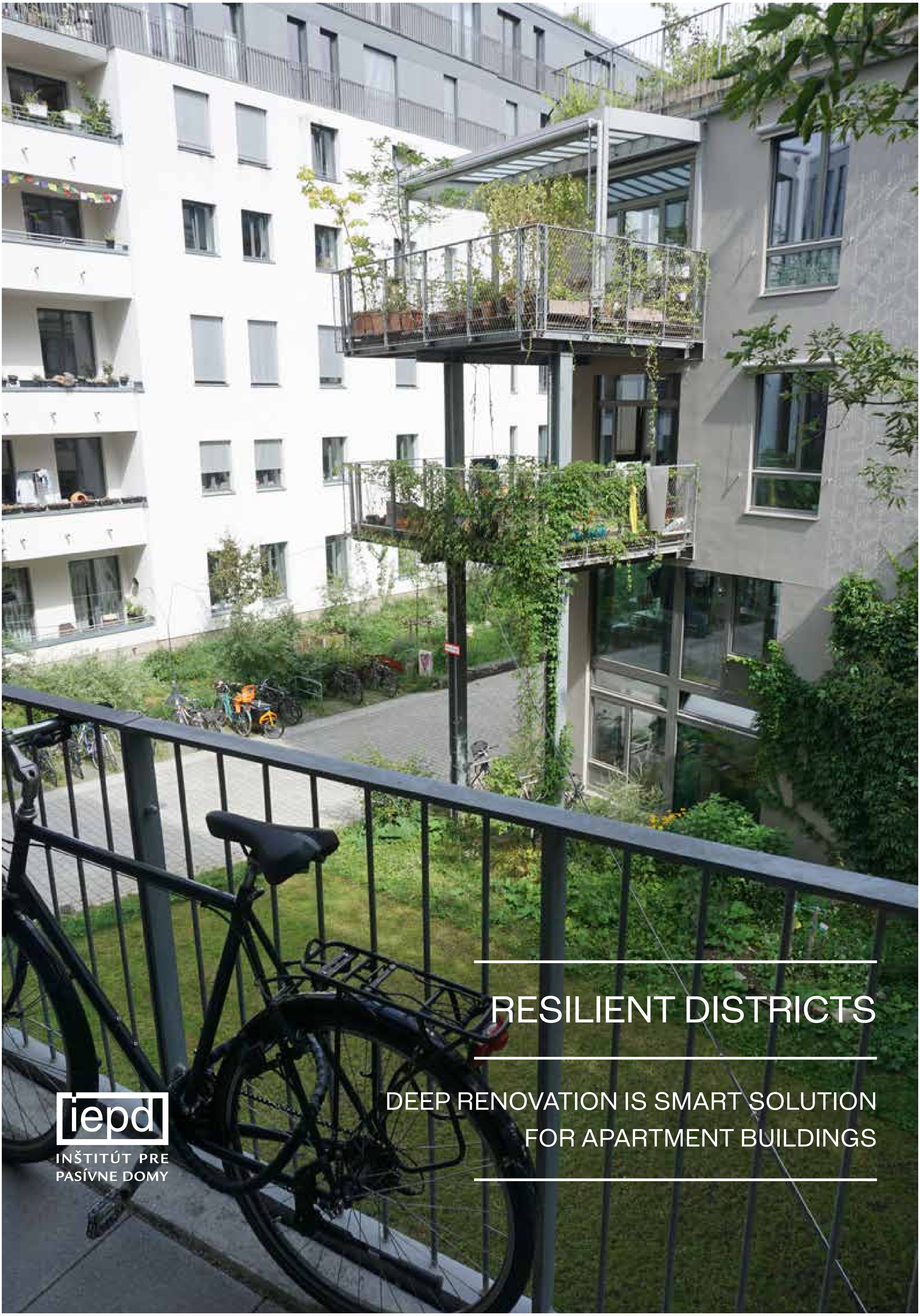

RESILIENT DISTRICTS

DEEP RENOVATION IS SMART SOLUTION FOR APARTMENT BUILDINGS

INŠTITÚT PRE
PASÍVNE DOMY

Editors:
Ing. Ľubica Šimkovicová, Passive House Institute Slovakia
Ing. arch. Ivana Nemethová, Passive House Institute Slovakia

Editors:
Ing. Ľubica Šimkovicová, Passive House Institute Slovakia
Ing. Zuzana Hudeková,
Ing. Vladimír Šimkovic, Passive House Institute Slovakia
Ing. arch. Michal Hybský

Cover photos:
Residential complex Spreefeld, Berlin, Germany. Photo: Vladimír Šimkovic

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Residential complex Bahnhof Heidelberg, passive residential houses, 2020.
Photo: Vladimír Šimkovic

1. MODERN HOUSING ESTATES AS CULTURAL AND SUSTAINABLE URBAN NEIGHBOURHOODS

Urban areas account for 60–80 % of global energy consumption and around the same proportion of CO_2 emissions. [1] Despite their negative impact on climate change to date, cities are also becoming a promising tool for effectively achieving climate goals.

Cities are currently home to 55 % of the global population, projected to reach 68 % by 2050. [2] This projected population growth will put a renewed strain on the building sector, with buildings already responsible for 40 % of global energy consumption and 36 % of associated greenhouse gas emissions, mainly from construction, use, renovation and demolition. [3]

"Cities in Slovakia will be managed in such a way that through a sufficiently varied supply of employment opportunities, adequate housing and services with an emphasis on the quality of the environment, including quality urban and architectural solutions, they provide a healthy settlement environment for a quality life," states the Concept of Urban Development of the Slovak Republic until 2030 [4].

Cities are often highly vulnerable urban ecosystems due to the high concentration of human activities, high development dynamics and intensive use of resources, often at the limits of sustainability. Buildings are an essential element of this ecosystem.

A global transformation of the building and construction sector to energy-efficient and low-carbon is essential to realise the ambition of limiting the global average temperature increase to less than 2 °C above pre-industrial levels by 2030. To avoid conserving the state of energy inefficient buildings for decades to come, the coming decade will be critical to address emissions reductions [5].

Working with the existing building stock and its architecture is an important tool for achieving the set objectives. In our conditions, the settlements of the second half of the 20th century represent an essential part of this fund. Considering prefabricated housing estates as sustainable neighbourhoods fit for life in the future is a challenging but important part of this task. In the spirit of the striking slogan "Don't demolish, transform!" from the pen of Lacaton&Vassal, architects become one of the actors of these changes. It is important to note that the range of solutions does not only include basic renovation in the form of necessary repairs and insulation. There is a whole spectrum of possibilities, from building-structural interventions, to smart-solutions, to working with public space.

In addition to energy efficiency, such adapted, renovated and newly built housing units will also gain a population identified with their neighbourhood. In short, settlements can be cultivated and at the same time can be cultivated.

2. CURRENT PRACTICE OF URBAN RENEWAL OF SETTLEMENT STRUCTURES

Buildings in Slovakia are constructed according to standards established mainly in the second half of the 20th century on the basis of the climatic conditions, technical possibilities and quality of construction at that time. Therefore, they are not adapted to provide their users with comfort and a healthy environment in the new climatic conditions [6].

The basic function of a town or village is housing. The renovation of residential buildings and the improvement of their energy efficiency is one of the most important tasks to be addressed by the municipality in cooperation with the owners of residential buildings and residential districts in the case of newly-built residential buildings. The quality of the living environment has a direct impact on the quality of life in the city and it is in this context that the city is currently facing major challenges. The approach to the renovation of buildings has changed radically in recent decades. Environmental requirements for the renovation of buildings should go hand in hand with requirements for interventions in the architecture of the interior and exterior of the building.

THE MAIN OBJECTIVE OF THE RENOVATION OF APARTMENT BUILDINGS IS USUALLY:

- removal of disrepair and static defects: balconies, sheeting, parapets, plaster, façades, elevators, staircases, masonry (walls) on the ground floor of buildings, storm drains and basements
- elimination of system failures of buildings and system failures of prefabricated buildings
- elimination of roof leakage over staircases, problems of leakage into the 1st floor (basements) during heavy rains
- to eliminate the problem of damp masonry (walls) in common areas, staircases and apartments, especially on the ground floors and basements of buildings
- to bring the quality of construction in line with the requirements of current technical standards to increase the energy efficiency of buildings
- to improve the quality of the indoor environment
- to achieve a suggestive restoration of the original façade and the restoration of the original façade, especially in terms of architecture, construction and materials on listed buildings
- the use of spaces on the top floor, in the basements of buildings (cellars) for housing and possibly also the use of spaces for commercial purposes [7].

Faced with the challenges of climate change, rapid urbanisation and the impact of the COVID 19 pandemic, there has never been a more important time for architects and building professionals to contribute to this pressing global agenda.

Residential house Karlova Ves, renovated façade, 2020.
Source: iEPD

3. HISTORY OF CONSTRUCTION OF APARTMENT BUILDINGS IN SLOVAKIA

Mass housing construction became both a consequence and an immediate part of the modernisation process and social transformation in the second half of the 20th century. Although objections to mass housing had been raised since the early 1960s, more comprehensive analyses of the problems waited until the 1980s. The criticism of this method of construction, which was part of the official agenda of the authoritarian regime, became fully manifest only after its fall in 1989.

Mass housing construction, on the other hand, has contributed substantially to solving the housing shortage problem. After all, during the years of construction of housing estates, more than 1.2 million flats were built in Slovakia, which provided their inhabitants with housing of a very decent spatial and hygienic standard [8].

Various types of residential buildings and construction systems T11 to 16, T03 B, PV-2, BA, G-57, LB (MB), MS 5, MS 11, T 06 B (regional variants Košice, Žilina, Banská Bystrica, Bratislava and Nitra) and T 08 B were used for the construction of residential buildings until 1970. After 1970, the regional variants of the T 06 B construction system continued to be used in construction, but new systems also began to be used. The structural system was followed by the ZT and ZTB panel system, construction in the Bauring Camus (B-BC), B-70 and BA-NKS structural system with layered perimeter elements. After 1983, a new stricter thermo-technical standard was in force, construction was carried out almost exclusively in building systems P 1.14 and P 1.15. The envelopes after 1970 were layered [9].

4. CURRENT STATE OF APARTMENT BUILDINGS BUILT UNTIL 1991 IN KARLOVA VES

Almost the entire housing stock in Karlova Ves is renewed (approximately 80 % renewed). The renovation of apartment buildings has been carried out for about 20 years. It was inevitably necessary to start solving in particular the removal of system failures in apartment buildings, which were not caused by neglect of maintenance and repairs by the users of the apartments, but have their origin in the incorrectly used construction technology, in a faulty design solution, in incorrectly designed materials or in non-compliance with the proposed procedure for the implementation of the construction [3].

For buildings older than 30 years, it is efficient to carry out a comprehensive renovation of the building, including the removal of system faults. Comprehensive renovation includes the replacement of internal piping (gas, water, central heating, wiring), modernization or replacement of elevators, replacement of window openings to ensure sufficient air exchange, increase the thermal protection of roof and building envelope, as well as dividing structures between heated and unheated spaces by insulating them [9]. A qualitative diagnosis of the current state of the buildings concerned can only be carried out on the basis of a reassessment and processing of the design documentation of the existing state (not the subject of this activity).

In determining the scope and sequence of renovation, it is important to know the complex structural design of apartment buildings of different types, structural systems and building systems, the principles of structural design, materials of composition and the solution of details [9].

The applied degree of renovation of individual apartment buildings was implemented depending on the time of implementation and therefore on the applicable legislation and requirements for energy efficiency of buildings at the time of implementation of the renovation as well as on the professional maturity on the part of the client as well as the contractor of the construction works. The primary aim of the renovation was often to remove system faults and thus allow safe use of the building as well as to reduce energy consumption. This is one of the reasons why there has often been no significant reduction in energy consumption after renovation.

Apartment housings in Karlova Ves are built in panel systems ZT and ZTB, Dlhé Diely was built in panel system P1.14-15.

Residential house Kempelenova, Karlova Ves.
Source: iEPD

HEATING SYSTEM, HEAT SOURCE

Usually, apartment buildings in Karlova Ves are connected to the District Heating System (DHS). In the basement of the apartment building or nearby are located substations for the needs of heating and hot water preparation. The original heating system usually encounters several problems. The biggest of these is controllability and losses in the distribution system. After energy-saving measures, the heat losses of the building are significantly reduced. The regulation of heating elements is often in poor technical condition, the control valves often do not work and therefore the users have them fully open and in case of high temperatures they regulate the temperature in the room simply by opening the windows.

The most common modifications to the heating system to ensure that the necessary savings are achieved after the heat losses of the building have been reduced by modernization:

- re-regulating the heating system to a lower temperature gradient, resulting in a significant reduction of heat losses during distribution
- use of thermostatic valves on radiators, which automatically regulate the consumption according to the set temperature
- insulation of heat and hot water pipes with thickness up to twice the pipe diameter

Duct insulation is often neglected and minimal insulation thickness is used.

DISTRICT HEATING SYSTEM – DHS

After 1990 – together with social changes, the phenomenon of disconnection from the DHS system appeared as a result of the bankruptcy of companies that operated co-generation plants supplying heat to the DHS system of adjacent residential zones. The DHS system often disintegrated due to the fact that the owner, usually the municipality, was not able to ensure the operation and maintenance of the DHS system and the efforts of the inhabitants to solve the problem of the price of the supplied heat or the quality of the heat supply.

The supplier of heat for Karlova Ves and Dlhé Diely until 2022 was Bratislavská teplárenská, a.s., which owns and operates the two largest DHS systems, while covering several city districts at the same time. Since 2023 it belongs to MH Teplárenský holding. Both systems are supplied with heat from gas-fired combined heat and power generation. The DHS system Bratislava – Západ in the city districts of Dúbravka and Karlova Ves, including the locality of Mlynská dolina, provides heat supply by its own source. West heating plant with an installed thermal capacity of 242 MWt and an installed electrical capacity of 25 MWe. In 2017, it started operation of renewable energy sources (RES), solar DHW systems and commissioned an absorption chiller unit. The external source Cogen WEST supplies heat to the DHS system BA – Západ.

The company produces heat and electricity in a so-called combined way. It combines heat and power – CHP. BAT used natural gas, the combustion of which produces steam at high pressure in the boilers. The steam is then fed to a turbine, which is connected to an electric generator. The steam is discharged from the turbine to the steam--water exchanger.

Most of the apartment buildings are connected to the DHS, only a few apartment buildings have disconnected (until the amendment of Act No. 100/2014 Coll. on thermal energy, which is valid since 1 May 2014) and built their own boiler room with gas boilers.


Residential house Hlaváčikova, Dlhé Diely
Source: iEPD

VENTILATION

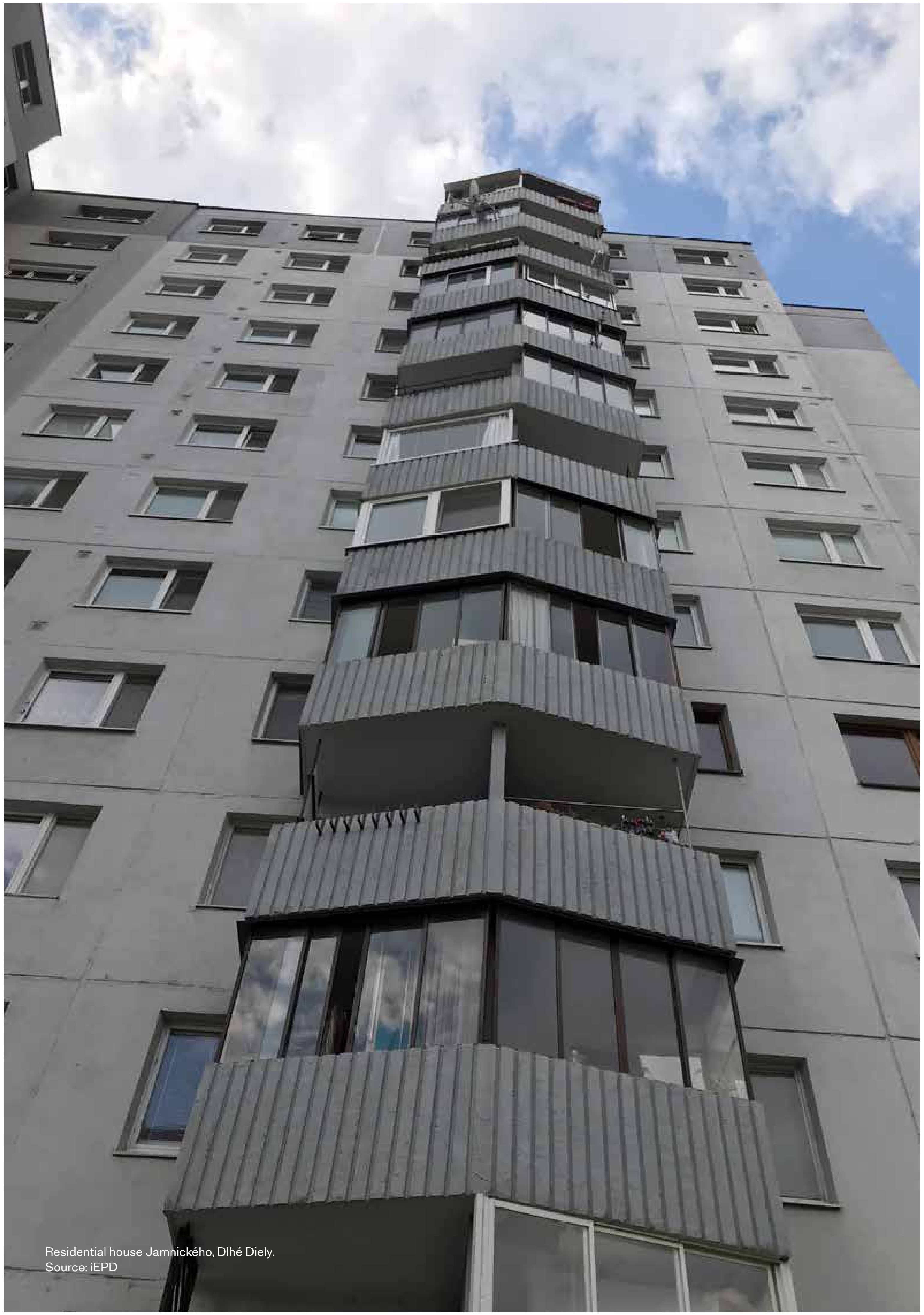
Ventilation in the apartment building is usually solved by forced ventilation of the kitchen hood, bathroom and toilet, by a common pipe in the technical shaft. Another problem is the inappropriate choice of materials used, where asbestos cement predominates. The supply of fresh air is not solved by a separate duct, only infiltration is used, which is created by under pressure or overpressure when the wind acts on the facade. In this way, it is not possible to control the intensity of air exchange, nor to ensure the hygienic requirement for air exchange in accordance with the applicable standard. Thanks to new windows and insulation systems, ventilation through infiltration is reduced. In an apartment where there were once leaky windows and a cladding without insulation, there is up to more than a 10-fold reduction in natural ventilation compared to the original state. Tight envelope and inadequate ventilation results in an increase in relative humidity above 60 %, which, together with the low surface temperature on the internal structures, causes the formation of mould. At the same time, the CO_2 concentration increases, which has a negative impact on the health of the users.

AIRTIGHTNESS OF THE STRUCTURE

Airtightness in unrestored buildings is usually too high, adversely affecting the quality of the indoor environment as well as heat loss through infiltration. Common circulation areas, stairwells, and elevator shafts are not sufficiently sealed and the air flow in the heating season significantly increases the heating demand in the heating season.

THERMAL BRIDGES

A thermal bridge is a location in the energy envelope of a building through which an increased amount of thermal energy passes locally between the interior and exterior, compared to the surrounding structure. Thermal bridges are structural and geometric, they arise as a result of structural deficiencies in the design of building systems, improper insulation technology – degradation of insulation on perimeter walls, improper installation of replaced windows, non-insulation of balcony panels and side parts, protruding elements (attics, anchoring elements, etc.), connection of structures (windows, roofs, ceilings, joints of panels), etc. Significant thermal bridges occur between heated and unheated spaces. The consequence of thermal bridges is a reduction of the surface temperature on the inner surface of the building energy envelope (walls, ceilings, floors, openings, etc.), resulting in condensation of air humidity and the creation of an environment for the formation of mould. Combined with inadequate ventilation, the quality of the indoor environment deteriorates significantly.



Residential house Jamnického, Dlhé Diely.
Source: iEPD

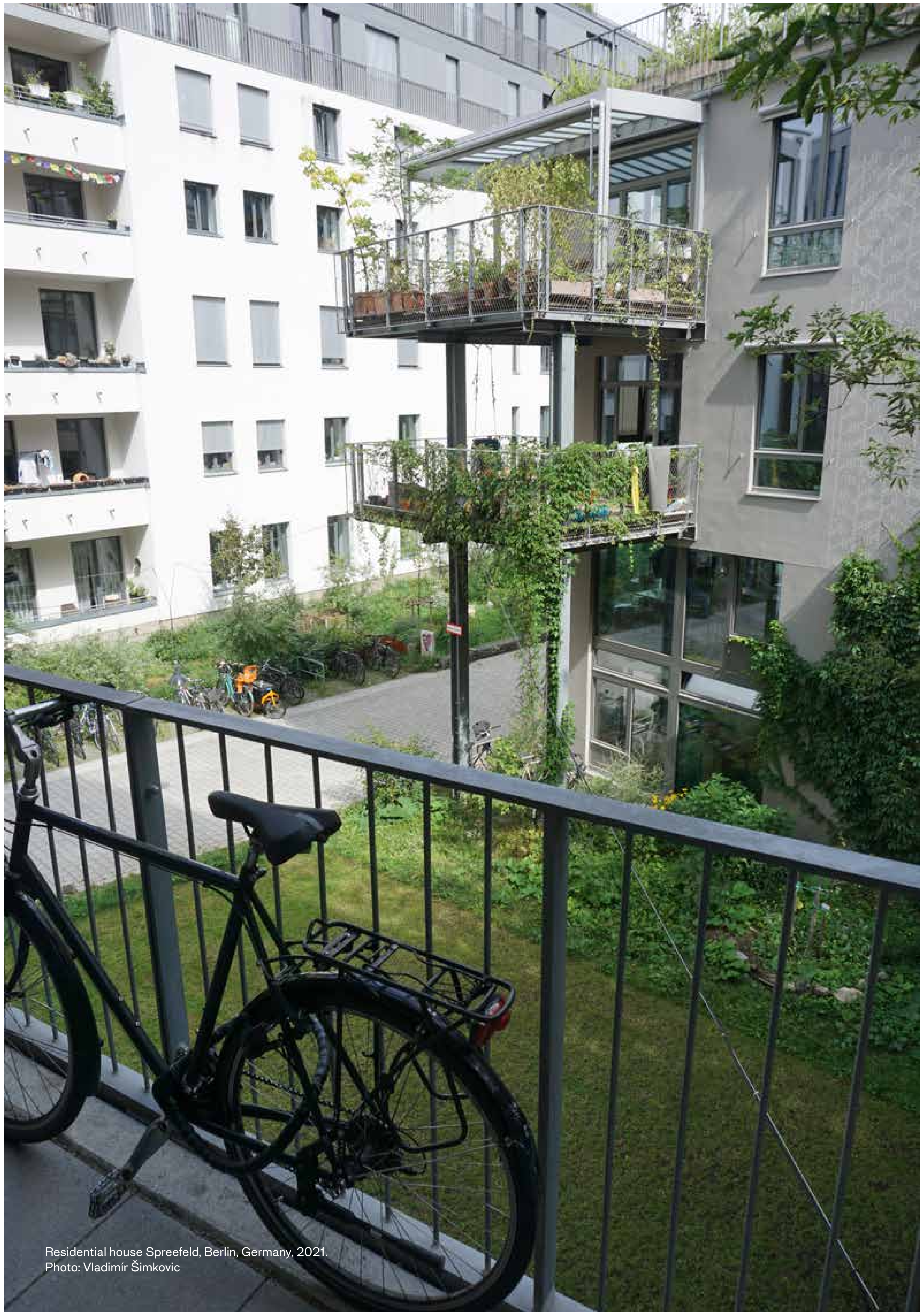
SUMMER THERMAL PROTECTION

Protection against overheating of the interior is usually solved by internal shading or inter-window blinds, which, however, insufficiently eliminates the heat load in the summer period. Therefore, air-conditioning units are often seen installed on the facade of apartment buildings or loggias, which although they reduce the temperature in the air-conditioned spaces, but contribute mainly to increasing the temperature in the vicinity of the installed outdoor part of the unit (it removes heat from the air-conditioned spaces), there is also acoustic discomfort in the surroundings. Rarely are shading awnings installed on loggias, or outdoor shading elements that can significantly eliminate overheating of the interior. In addition, insufficient thermal insulation of the roof cladding leads to overheating of the living spaces on the top floor, where often no other solution is possible than the installation of air conditioners.

APARTMENT BUILDINGS CURRENTLY SUFFER MAINLY FROM THE FOLLOWING PROBLEMS:

- Insufficient thickness of the thermal insulation envelope of the building, usually insulation thickness of 20 – 80 mm is used in the renovation of an apartment building,
- insufficient thermal insulation capacity of the roof sheathing, problems with the integrity of the waterproofing and the continuity of the plumbing elements – sheathing, overheating of the upper floors,
- underground, basement, non-residential premises suffer from leakage through plinths, overflow through windows, damp walls and mould,
- existing thermal bridges in the structure as well as between heated and unheated spaces, most of the original windows were replaced with windows with a plastic frame with a high degree of tightness, which reduced the extent of the original joint infiltration (joints at the junctions of the frame and lining, blowing through the window sashes), and thus the ventilation of the interior, with consequent problems caused by increased humidity and condensation,
- summer overheating of residential and non-residential premises, without the possibility of reducing the heat by night ventilation through the windows, due to the accumulated heat in the structure – perimeter walls, loggias, roof cladding, etc.

The current state of residential buildings is still marked by incorrectly used construction technologies, faulty project design of renovation, insufficient scope of renovation, especially in terms of the extent of insulation and the thickness of the insulation used, does not meet the requirements of STN 72 0540 (Thermal protection of buildings, Thermal properties of building structures and buildings), especially in terms of energy efficiency, as well as hygiene. In the case of buildings that have not been renovated, the safety aspect in particular is already crucial, given the system failures that are present.



Residential house Spreefeld, Berlin, Germany, 2021.
Photo: Vladimír Šimkovic

5. QUALITY AND CULTURE OF THE LIVING ENVIRONMENT

An idea of the culture of the residential environment and its changes in the issue of housing estates can be gained by a short comparison. Comparing the values of former modernist architects with those of contemporary construction actors, we find a number of important differences.

The idea of the modernists was a hygienic, well-lit, but also uniform, typified solution to the housing question. By virtue of its uniformity and repetitiveness, it was also intended to be a solution accessible to different social groups. Repeatability and availability led to industrialization and prefabrication. This creates a group of attributes that are an apt characteristic of prefab housing. The contemporary view of quality residential environments largely processes the experience of prefabrication and housing estate life. Both in a positive and negative sense. While housing affordability is still a fundamental value, uniformity and mass constructing are rarely found as qualities in the vocabulary of contemporary architecture. More fundamentally, however, contemporary vision brings a new framework of thoughts. The framework is the sustainability triangle, figuratively a trio of interlinked concepts: environmental, social and economic sustainability.

This trio brings a holistic view of the quality of housing and architecture. Each of the trio of concepts uses a range of tools that seeks to make buildings more resilient. On the environmental side, we are talking, for example, about energy efficiency and appropriate design (see e.g. Chapter 2). On the social side, we are talking about the participation of the inhabitants in the choice of solutions for a given location, so-called participation, or the creation of opportunities for the emergence of a community (see e.g. Chapter 12). On the economic side, we are talking about affordability or construction financing.

In general, there has been a shift in thinking about the values and quality of housing from a strongly anthropocentric position in the modernist sense, to a holistic position, taking into account a broader spectrum of aspects of contemporary society and the world.

6. CASE STUDIES OF TWO APARTMENT BUILDINGS IN KARLOVA VES

Although most of the residential buildings in the Karlova Ves district have already been renovated, it still represents a great potential for energy savings, because the current scope of the renovation covers mainly the necessary repairs of the buildings aimed at eliminating systemic defects – such as roof leakage, façade defects, including thermal protection (currently mostly with insufficient thickness of the insulation material, although in accordance with the regulations in force at the time when the renovation was carried out), replacement of windows, and so on.

The Karlova Ves residential complex is the first prefabricated housing estate built in Bratislava on significantly sloping terrain. The construction programme envisaged more than 7,000 flats, adequate school, commercial, medical and other facilities, part of which was to be concentrated in its own centre close to the Danube River. This residential complex was evaluated as the best post-war urban solution in Slovakia and successfully represented our architecture abroad, e.g. at the Grand Prix in Cannes and many professional exhibitions and events. At the end of the 90s of the last century, the construction of the so-called complex housing construction in Karlova Ves was already finished and the housing estate was being completed mainly by landscaping and orchard landscaping.

Another multi-purpose centre is being built on the site of the original horticultural centre. Instead of the originally envisaged green space, several multi-storey residential buildings were built in multifunction with civil facilities and church and community facilities. This cultural and social centre was complemented by the construction of low-rise urban villas on the gently sloping terrain. In the old development, some low-rise “prefabricated buildings” have changed their shape by adding attic flats, providing suitable housing [10].

In the Karlova Ves valley, the architects‘ goal was to find a compromise for a functional layout while respecting the views offered by the undulating terrain. Individual housing units have three height levels – 4, 6 – 8, 12 storeys, where they were divided into low-rise buildings, 50 % of the buildings were mid-rise buildings, oriented in the east-west direction, finally the highest were tower houses. All deployed to create a dynamic structure [11].

The architects designed the housing estate as a strongly graduating mass composition, succeeding in creating one of the most diverse housing estates in the city. The characteristic figure of the urban structure is a block with a U-shaped plan. It consists of two four-storey apartment buildings, which define a specific semi-public inner-block space [10].

The proposal also raised the issue of parking, where the authors sought to respond to indications of future motoring expansion. The solution envisaged off-street intersections or parking spaces, garages, but encountered complications during approval.

Residential house Kempelenova-inner block, Karlova Ves, 2019.
Source: iEPD

Residential house Silvánska-partial renovation, Karlova Ves, 2019.
Source: iEPD

The Dlhé Diely housing estate entered the panorama of the city in a visually exposed location as the last complex project of prefabricated housing complexes at the end of the 1980s. Dlhé Diely was supposed to be an example of a new individual approach to the design of residential complexes, starting with the urban composition and ending with the shaping of individual residential complexes. The construction of the residential complex on the steep slopes above the Danube in the immediate vicinity of the Karlova Ves housing estate began in June 1987. The high density of development and the monotonous height level of most eight-storey buildings were to be compensated by the articulation of small architectural scale of diverse atypical elements, balconies of loggias, as well as for the first time applied distinctive colouring of prefabricated apartment buildings. The construction of prefabricated apartment buildings was only completed in the mid-1990s [10].

The settlement is still under pressure of new construction and densification due to its attractive location near the Danube River and the Devínská Kobyla massif, as well as the accessibility of the city centre [11].

SELECTION OF TWO APARTMENT BUILDINGS – RESTORED AND UNRESTORED

For the purposes of the case study, two apartment buildings were selected. The first one on Karloveská 57, Levárska and Silvánska streets was restored, the second one not restored on Pribišova 33 – 37 street. For both buildings were gradually implemented inspections, meetings with representatives of residential buildings, securing project documentation, analysis of the provided documents on energy and gas consumption, meetings of a multidisciplinary team consisting of internal and external experts from the Slovak Chamber of Architects and from the DELIVER project team, consisting of: Ing.arch. Pavol Paňák, Ing.arch. Pavol Pokorný, Ing.arch. Michal Hybský, Ing. Vladimír Šimkovic, Ing. Zuzana Hudeková PhD. a Ing. Ľubica Šimkovicová. Subsequently, energy optimizations for both apartment buildings were developed in turn, using the specialised Passive House Planning Package (PHPP) calculation software developed by the Passivhaus Institut in Darmstadt. Based on participatory meetings with residents, inspections and recommendations from the energy optimization using PHPP, a multidisciplinary team followed up and developed a proposal for an architectural solution for the renovation of both apartment buildings.

The data obtained from the results of the individual activities provided the basis for the analysis of the potential energy savings and CO_2 emissions of the housing stock of the Municipality of Bratislava-Karlova Ves, and the quantification of the indicators.

Residential house Pribišova - before renovation, Dlhé Diely.
Source: iEPD

7. ARCHITECTURAL STUDIES OF SELECTED APARTMENT BUILDINGS: ARCHITECTURAL AND TECHNICAL DESIGN, ENERGY PERFORMANCE ASSESSMENT, PROPOSAL OF MEASURES TO REDUCE ENERGY CONSUMPTION

“The hardest thing about this topic is achieving a holistic result. That is, one that meets the requirement to minimise the energy costs of using the apartment, whose added value is the extension of its spatial and surface quality, which is a new aesthetic and architecturally valuable layer on the body of architecture. In addition, the aim of these re-claddings should be to interpret the original tectonic identity, the legibility of the underlying structural system, etc. Ultimately, it is about adding a new cultural layer that speaks to our current values and aspirations.” says Ing. arch. Pavol Paňák from Architekti A B.K.P.Š. and member of the multidisciplinary team.

APARTMENT BUILDING KARLOVESKÁ 57

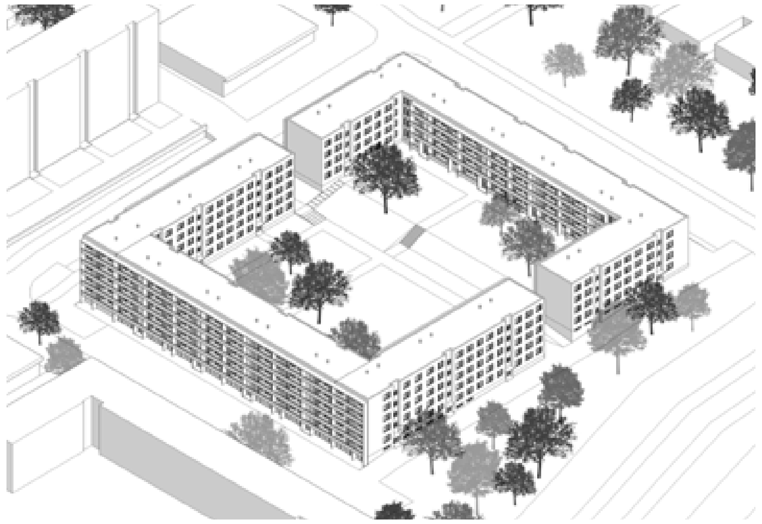
Architectural solution

The concept of the reconstruction of both panel houses is based on a thorough analysis of the structural system, evaluation of its technical condition and examination of the potential of possible interventions with regard to defining new requirements for the building in its current historical situation (increase in energy efficiency and user comfort of individual flats). The ZT panel system allows architectural access to continuous loggias. This intervention is primarily generated by the requirement for a renovation often affected by system failures, a structure structurally independent of the main building, a suitable spatial concept can achieve both desired benefits – extension of the inadequate layout of the kitchen/living space (in both variants A+B) + streamlining of the protection against summer overheating. The basic approach to renovation in the form of replacement of window openings, insulation and elimination of thermal bridges is considered self-evident and automatic.

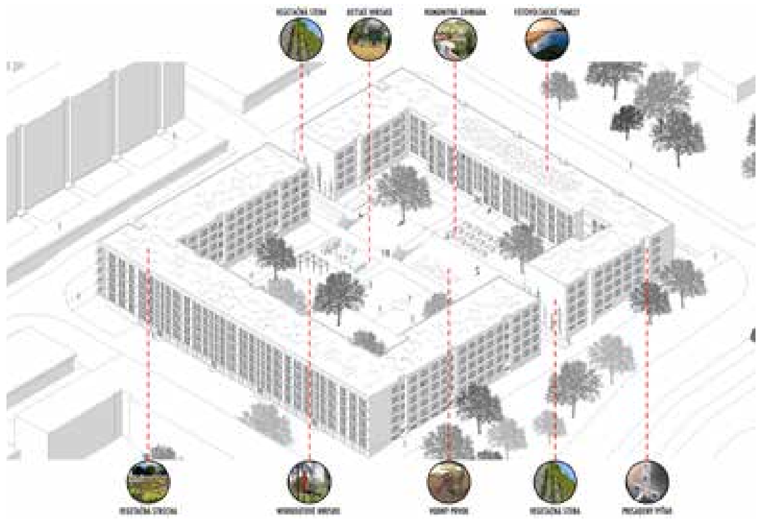
Technical solution

The subject of the solution was the identification of the existing state of the buildings, the design of architectural modifications and the subsequent energy assessment and optimization of the energy performance of the building. The activity consisted of several sequential steps. The first was to compare the current energy consumption for heating, hot water preparation with the calculated values. For this purpose, we used PHPP (Passive House Planning Package, developed by the Passivhaus Institut in Darmstadt, Germany), which is designed for the design of passive houses, and is also recommended for the design of buildings with almost zero energy demand. We obtained the actual energy consumption from the invoices provided by the representatives of the apartment owners‘ association. Next, based on the determined parameters of the building, we proposed alternative solutions for architectural modifications. The resulting adjustments, together with the design of technical measures, were transferred into the PHPP calculation and in the second phase the buildings were energy optimised. Description of measures to reduce the energy consumption of the residential building in order to reduce CO_2 emissions: Apartment buildings Karloveská 57-59, Levárska 1-7, Silvánska 18-20, Municipal district Bratislava-Karlova Ves were built in 1966–68. Apartment buildings form two blocks between which an inner block is created. In 2008, the apartment buildings were partially restored, insulation of the facade EPS thickness 20–80 mm, insulation of the roof cladding 200 mm EPS. The PHPP calculation captures the existing condition after reconstruction. The specific heat demand for heating, as one of the main parameters for assessing the energy performance of the building, is at the level of 68 kWh/m^2.a.

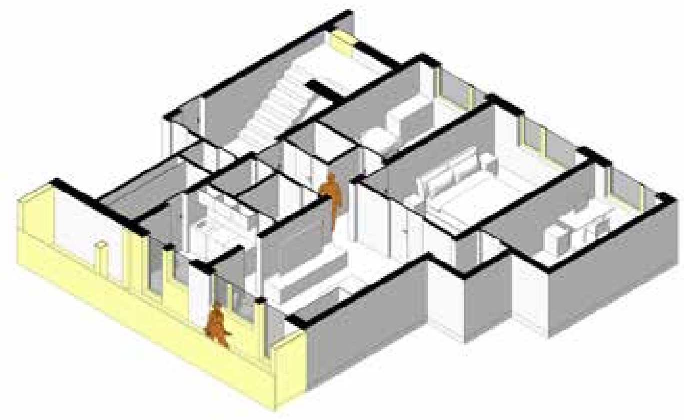
Residential house Karloveská, existing situation



Residential house Karloveska, variant 1 with a description of the measures



Structural interventions at the level of the apartment for variant 1, south side



Adapted apartment variant 1, south side

Structural interventions at the level of the apartment for variant 1, north side

Adapted apartment variant 1, north side

Residential house Karloveská, visualisation of variant 1

Description of measures to reduce the energy consumption of the apartment building in order to reduce CO_2 emissions

1. Building envelope – improving thermal insulation properties
- façade: original U = 0.389 W/m².K, proposed U = 0.186 W/m².K
- gable walls: original U = 0.362 W/m².K, proposed U = 0.176 W/m².K
- roof sheathing: original U = 0.162 W/m².K, proposed U = 0.157 W/m².K (addition of substrate for extensive roof vegetation in the roof sheathing) – application of roof substrate to create an extensive vegetation layer in combination with light-coloured gravel spreading to reduce the heat load and overheating in the attic spaces during the summer period
- improvement of thermal insulation properties also of structures above unheated basement spaces

2. Elimination of thermal bridges
- elimination of thermal bridges preferably from the balcony slabs, by extending the space and creating a separate supporting structure without a direct surface connection to the building of the apartment building

3. Airtightness of the structure
- improvement of the air permeability degree of the building envelope from the assumed n_{50} = 3/hr. to n_{50} = 1/hr. as for low-energy buildings – this parameter can be verified by measuring the air permeability with the so-called BlowerDoor test

4. Transparent construction-improvement of thermal insulation properties
- replacement of windows with plastic windows with better parameters: in the calculations considered frames Uf = 0.79 W/m².K – change of glazing, improvement of parameters Ug = 0.73 W/m².K

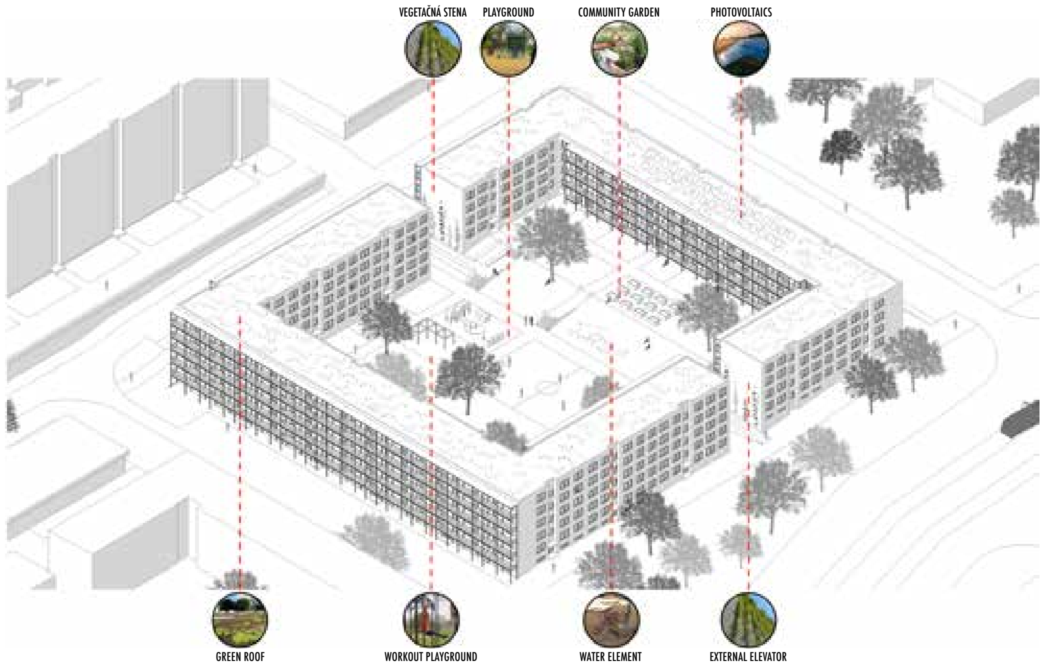
5. Reduction of heat load
- installation of exterior shading elements on window structures with East, South and West orientation – vegetative installation of shading elements on gable walls in order to reduce the heat load in the summer period

6. Technical systems
- installation of controlled ventilation systems for each housing unit separately with a common air supply with the possibility of adjustment and separate exhaust through the facade. anticipated efficiency of recuperation at the level of min. 75 %

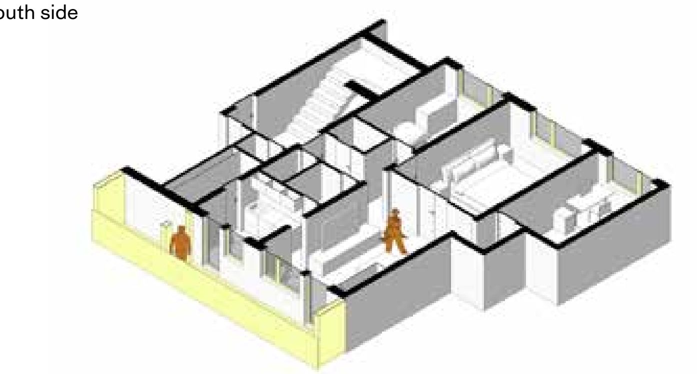
7. Other measures
- addition of vegetation and water features in the immediate vicinity of the apartment building, especially in the enclosed central part in order to improve air quality as well as noise and dust parameters of the environment addition of hot water lines supplying the building of the apartment building with energy consumption meters to control the invoiced heat supply
- consideration of the possibility of disconnecting the apartment building from the remote heat supplier and building a separate source of heat and hot water based on heat pumps in the ground/water system with sizing for the expected lower heat losses of the building.

Conclusion: The proposed measures will result in a reduced specific heating demand of approximately 23,6 kWh/m².a, i.e. only 1/3 compared to the current situation. This can be matched by a reduction in CO_2 emissions depending on the method of production, distribution as well as the heat source used, not to mention an overall increase in the quality of the indoor as well as outdoor environment.

Residential house Karloveska, variant 1 with a description of the measures

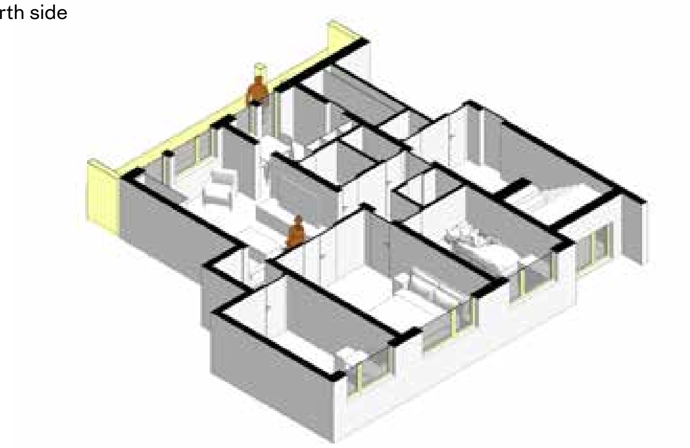


Structural interventions at the level of the apartment for variant 2, south side



Adapted apartment variant 2, south side

Structural interventions at the level of the apartment for variant 2, north side



Adapted apartment variant 2, north side

Residential house Karloveská, visualisation of variant 2

APARTMENT BUILDING PRIBIŠOVA 37

Architectural solution

The concept of reconstruction of the panel house is based on a thorough analysis of the structural system, evaluation of its technical condition and examination of the potential of possible interventions with regard to defining new requirements for the building in its current historical situation (increase in energy efficiency and user comfort of individual flats). The panel system P1.14 does not allow for a significantly formative architectural input into the overall expression of the building with the ambition of a legible change in tectonic signature. Even so, it is possible to define details in detail, by updating which it is possible to achieve a significant improvement in both architectural, thermal-technical and structural parameters. The basic approach to renovation in the form of replacement of window openings, insulation and elimination of thermal bridges is considered self-evident and automatic.

Technical solution

The subject of the solution was to determine the current state of the building, the design of architectural modifications and the subsequent evaluation and energy optimization of the energy performance of the building. The proposals were preceded by a comparison of the actual energy consumption for heating, hot water preparation with the calculated values. For this purpose we used the PHPP (Passive House Planning Package, developed by the Passivhaus Institut in Darmstadt, Germany) calculation software, which is designed for passive houses and is also recommended for near-zero energy buildings. Based on the established parameters of the building, they proposed alternative solutions for architectural modifications. The resulting modifications together with the design of technical measures were transferred into the PHPP calculation and in the second phase the building was energy optimised.

Description of measures to reduce the energy consumption of the apartment building in order to reduce CO_2 emissions

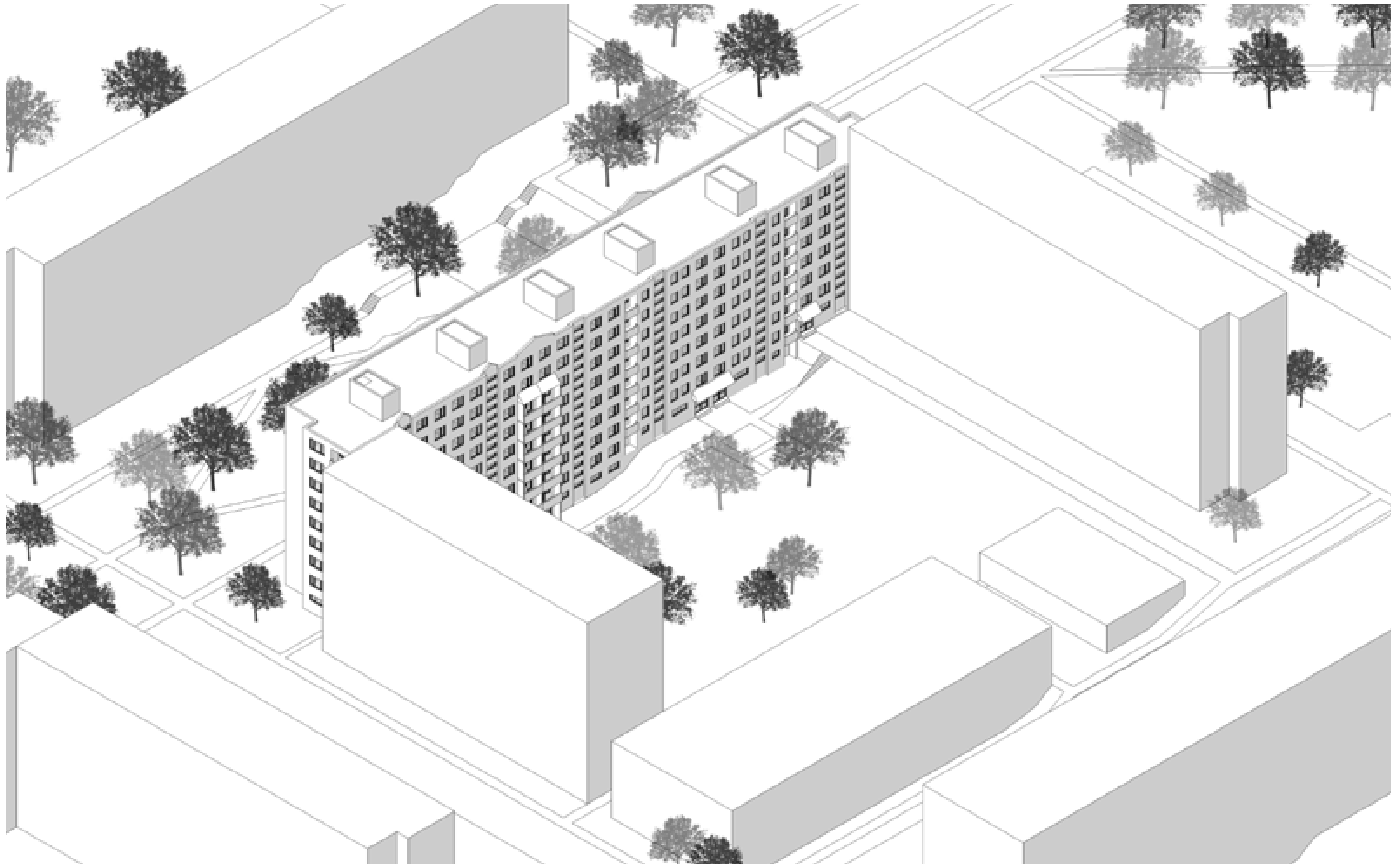
Apartment building Pribišova 27-37 in Dlhých Diely, Municipal district Bratislava – Karlova Ves was built in 1990 – 92, underwent partial reconstruction – insulation of the roof cladding in 2017, the PHPP calculation captures the state after reconstruction. The specific heat demand for heating, as one of the main parameters for assessing the energy performance of the building, is at the level of 68 kWh/m^2.a.

The following measures are proposed:

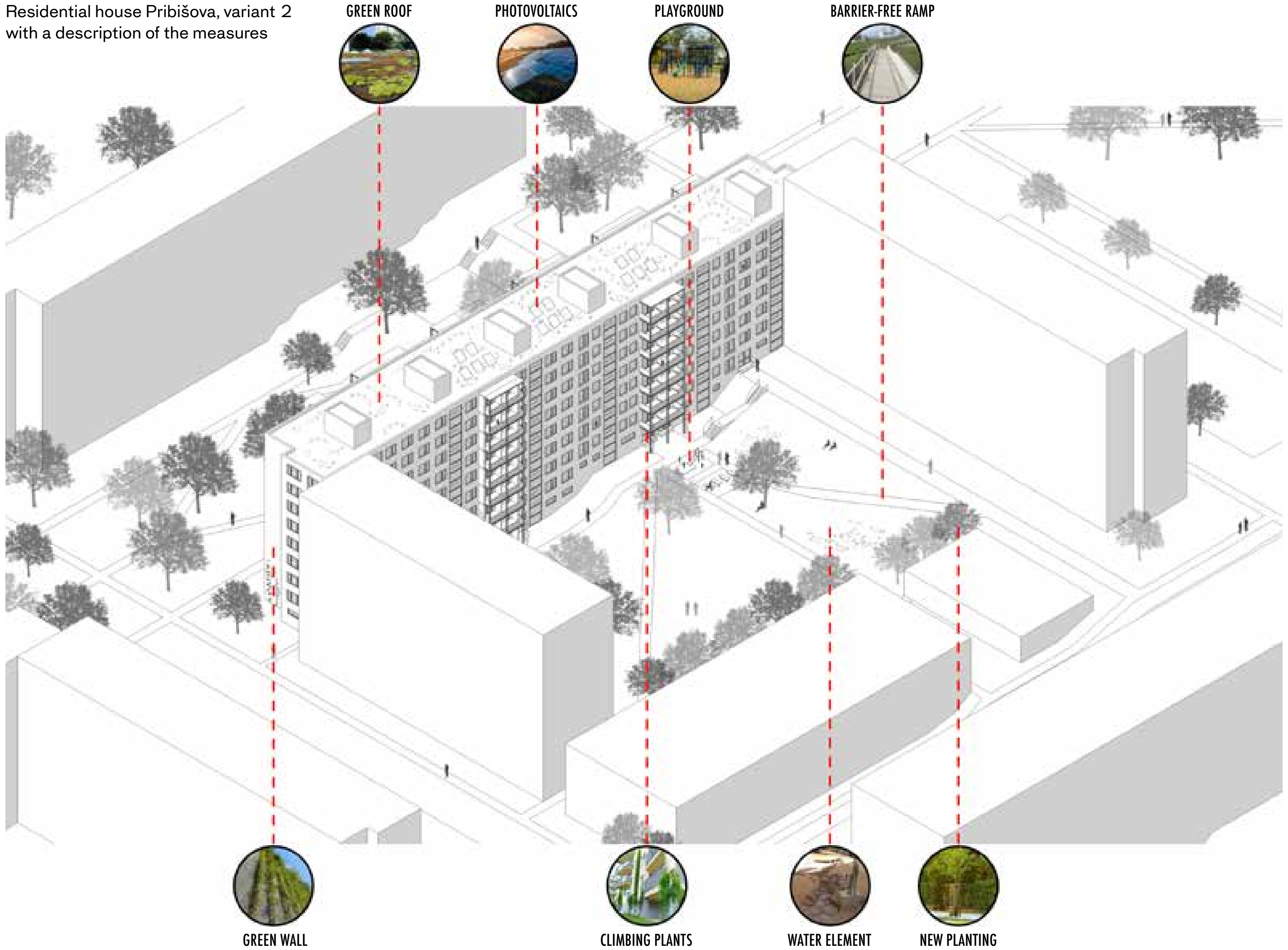
1. **Building envelope – improving thermal insulation properties:**

- façade: original U = 0.681 W/m^2.K, proposed U = 0.153 W/m^2.K
- basement: original U = 0.427 W/m^2.K, proposed U = 0.187 W/m^2.K
- roof sheathing: original U = 0.188 W/m^2.K and proposed U = 0.128 W/m^2.K (in the case of roof sheathing, addition of substrate for extensive roof vegetation)
- improvement of thermal insulation properties and structures above unheated basement spaces – application of light-coloured gravel embankment to reduce heat load and overheating in the attic spaces during the summer period

residential house Pribišova, existing situation



Residential house Pribišova, variant 2 with a description of the measures



2. **Elimination of thermal bridges**
- elimination of thermal bridges preferably from the balcony slabs, by extending the space and creating a separate supporting structure without a direct surface connection to the building of the apartment building

3. **Air permeability of the structure**
- improvement of the air permeability degree of the building envelope from the assumed n_{50} = 3/hr. to n_{50} = 0.6/hr. as for passive buildings

4. **Transparent structures**
- improvement of thermal insulation properties – replacement of windows with plastic frames with Uf = 0.75 W/m^2.K, change of glazing, improvement of parameters Ug = 0.73 W/m^2.K – installation with pre-set windows fitted completely into the plane of the new thermal insulation is considered

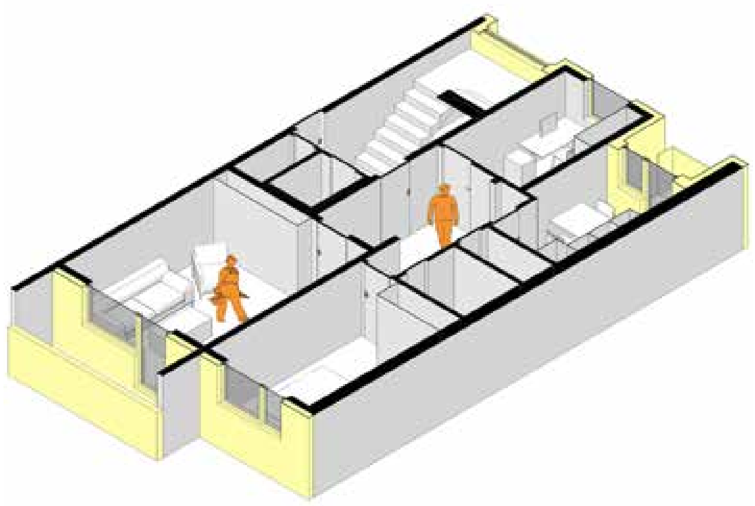
5. **Reduction of heat load**
- installation of exterior shading elements on window structures with East and West orientation – installation of shading elements on façade walls in order to reduce the heat load in summer

6. **Technical systems**
- installation of controlled ventilation systems for each housing unit separately with a common air supply with the possibility of adjustment and separate exhaust through the facade. anticipated efficiency of recuperation at the level of min. 85 %

7. **Other measures**
- addition of vegetation and water features in the immediate vicinity of the apartment building, especially in the closed central part in order to improve air quality as well as to improve noise and dust parameters of the intra-block environment
- addition of hot water lines supplying the apartment building with energy consumption meters for control of invoiced heat supply. Consideration of the possibility of disconnecting the apartment building from the district heating supplier and building an independent heat and hot water source based on heat pumps in the ground/water system with sizing for the expected lower heat losses of the building.

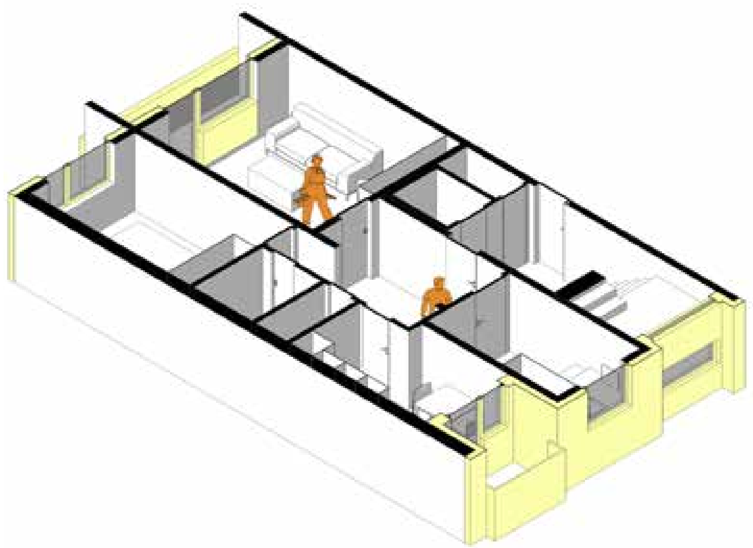
Conclusion: The proposed measures will result in a reduced specific heating demand for the Pribišova apartment building of approximately 17.9 kWh/m^2.a, i.e. only a fraction compared to the current situation. This can be matched by a reduction in CO_2 emissions depending on the method of production, distribution as well as the heat source used, not to mention an overall increase in the quality of the indoor as well as outdoor environment.

Structural interventions at the level of the apartment, west side

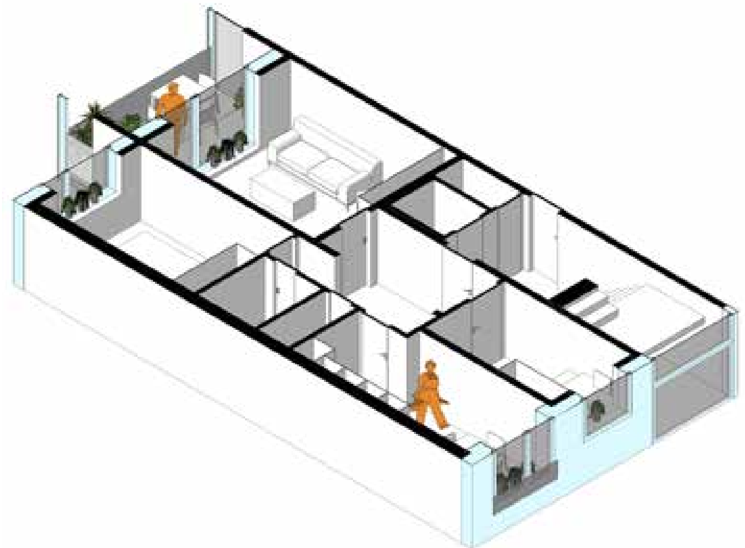


Adapted apartment, west side

Structural interventions at the level of the apartment, east side



Adapted apartment, east side



Residential house Pribišova, visualisation of the design proposal

EnerPHit-Hodnotenie

Budova:	BD Karlova Ves	
Ulica:	Karloveská 57,59, Levárska 1-7, Silvánska 18,20	
PSČ/Mesto:	841 01	Bratislava
Kraj/Štát:	Bratislavský	SK-Slovakia
Typ budovy:	Bytový dom	
Klimadáta:	SK0001a-Bratislava	
Klimatická zóna:	3: Studená-mierna	Nadmorská výška: 203 m
Investor:	Spoločenstvo vlastníkov bytov Silevka	
Ulica:	Karloveská 57,59, Levárska 1-7, Silvánska 18,20	
PSČ/Mesto:	841 01	Bratislava
Kraj/Štát:	Bratislavský	SK-Slovakia

Architektúra:	Krajský projektový ústav		TZB:		
Ulica:	ulica 29.augusta č.12		Ulica:		
PSČ/Mesto:	811 08	Bratislava	PSČ/Mesto:		
Kraj/Štát:	Bratislavský	SK-Slovakia	Kraj/Štát:		SK-Slovakia
En. poradenstvo:	Inštitút pre pasívne domy		Certifikácia:		
Ulica:	Panónska cesta 17		Ulica:		
PSČ/Mesto:	851 01	Bratislava	PSČ/Mesto:		
Kraj/Štát:	Bratislavský	SK-Slovakia	Kraj/Štát:		SK-Slovakia

Rok výstavby:	2008	Vnútorná teplota v zime [°C]:	20,0	Vnútorná teplota v lete [°C]:	25,0
Počet bytov:	80	Vnútorné zdroje tepla (IWQ) počas vykurovania [W/m²]:	2,8	IHG chladenie [W/m²]:	2,8
Počet osôb:	151,4	merná tepelná kapacita [Wh/K na m² TFA]:	204	Mechanické chladenie:	

Charakteristické ukazovatele budovy vztiahnuté na jednotku plochy a rok

					Kritériá	Alternatívne kritériá	Splnené?[2]
	Energeticky vzťažná plocha	m²	5832,0				
Vykurovanie	Potreba tepla na vykurovanie	kWh/(m²a)	23,6	≤	25	-	áno
	Tepelná strata	W/m²	17,8	≤	-	-	
Chladenie	Potreba chladiť a odvlhčovať	kWh/(m²a)	-	≤	-	-	-
	Tepelná záťaž	W/m²	-	≤	-	-	
Prekorčenie najvyššej prípustnej teploty (> 25 °C)		%	7	≤	10		áno
Prekorčenie požadovanej vlhkosti (> 12 g/kg)		%	0	≤	20		áno
Vzduchová priepustnosť	n_{50}	1/h	0,6	≤	1,0		áno
Primárna energia z neobnoviteľných zdrojov (PE)	Ukazovateľ PE	kWh/(m²a)	115	≤	130,342913		áno
Primárna energia z obnoviteľných zdrojov (PER)	PER-potreba	kWh/(m²a)	117	≤	-	-	-
Výroba energie z OZE vztiahnutá na zastavanú plochu		kWh/(m²a)	0	≥	-	-	

[2] prázdna bunka: chýbajú údaje; '-': žiadna požiadavka

Potvrdzujem, že tu uvedené hodnoty boli stanovené výpočtovou metódou PHPP, na základe charakteristických vlastností budovy. Výpočet PHPP je uvedený v tomto hodnotení.

EnerPHit Classic? **áno**

Funkcia:	Meno:	Priezvisko:	Podpis
1-Projektant	Vladimír	Šimkovic, Dipl.Ing.	
	Vydané dňa: September 2019	Mesto: Bratislava	

EnerPHit-Hodnotenie

Budova:	Bytový dom Pribišova 33-37 návrh	
Ulica:	Pribišova	
PSČ/Mesto:	841 05	Bratislava
Kraj/Štát:	Bratislavský	SK-Slovakia
Typ budovy:	BD	
Klimadáta:	SK0001a-Bratislava	
Klimatická zóna:	3: Studená-mierna	Nadmorská výška: 232 m
Investor:	Spoločenstvo vlastníkov Pribišova	
Ulica:	Pribišova	
PSČ/Mesto:	841 05	Bratislava
Kraj/Štát:	Bratislavský	SK-Slovakia

Architektúra:	ŠPTÚ Bratislava		TZB:		
Ulica:	Drieňová ul.		Ulica:		
PSČ/Mesto:	821 01	Bratislava	PSČ/Mesto:		
Kraj/Štát:	Bratislavský	SK-Slovakia	Kraj/Štát:		
En. poradenstvo:	Inštitút pre pasívne domy		Certifikácia:		
Ulica:	Panónska cesta 17		Ulica:		
PSČ/Mesto:	851 01	Bratislava	PSČ/Mesto:		
Kraj/Štát:	Bratislavský	SK-Slovakia	Kraj/Štát:		

Rok výstavby:	1992	Vnútorná teplota v zime [°C]:	20,0	Vnútorná teplota v lete [°C]:	25,0
Počet bytov:	40	Vnútorné zdroje tepla (IWQ) počas vykurovania [W/m²]:	2,7	IHG chladenie [W/m²]:	2,7
Počet osôb:	85,2	merná tepelná kapacita [Wh/K na m² TFA]:	204	Mechanické chladenie:	

Charakteristické ukazovatele budovy vztiahnuté na jednotku plochy a rok

					Kritériá	Alternatívne kritériá	Splnené?[2]
	Energeticky vzťažná plocha	m²	3411,6				
Vykurovanie	Potreba tepla na vykurovanie	kWh/(m²a)	17,9	≤	25	-	áno
	Tepelná strata	W/m²	14,4	≤	-	-	
Chladenie	Potreba chladiť a odvlhčovať	kWh/(m²a)	-	≤	-	-	-
	Tepelná záťaž	W/m²	-	≤	-	-	
Prekorčenie najvyššej prípustnej teploty (> 25 °C)		%	2	≤	10		áno
Prekorčenie požadovanej vlhkosti (> 12 g/kg)		%	0	≤	20		áno
Vzduchová priepustnosť	n_{50}	1/h	0,6	≤	1,0		áno
Primárna energia z neobnoviteľných zdrojov (PE)	Ukazovateľ PE	kWh/(m²a)	102	≤	123,426925		áno
Primárna energia z obnoviteľných zdrojov (PER)	PER-potreba	kWh/(m²a)	96	≤	-	-	-
Výroba energie z OZE vztiahnutá na zastavanú plochu		kWh/(m²a)	0	≥	-	-	

[2] prázdna bunka: chýbajú údaje; '-': žiadna požiadavka

Potvrdzujem, že tu uvedené hodnoty boli stanovené výpočtovou metódou PHPP, na základe charakteristických vlastností budovy. Výpočet PHPP je uvedený v tomto hodnotení.

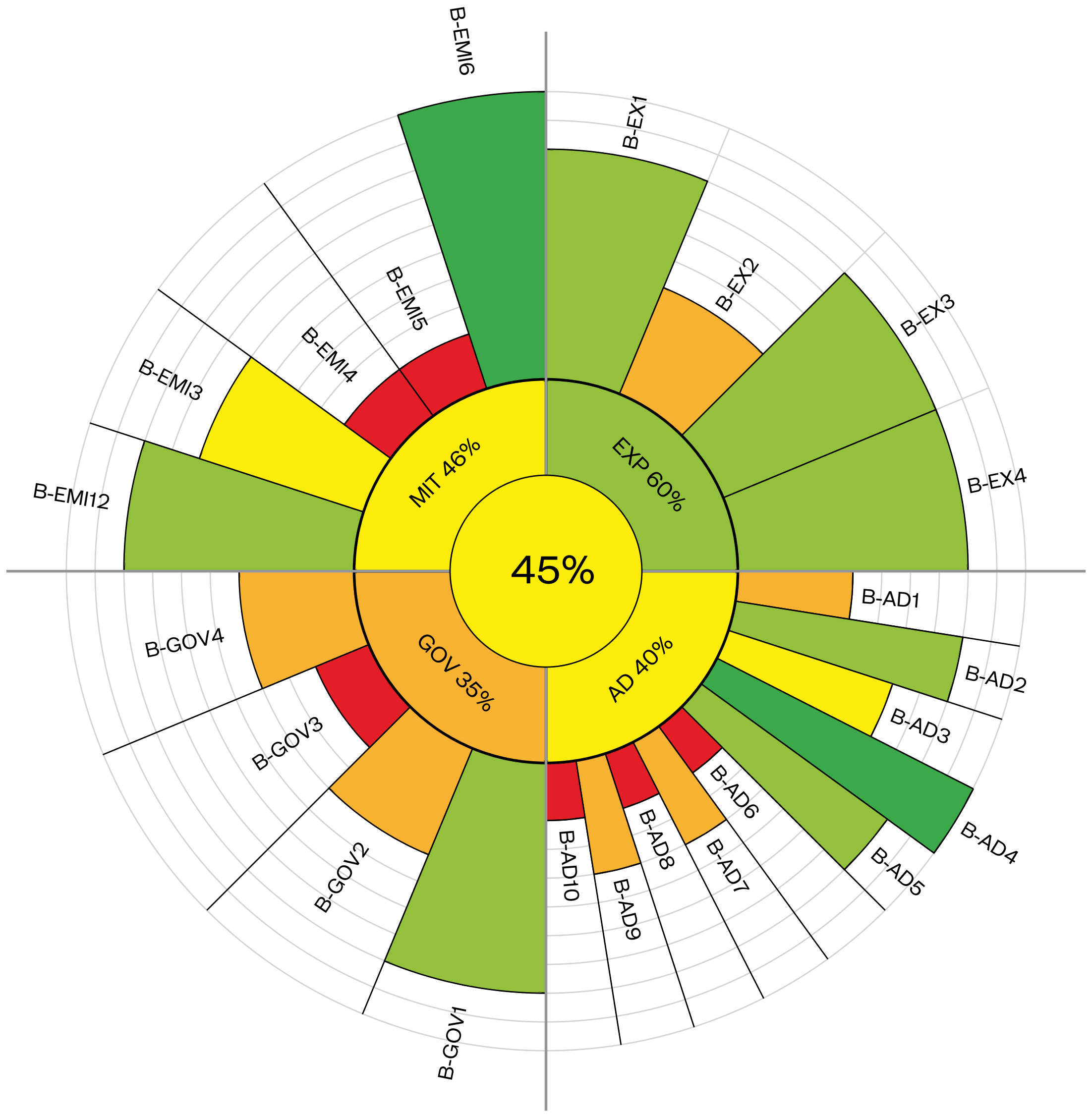
EnerPHit Classic? **áno**

Funkcia:	Meno:	Priezvisko:	Podpis
1-Projektant	Vladimír	Šimkovic, Dipl.Ing.	
	Vydané dňa: Marec 2020	Mesto: Bratislava	

8. EVALUATION OF THE SELECTED BUILDING OF THE PREFABRICATED APARTMENT BUILDING KARLOVESKÁ 57, LEVÁRSKA AND SILVÁNSKA USING THE KLIMASKEN TOOL

Prefabricated apartment buildings Karloveska 57, Levárska and Silvánska were also evaluated with the help of the KLIMASKEN tool. As a result of the assessment, a "climate label" is achieved, which illustrates the four main areas of a building's assessment in terms of adaptation to climate change (exposure, sensitivity and capacity) as well as in terms of emissions, i.e. the amount of greenhouse gas (GHG) emissions produced. Each area is further subdivided into smaller sections, which are represented by sub-indicators (factors) that represent that area. 5 colours (red, orange, yellow, light green and dark green) are used throughout the label to indicate the negative (red) or positive (dark green) state or development of the system described by the indicators used. The overall condition of the building is expressed both as **mean value in percentage** as well as in colour. The rated building received a score of 45 % (out of 100).

Fig. 1: Climate label for selected prefabricated apartment building Karloveská 57, Levárska and Silvánska



Degree of certainty: 95.7 %
Data completeness: 100.0 %

9. POTENTIAL FOR ENERGY SAVINGS IN PREFABRICATED HOUSING STOCK IN KARLOVA VES

The quantification of the energy saving potential of the housing stock was based on a detailed assessment of the state of renovation of apartment buildings (the assessment covers prefabricated houses built before 1991). The data processing and the quantification itself were preceded by activities that provided the necessary background information on the state of renovation of prefabricated apartment buildings. The data obtained from the results of the individual activities provided the basis for the analysis of the potential energy savings and CO_2 emissions of the housing stock of the Municipality of Bratislava-Karlova Ves, and the quantification of the indicators.

DESCRIPTION OF METHODOLOGY AND CALCULATIONS

The design of the building categories is based on the expert assessment of the buildings on the basis of the processed analysis of the existing condition of the apartment buildings of the Municipal District Bratislava-Karlova Ves, the report from the survey of the existing condition of the apartment buildings of the Municipal District Bratislava-Karlova Ves, while this activity provided us with an overview and background information on the buildings and finally from the results of the energy optimization with the PHPP calculation software we have created 4 categories of buildings according to the scope of the renovation. In determining the savings potential, we based the calculation on the renovated and non-renovated apartment building.

DESCRIPTION OF CREATED BUILDING CATEGORIES

Category 0: renovated building with a heating demand of approx. 50 kWh/m².a
The renovated building in its entirety has implemented thermal protection of the building envelope with a minimum insulation thickness of 10 cm. The roof has added insulation in thicknesses of min. 20 cm. Balcony slabs are insulated. The building has replaced the windows with windows with plastic frame (or other) and with double or triple glazing in the range of about 90 %.

Category 1: partially renovated building with a heating demand of approx. 70 kWh/m².a
The partially restored building has undergone renovation to the extent required by legislative requirements. The façade of the perimeter cladding has added insulation in thicknesses of 4–8 cm. The roof has added insulation in a thickness of about 20 cm. Balcony slabs are usually not insulated. The building has had its windows replaced with plastic framed windows (or others) and double glazing in the 50–90 % range.

Category 2: minimum renovated building with a heating demand of approx. 90 kWh/ m².a
Minimally restored building is in a state e.g. with a repaired roof or with the addition of thermal insulation with a thickness of about 20 cm, or with an insulated façade from the north side, or with insulation of the gable walls. The building has had its windows replaced with uPVC framed (or other) windows with less than 50 % double glazing.

Category 3: non-renovated building with a heating demand of approx. 120 kWh/m².a
The unrestored building is in its original state, without insulation of the outer perimeter walls, insulation of the roof, or has replaced windows with plastic (or other) with double glazing in the range of less than 30 %. This includes buildings where repairs have been carried out to system faults, filling cracks in the façade cladding of the building, fixing roof leaks without adding insulation.

ENERGY SAVING OPPORTUNITIES BASED ON THE DEVELOPED ASSESSMENT METHODOLOGY

Both buildings were optimised by the PHPP calculation program to almost the same level of specific heating demand of about 20 kWh/m^2.a, although they were based on different starting levels of energy efficiency.

Total floor area assessed: 935,500 m^2
Energy savings on heating demand: 59,420 MWh/a
Average specific energy savings on heating demand: 63 kWh/m^2.a
Estimated CO_2 emission savings for the energy medium – gas: 16,500 tonnes/year

This level of energy savings can realistically be assumed for all housing estates in Slovakia and the Czech Republic.

MEASURES AND RECOMMENDATIONS FOR QUALITY BUILDING RENOVATION

When renovating buildings, the best solutions are often not taken into account. Many factors influence a good result, such as the type and thickness of the insulation material, the type of windows and the way they are fitted, the regulation of the heating system, etc.

There is no point in saving on insulation thickness. It is important to note that an increase in insulation thickness does not mean a linear increase in price. The individual layers of the insulation system (adhesive, reinforcing fabric, mastic, plaster, paint) remain the same, only the cost of insulation and possible anchoring increases. The designer's task, in order to achieve quality insulation, is to solve all the details and design a continuous thermal insulation envelope without breaks. Weakening in the thermal insulation envelope, the so-called thermal bridges, can contribute significantly to the heat loss of the building. Especially protruding elements (balconies, attics, anchoring of elements, etc.) or structural connections (windows, roofs, ceilings, panel joints) are problematic points that need to be solved precisely. Thermal bridges result in cooled areas inside and, conversely, heated areas outside, where much more heat passes through than through the insulated envelope. Thermal bridges can be identified with a thermographic camera.

Sufficient insulation thickness throughout the building envelope has a concomitant effect on the internal surface temperature. The possible occurrence of thermal bridges causes a local decrease in the internal surface temperature, which can result in condensation of water vapour in cold spots, subsequent growth of mould spores and damage to the structure. In such cases, then it is impossible to talk about a quality indoor environment. In well-insulated buildings there is no such danger. Increasing comfort – thermal comfort without uncomfortable temperature differences in rooms and the quality of the indoor environment are some of the main attributes of quality modernisation.

ROOF INSULATION

A quality roof insulation project is absolutely essential. Before designing a structural solution, it is necessary to carry out a survey of the existing roof structure and to draw up an assessment of the suitability or remediation of the individual materials of the roof sheathing. At the same time, it is necessary to assess the structural capacity of the entire roof structure. Another important step is the correct choice of thermal insulation, according to the purpose of the roof and the type of construction. Flat roofs require very precise construction details, in all the craftsmanship involved in the construction of the roof.

Flat roofs are often the site of damage because the external covering (usually asphalt strips or foil insulation) is exposed to large fluctuations in temperature, weather changes and UV radiation. For single-skin roofs, an inverted roof system is often used. Compared to the usual composition of the layers, their order is reversed, i.e. the thermal insulation lies above the waterproofing layer. In this way, the service life of the roof sheathing is significantly extended. In the case of a roof with a reversed order of layers, only high quality load-bearing and non-absorbent materials can be used as thermal insulation, e.g. extruded polystyrene, polyurethane or foam glass, polystyrene foams, where the waterproofing is covered with a non-absorbent layer of insulation. This is followed by a separation layer and a water-permeable top operational layer – dry-laid paving, a layer of small stones or, in the case of a more load-bearing layer, a vegetation layer, the so-called green roof. Lightweight insulation such as blown cellulose or mineral wool and others can also be used, of course in a timber grid of I-joists or other timber-based load-bearing elements. The waterproofing is placed on top of the backfill of the structural slabs and the next operating layer, or the substrate with subsequent greening, comes on top of it. Due to the significant thermal bridge, the attic must be insulated around the entire perimeter, just like the roof or perimeter wall. Alternatively, the attic insulation solution can be avoided during reconstruction by creating a pitched roof construction.

In the case of double-skin roofs, the top skin can be dismantled, the gap increased to the required height, insulation laid and the top skin reinstalled. A ventilation gap must be maintained to prevent condensation. It is not recommended to insulate a double skin roof from the top side. There would be a significant reduction in the thermal insulation properties of the roof and the ventilated gap would cause severe cooling of the ceiling. A change to a single skin design is then more appropriate.

WINDOW RENOVATION

Windows are a common source of large losses in older buildings. Not only through poor-quality glazing, but especially through leaks in the lining, the heat literally escapes outside. Low surface temperatures on the frame or the edge of the glazing often result in dewetting, subsequent condensate running down the window frame and damage to the frame structure. In the case of renovations, the same principles are used in the selection of windows and their installation as in the case of passive new buildings. Windows with triple glazing and a whole window transmittance $U_w \leq 0.8$ W/(m^2.K) will provide sufficient thermal protection. Thermal bridges at the connection point of the frame to the supporting structure can be avoided by pre-inserting the window into the insulation layer and then re-insulating part of the frame. In the worst case, the windows should be fitted into the face of the structure. It is also necessary to make a precise airtight connection of the frame using special tapes or strips.

If only partial insulation of the façade is planned, it is important to prepare the windows for later replacement. It is necessary to place an insulating fitting in the outer lining of the window, which serves as a temporary solution for the lifetime of the current windows. When replacing, this fitting is cut out and a window profile is simply fitted in its place without disturbing the existing façade.

A frequent phenomenon after "normal" and especially insufficient reconstruction and replacement of windows is the formation of mould on the inner lining of the windows. This is a combined problem of thermal bridges and inadequate ventilation. Incorrect installation of windows in the plane of the supporting structure and insufficient insulation of the window lining leads to a decrease in the surface temperature on the inner lining. Inadequate ventilation with new sealed windows increases indoor humidity and leads to condensation in cold spots. With comprehensive modernisation, we need not worry about this. Properly fitted passive windows have a higher surface temperature on the inside and controlled ventilation ensures the necessary air exchange.

WHAT WINDOWS TO CHOOSE – PLASTIC OR WOOD?

The choice of window material is mostly a question of finances, durability and the need for maintenance. All three requirements are combined in most cases by the best vinyl windows. The quality of the frame is important, where the U-value of the frame should not exceed 1.0 W/(m^2.K) and the window frames should allow for the lining of the frame to be re-insulated with as much insulation as possible, even at the sill. In terms of ease of maintenance and durability, aluminium and plastic windows are the best. However, aluminium windows do not meet the requirements for thermal protection and the possible combination of wooden windows with external aluminium protection is more expensive.

An important element in the retrofit is to ensure summer comfort as well as protection against summer overheating. The questionnaires show that residents of prefabricated houses are more dissatisfied with excessively high indoor temperatures in summer than in winter. It is important to take this into account when retrofitting and install quality sun protection, whether integrated into the window design or possibly internal blinds.

HEATING SYSTEM

The original heating system usually encounters several problems. The biggest of these is controllability and losses in the distribution system. After the energy-saving measures, there is logically a significant reduction in the heat losses of the building. If the heating system remains unchanged, the heat savings will fall far short of the predicted figures. The regulation of the heaters is in most cases also in poor technical condition – the control valves often do not work and therefore the users have them fully open and in case of very high temperatures the room temperature is regulated simply by opening the windows.

The most common modifications to the heating system to ensure that the necessary savings are achieved after the heat losses of the building have been reduced by retrofitting:

- re-regulating the heating system to a lower temperature gradient, resulting in a significant reduction of heat losses during distribution,
- use of thermostatic valves on radiators, which automatically regulate the consumption according to the set temperature,
- insulation of heat and hot water pipes up to twice the pipe diameter, insulation of pipes is often neglected and the minimum insulation thickness is used. Studies show that it pays to insulate pipes up to twice the thickness of the pipe diameter.

Airtightness measurement, installation of the Blower Door device in the door opening. Source: iEPD

Airtightness measurement, air flow through the window frame. Source: iEPD

Airtightness measurement, air flow through the electrical outlet. Source: iEPD


External shading blind. Source: iEPD

10. MEASURES TO IMPROVE PUBLIC SPACES, IMPACT ON ENERGY PERFORMANCE OF BUILDINGS

Apartment buildings are integrated into their surroundings and it is their surroundings that provide various opportunities for social contact, which is a natural need of the human community. A special role is played by the quality of the common spaces around the apartment building. Front gardens and transitional spaces from public (street) to private (apartment) provide a space for social contact for the inhabitants of the house or "neighbourhood".

CREATING PUBLIC SPACES

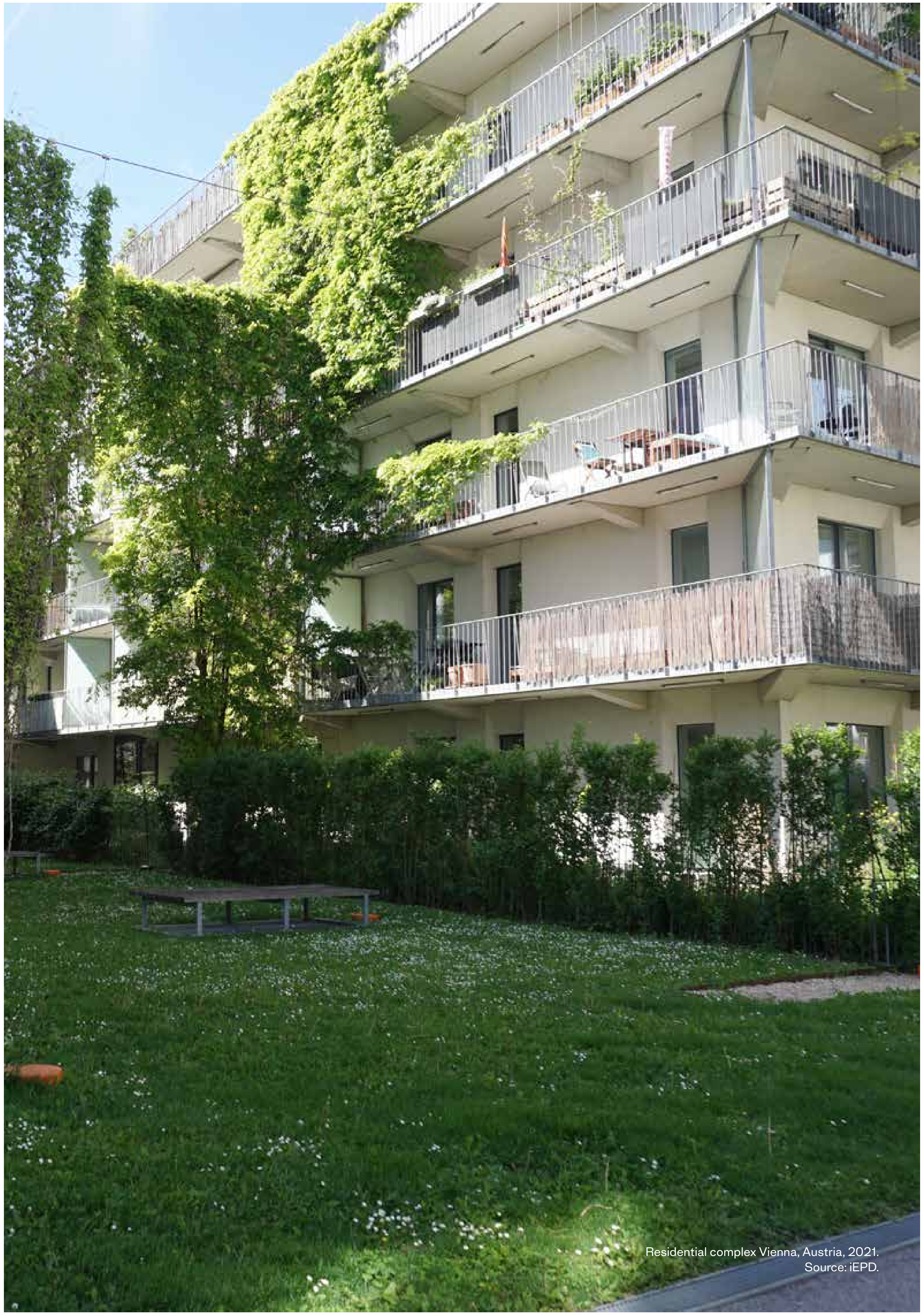
Of particular importance are semi-private spaces that are only accessible to a clearly defined group of people, such as the residents of a particular block of flats. Transition areas between public spaces of different accessibility also offer important opportunities for social control. The common courtyard is an ideal space for social contact of the inhabitants of the house and for short-term recreation, especially with children.

The quality of surfaces in public spaces contributes significantly to the aesthetic quality of the entire public space. When designing or reconstructing surfaces in public spaces, we suggest using more environmentally friendly walking surface solutions. Minimising the proportion of impermeable surfaces can be very effective in preventing flooding of the urban area by rainfall during heavy rainfall when the sewerage network does not have the capacity to convey stormwater. Permeable surfaces in public spaces allow rainwater to infiltrate and thus also help to maintain the water cycle in the urban landscape.

The draining of paved areas around the house (sidewalks, roads, parking lots, etc.), especially those formed by water-permeable surfaces, must be consistently in the direction away from the dwelling house. It happens that even properly implemented areas sink over time and create various depressions where rainwater accumulates when it rains. The seepage of accumulated water through cracks into the subsoil causes further deterioration and permanent subsidence of the affected paved areas. In winter, the destruction accelerates. The approach to the house must always be slightly higher than the surrounding areas so that rainwater from the pavement always has somewhere to run off. Drainage of water from grass areas adjacent to the building should be paid particular attention around entrances and roads – incorrect elevation of lawns above the level of roads causes muddying of communication areas at each rain (and after drying higher dustiness) and washing out of the humic layer of soil. Properly, when it rains, the water from the pavements should drain into the depressions created in the lawns, which will improve the moisture regime of the greenery. [7]

VEGETATION IN PUBLIC SPACES AROUND APARTMENT BUILDINGS

Trees and shrubs have a pronounced micro-climatic effect, which includes cooling the surrounding environment, which is particularly pronounced in the summer heat. In addition, greenery in settlements has other functions (e.g. recreational, aesthetic, wind protection, pollution capture, noise mitigation). In connection with the renovation of the apartment building, it is necessary to plant greenery in such a way as to prevent excessive heat loss of the buildings in winter and excessive overheating in summer, with special emphasis on sufficient distance from the facade and the use of inappropriate species of trees (preference for deciduous trees).



Residential complex Vienna, Austria, 2021.
Source: iEPD.

Growing vegetables and aromatic herbs in the form of “community gardening” in public spaces is becoming increasingly popular. Community gardens offer people new opportunities to use public spaces and green areas. In addition to encouraging residents‘ interest in their immediate surroundings, they have a positive impact on neighbourhood relations and the formation of a community of residents. The cultivation of aromatic herbs and vegetables for kitchen use can be complemented by other vegetables that are also highly decorative and ornamental trees that have edible fruits (e.g. chokecherry, cherry plum, Cornelian Cherry, Kamchatka and edible groundsel). We also recommend not planting species that provide food and shelter for birds or species with strong flowering.

The use of climbing vegetation continuously covering the façade contributes to the thermal insulation of buildings by significantly reducing the temperature of the walls in summer (by 10 to 30 °C). Reducing the wall temperature by 5.5 °K saves half of the energy spent on air conditioning. Climbing plants (especially evergreens such as ivy) therefore bring significant energy gains. For the use of vertical greenery on facades, several types of perennial plants are used, which are able to adhere to the wall.

VIENNA TACKLES GREENING OF APARTMENT BUILDING FAÇADES

Vienna and other cities offer many opportunities for greening buildings. Until now, however, there has been no technically simple solution for planting vertical vegetation on buildings along streets that can be implemented quickly and at low cost. In addition, the implementation was complicated by clearance and approval processes.

The “50 Green Houses” project team, together with the City of Vienna, developed an integrated combined solution: the BeRTA green façade module and a form of online inspection that simplifies the process. In early 2019, home communities were able to apply for 50 prototypes. In autumn 2019, the first BeRTA modules were installed on eight selected buildings in the target area. The evaluation lasted until the summer of 2021. Measurements related to vegetation provide information on the condition of plants. As part of the social-scientific monitoring, evaluations of the residents of the house and the workers who take care of the vegetation are collected through surveys. For more information, visit www.berta-modul.at. Green Houses – not only for Vienna! The innovations developed in the “50 Green Houses” project can also be adapted to other cities.

So far, green facades have been implemented in nine streets: Absberggasse 5, Buchengasse 6, Hasengasse 24, Jagdgasse 25, Kudlichgasse 46, Herzgasse 47, Kudlichgasse 14, Wielandgasse 23 / Quellenstraße 107, Buchengasse 77.

The programme 50 green houses (50 grüne Häuser) – with implemented green facades is supported by the programme “Stadt der Zukunft” (City of the Future). The “Stadt der Zukunft” programme is a research and technology programme of the Federal Ministry of Transport, Innovation and Technology, BMVIT. Green facades are implemented in nine streets in Vienna‘s Favoriten district (https://50gh.at/50-gruene-haeuser-das-projekt/).

Residential complex Vienna, Austria, 2021
Source: IEPD.

PROMOTING BIODIVERSITY IN PUBLIC SPACES AND BUILDINGS

When establishing and maintaining greenery in public spaces around residential buildings, it is advisable to apply procedures that promote biodiversity, e.g. giving preference to native tree species, planting xerothermic species of perennials, establishing extensive lawns – flowering meadows, etc.

Turning parts of the lawn into flowering meadows not only brightens up the lawn areas – such a decorative area also contributes to biodiversity conservation, providing food for bees, butterflies and other insects. More than 400 species of flowering plants can grow on the sandy soil, many of which may be protected, rare or endangered in the wild. Nowadays we can find special mixtures of flowers “for butterflies” or “for bees” in the commercial network. The inner city is often a refuge for various species, especially protected species (birds and bats) within buildings. These animals use various parts of the exterior and interior of buildings as nesting and hiding places. In some cases, such possibilities have already arisen during the construction of individual buildings (e.g. expansion joints, ventilation attic and pantry openings), in other cases these are spaces that have been created over time by neglected maintenance of the building – e.g. joints under roof sheathing and parapets, fallen parts of masonry, cracks) or by additional interventions (e.g. ventilation of heating equipment in apartments).

If protected animals already occupy and use such spaces, it is imperative that the restoration of the buildings does not involve interventions that would lead to the direct killing of these animals and, if possible, to the irreversible disappearance of the spaces used by them. Therefore, the Guideline of the Ministry of Environment of the Slovak Republic and the Ministry of Transport of the Slovak Republic on the procedure of state bodies for nature and landscape protection and state administration bodies for spatial planning, construction and housing in ensuring the protection of the nesting population of earthworms (*Apus apus*) and bats (*Chiroptera*) during thermal insulation and other construction modifications was issued. This guideline regulates, among other things, the builder‘s procedure for the planned renovation of buildings.

From the point of view of the complexity of implementing additional measures, it is more advantageous (easier and cheaper) for builders to adapt the construction timetable to the given conditions and to use appropriate technical solutions already when planning the construction, rather than to neglect the issue of protected species protection and deal with it only during the implementation of the construction or after its completion. A proactive approach to creating suitable conditions in buildings for protected species is not to be feared either. Possible pollution of buildings by animal droppings can be prevented by technical measures and the prices of the simpler types of hutches start from 30 €. The time, energy and finances invested will be returned in the form of increased habitat amenity, as birds and bats that find suitable roosting opportunities there can make a significant contribution to reducing the number of nuisance insects.

Residential district Favoriten, Vienna, Austria, green façades, 2021.
Source: iEPD

Green façade, residential house Seestadt Aspern, Vienna, Austria.
Photo: Ľubica Šimkovicová

11. GREEN ROOFS, RAINWATER MANAGEMENT, BIODIVERSITY IN THE URBAN ENVIRONMENT

CREATING VEGETATED ROOFS ON BUILDINGS

It is very appropriate to implement a green roof on the roof structure of a residential building. The extensively vegetated roof consists of roof layers weighing 60 – 300 kg/m^2. Plants that grow into the surface (perennials) and drought-loving plants that can withstand extreme conditions of alternating heat, drought and frost are suitable for it. Intensive roof greenery sometimes requires a structural load-bearing capacity of up to 1,000 kg/m^2 and the possibility of using soil 1 to 1.3 m thick for planting shrubs and low trees. Green roofs moderate the temperature in the spaces under the roofs by several degrees. Measurements on summer days in recent years have shown that if the outside temperature is 25 – 30 °C, the temperature of the indoor room under a green roof is reduced by 3 – 4 °C. Measurements have shown that 20 – 40 cm tall plants growing on 20 cm of substrate are comparable to 15 cm of mineral wool insulation in terms of summer thermal comfort. Green roofs absorb roughly 150 W/m^2 of heat energy in summer, and the lower overheating leads to no need for air conditioning – if it is used, every 0.5 °C reduction in indoor temperature leads to 8 % electricity savings. [7]

SUSTAINABLE RAINWATER MANAGEMENT

Currently, in the vast majority of cases, rainwater from paved areas around buildings and from the roofs of buildings is discharged together with sewage water into a common sewer system. This situation is proving to be very unsatisfactory, unnecessarily burdening the budgets of private owners with sewerage costs and quickly diverting water from areas where vegetation is then lacking. The use of rainwater should be implemented in the form of connecting roof and terrace drains to collecting ditches or pipes and diverting the captured water to underground seepage, collecting ponds, polders with surface seepage or “rain gardens” with plant communities that maintain water quality and promote its evaporation. In this way, rainwater is retained in the urban landscape, further drying out of the area is prevented, biodiversity is promoted and some of these measures also have an aesthetic effect.

RAINWATER AND PROTECTION OF THE APARTMENT BUILDING

Rain (horizontal) gutters must not be leaky or rusted from a great height and the falling water will splash on the walls up to a height of 60 cm. Older galvanised gutters must therefore be regularly treated against corrosion with a protective coating. In the case of their replacement, it is advisable to use maintenance-free, permanently corrosion-resistant materials, even at the cost of higher investment costs.

Roof drains from flat roofs (and also inlets from gutters into vertical rainwater downspouts) should also be fitted with a simple leaf catcher. However, the sediment trapped in it needs to be removed from time to time. It is an inexpensive protection for catching larger debris from roofs. Any leaks around gutters and downspouts that could allow rainwater to flow into the structure or onto the façade should be avoided.

Rainwater downpipes should be securely fastened to the façade, flawlessly tight and accurately vertical. If the storm drains are routed inside the building, it is advisable to equip the storm sewer with a backflow preventer before connecting it to the sewage sewer – in case of overflow of the public sewer, a water column of rainwater can form in the vertical joints.

12. THE SOCIAL ASPECT OF HOUSING LINKED TO THE QUALITY OF THE URBAN ENVIRONMENT

The social dimension of housing can be looked at from many perspectives, for example as a sociological topic or as a political issue, but here we will look at it as an issue of the built environment, i.e. as a topic of architecture and public space. As mentioned in Chapter 5, the social dimension is one of the three dimensions of sustainability in architecture. It strives for environmental resilience in aspects of human society, whether as individuals, members of a community, or a larger whole. Relationships play an important role here – whether interpersonal or relationship to place.

There are a number of ways in which specific processes and architectural interventions can influence these relationships in the locality. Of the process tools, the best known is participatory planning – a design method in which residents (or future residents) participate in shaping the form of their living environment. This method was also applied in the initial design phase for an apartment building in Karlova Ves and Dlhé Diely. The collected data served as a basis for specific interventions in buildings and public space in the vicinity. Another tool is, for example, the creation of a social mix, the occupation of housing units by people from different segments of society – but this can only be established in new construction. In the renovation of the existing housing stock it‘s possible only to a very limited extent.

The construction interventions or tools are mainly the creation of spaces for shared local activities, such as community gardens, sports grounds, local community centres and so on. Some of these elements were also reflected in the aforementioned studies of the apartment building. An architecturally cultivated, inclusive and transparent public space is also an important tool.

Architecture can use a spectrum of tools to enable the emergence of belonging among inhabitants, the emergence of community, as well as to build a relationship with a place of residence. While design alone does not create connections, it can positively influence their formation.

13. BEST PRACTICE EXAMPLES – RENOVATED APARTMENT BUILDINGS

DE FLAT KLEIBURG RESIDENTIAL COMPLEX, AMSTERDAM, NETHERLANDS

One of the largest apartment buildings in the Netherlands, it has 500 apartments, a length of 400 m and 10+1 floors. DeFlat Kleiburg was the last building in the Bijlmer site in its original state, built by the city in the 1960s as a contrast to the medieval housing in the city. The aim was to renovate the main structure – lifts, galleries, installations – but leave the apartments unfinished and unfurnished, thus minimising the initial investment and creating a new model of housing in the Netherlands. Most of the attempts to renovate apartment buildings in this area have focused on differentiation – to get rid of uniformity and to “humanise” the architecture. Many people perceived the repeated solution as evil. After three decades of individualisation, fragmentation and atomisation, strengthening uniformity seemed like an attractive idea. Although Kleiburg has the scale and character of a typical block of flats, the spacious lawns with greenery, sports grounds and community gardens create a peaceful atmosphere, also characterised by small gardens with seating areas, which the residents know how to enjoy. DeFlat Kleiburg was the winner of the European EU Mies Award in 2017.

WOZOCO HOME FOR THE ELDERLY, AMSTERDAM, NETHERLANDS

The project WoZoCo by the world-renowned Dutch studio MVRDV was created as part of the Green City project, which led to the creation of a narrow built-up area. As part of a major transformation project, there was a requirement to design a block of 100 flats for seniors. However, there were only 87 housing units in the main building area. The requirement was mastered by a studio with a curious idea. They “glued” additional housing units to the outside of the main building, which they placed on huge brackets on the north side of the building. To meet the screening requirement, the cantilevers are extended up to 11 metres and the flats are oriented east-west. The gallery is located to the north and the balconies of 87 small social flats are oriented to the south.

APARTMENT BUILDING BOIS LE PRÊTRE, PARIS, FRANCE

The Bois Le Prétre Tower in the 17th district of Paris is a 16-storey apartment building with 96 apartments, built in the early 1960s. Instead of demolition, the city agreed to a project to transform the existing building. Architects from the Lacaton&Vassal studio designed a generous extension of the apartments. On each floor they added a new floor built as a self-supporting structure around the entire perimeter. By creating glazed terraces that can be used as both conservatories and balconies, they expanded all the apartments. At the same time, the quality and comfort of the apartments have been improved by additional natural light and reduced energy consumption for heating. The original façade with small windows has been removed and replaced with a façade with large transparent openings, allowing residents to enjoy an exceptional panoramic view of Paris. Spaces for collective activities, two lifts and a new garden have been added. The reconstruction was carried out using prefabricated elements so that the residents could remain in the flats during the renovation.

Residential complex De Flat Kleiburg, Amsterdam, Netherlands.
Photo: Ľubica Šimkovicová

APARTMENT BUILDING PFORZHEIM, GERMANY

In Pforzheim, in south-west Germany, a nine-storey residential building from the 1970s stands next to the train station and was in dire need of renovation. As projects with innovative solutions and beyond the required standards received support from the government. The building meets the passive house standard. The occupants' comfort has increased significantly after improvements in sound, solar and thermal protection. The original heating system in the apartments was replaced by a completely new ventilation and heating system without burning fossil fuels. An interesting solution is heating and domestic hot water, which is produced using solar absorbers integrated into the façade in combination with a heat pump. The ice storage system serves as a seasonal heating and cooling source. Photovoltaic panels and a small wind turbine on the roof produce renewable energy to generate electricity for the building. Excess electricity is supplied by the building to the public network. Fresh air in the apartments is provided by ventilation units with heat recovery. Thanks to all these measures, CO_2 emissions have been reduced by 95 %. The building has won several awards, the 2015 DGNB Preis "Nachhaltiges Bauen" and the 2016 Europäischer Architekturpreis "Energie + Architektur".

APARTMENT BUILDING P. HOROVA, BRATISLAVA, SLOVAKIA

In-depth renovation and modernisation of a residential building at P. Horova 17,19 in Bratislava
The apartment building was built in 1988, has 42 residential units. Due to the inadequate thermal insulation properties of the building envelope and the poor quality of the windows, the energy consumption of the building was very high and the energy expenditure was significant. In Slovakia, more than 90 % of apartments are privately owned, so the main challenge for the success of sustainable renovation programmes has been the consensus of all tenants. The building has undergone deep renovation, including improving the thermal insulation properties of the roof, walls and foundations. Furthermore, windows with triple glazing were installed and balconies were glazed.

All apartments are equipped with a ventilation system with heat recovery and also a new heating system to improve heat distribution. The building has been disconnected from the district heating system and instead a cascade of four air-to-water heat pumps has been installed in a utility room in the basement. Each heat pump can produce more than 15 kW of heat per hour and the system is partially subsidised by 10 kWp of photovoltaic panels that are placed on the roof of the building. As a result, almost two-thirds of the energy consumed in the building comes from renewable energy sources.

The category of the building according to the level of energy performance achieved:
A – total energy consumption 18 kWh / (m^2.a)
A1 – primary energy 50 kWh / (m^2.a)
Construction period: 07/2015 – 03/2016

The project was implemented within the international project EU-GUGLE – European cities serving as Green Urban Gate towards Leadership in sustainable Energy from the FP7-ENERGY-SMARTCITIES-2012.
The EU-GUGLE building renovation design had to respect the requirements for an ultra-low-energy level of construction (according to the legislation in force at the time). With the implementation of the project, the apartment house became the first renovated apartment house in the Slovak Republic. The residential building meets the requirements for inclusion in the highest classes for the assessment of the energy performance of buildings (Energy Certificate No. 096839/2016/22/000112007/EC).

Renovation of an apartment building to a passive standard, Pforzheim, Germany.
Photo: Vladimír Šimkovic

Renovation of the apartment building Bois le Prêtre, atelier Lacaton&Vassal, Paris, France.
Photo: Vladimír Šimkovic

14. BEST PRACTICE EXAMPLES – SUSTAINABLE URBAN NEIGHBOURHOODS

SEESTADT ASPERN, VIENNA, AUSTRIA

The Seestadt Aspern district is considered to be the laboratory of the smart city concept in Vienna, which meets the demands of the 21st century lifestyle and at the same time fulfils the ambitious energy and climate goals of the city of Vienna. Seestadt Aspern is one of Europe's largest urban development projects in which innovative concepts in the fields of quality housing, social welfare, the use of local renewable energy and sustainable mobility are tested and implemented. By 2030, the 240 hectares of the former airport will provide a diverse living space for more than 20,000 people and roughly the same number of jobs. Underlying these developments is the current forecast that Vienna will continue to grow strongly. In an attempt to learn from past mistakes, Aspern first developed a traffic concept, then a public space concept and then a master plan based on an urban design by the Swedish architectural studio Tovatt Architects & Planners.

FUNENPARK, AMSTERDAM, NETHERLANDS

The residential complex is situated near the historical centre. A walkway paved with unusual pentagonal tiles in three shades of grey, for which the designers of this architecturally interesting residential complex have won an award, leads us between the apartment buildings located in a green park with an impressive number of planted acacia trees, up to 170 trees. Several buildings are interesting in their layout concept and shape. The exceptionally and unusually designed Block K by NL Architects with a valley-shaped roof has access to the flats from a diagonally placed alley in the middle of the block. The service areas are located inside, in a zone without direct light, while the façade is open to the park. In the arches of the extensive green roof are the open terraces of the apartments. The next building is a simple block surrounded by greenery in which the entrance and windows disappear. The absence of cars hidden in underground garages, open gardens at ground level in a large park where children can play freely, create a unique model not only of a peaceful lifestyle, but also of adaptation to climate change.

Passive residential house Living Garden, Seestadt Aspern, Vienna, Austria. Source: iEPD

Residential complex Funenpark, Amsterdam, Netherlands. Photo: Ľubica Šimkovicová

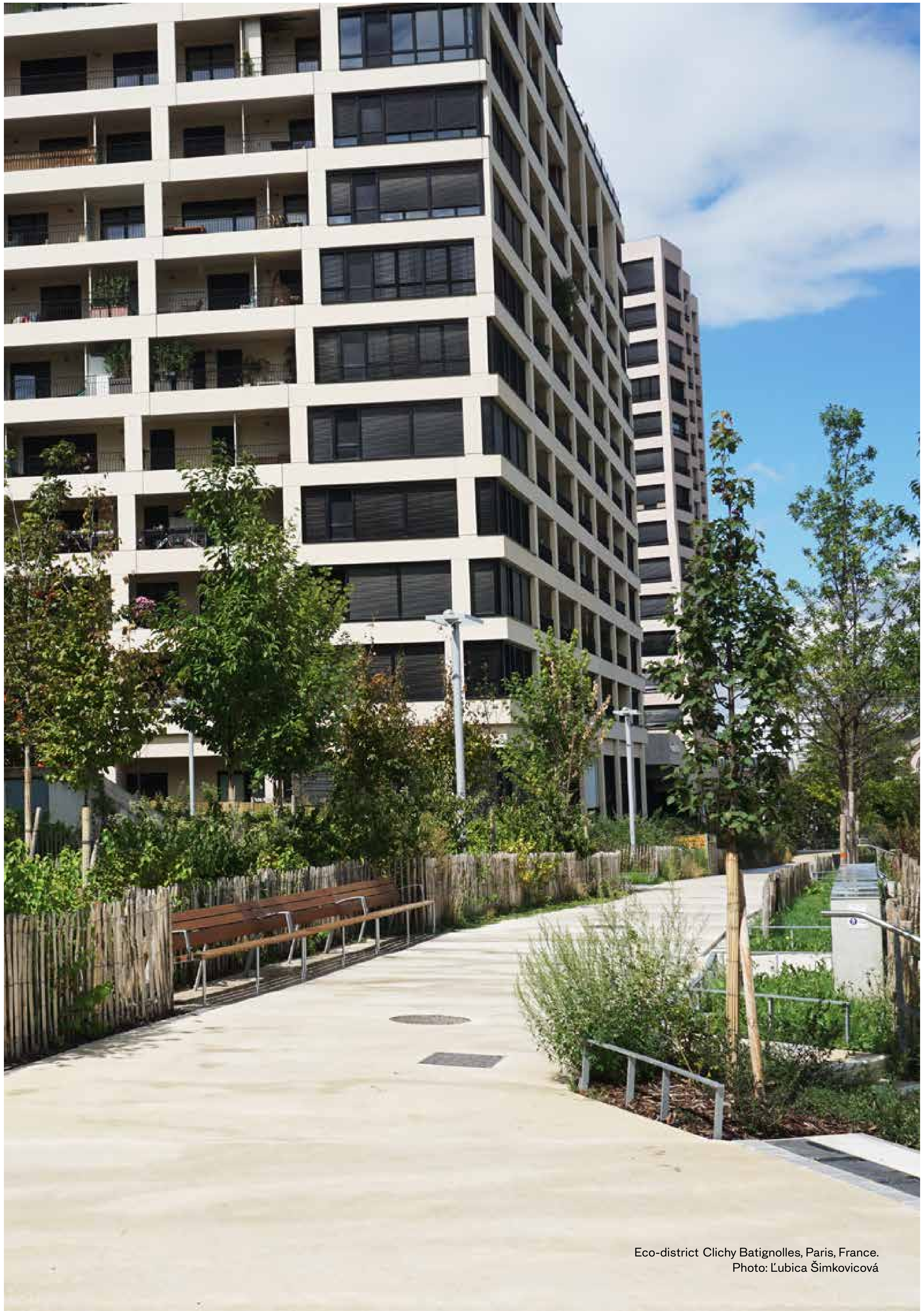
CLICHY BATIGNOLLES, PARIS, FRANCE

In the Clichy Batignolles district of Paris, in the 17th territory in the northeast of Paris, one of the largest eco-neighbourhoods in Paris is being built on 54 hectares on a former railway track, around the Martin Luther King Park. The architecture of the buildings maximises the benefits of the park, and it is possible to build apartment blocks up to 50 metres high. In the northern part of the district, Renzo Piano's 160-metre-high courthouse towers symbolically. The individual projects represent an interesting mix of architectural approaches and among them can be found other renowned names such as Odile Decq, Querkraft Architekten, Karawitz, Chartier-Dalix. The Clichy-Batignolles eco-district is a model of sustainable urban development, a project launched in 2002. It implements the city's ambitious goals in terms of functional and social diversity, energy efficiency, greenhouse gas reduction, biodiversity and water management. It implements not only Paris' climate plans but also its housing for all policy, limiting the use of cars and trucks while safeguarding major urban functions.

The eco-district focuses on carbon neutrality by combining energy saving and renewable energy. All buildings must meet passive standard criteria, which the design of the building itself contributes to. There are 35,000 m^2 of photovoltaic panels on the roofs, which cover up to 40 % of the district's electricity consumption, and 85 % of the energy for heating and hot water comes from renewable geothermal energy. The 6,500 m^2 of green spaces in the district are a place to relax in the middle of the bustling city. They also serve many species of plants, insects and waterfowl, as well as a means for rainwater management and for cooling the air through plant transpiration. Similarly, 26,000 m^2 of green roofs also contribute. Martin Luther King Park, with its 10 hectares of nature, serves as an urban air conditioner.

BAHNSTADT DISTRICT, HEIDELBERG, GERMANY

In Heidelberg, Germany, the world's largest passive house district is currently being built on 116 hectares. This urban district is leading the way by meeting 100 % of its energy requirements from renewable energy, producing almost zero CO_2 emissions. Passive standard was mandatory for all buildings. Therefore, the investor in the project phase, among other requirements, consistently monitored that the energy demand for heating did not exceed 15 kWh/(m^{2}a). For comparison, according to a study by Techem, the energy demand for heating in existing buildings for different categories averaged 112 kWh/(m^{2}a) in 2013 [Techem 2014]). A number of green and water areas make a very pleasant impression, which also contributes to improving the micro-climate around the houses and mitigates the effects of climate change.



Eco-district Clichy Batignolles, Paris, France.
Photo: Ľubica Šimkovicová

Residential complex of passive houses Bahnhof, Heidelberg, Germany.
Photo: Vladimír Šimkovic

15. CONCLUSION

Urban living offers many benefits to its inhabitants and its housing stock is in constant need of renewal. After 1989, the state shifted responsibility onto the shoulders of the population. Although they have become owners, they have also assumed responsibility for the condition of their apartment buildings. However, despite the different scope and form of renovation, it is important to motivate further improvement of the housing stock when considering further renovation of apartment buildings, increasing energy prices, based on the real economic possibilities of the inhabitants, as well as the available financial and other instruments.

We expect that by raising public awareness we will create interest in re-evaluation and subsequent measures to further reduce the current energy consumption for operation, as well as opportunities to improve the parameters of the indoor environment or the willingness to invest in further renovation, which will be directed to the standard of buildings with almost zero energy demand, or even to the passive standard, as the most important mitigation measure, and at the same time to include in the renovation of the adaptation measures at the level of the building, but also of the immediate surroundings. Reducing the energy intensity of buildings or gradually switching from current fossil fuel-based heat sources to renewable heat sources, operating costs can be reduced with a concomitant reduction in the carbon footprint.

Synergies between mitigation and adaptation measures are one of the important foundations for increasing interest in further renovation of buildings. A timely and sufficient understanding of the impact of climate change on buildings and the urban environment can create increased interest among residents and professionals to extend measures and requirements also at the level of legislation and regulations.

Another very attractive opportunity may be the gradual creation of energy-independent urban districts, which, thanks to very energy-efficient housing stock, as well as other buildings in the locality, will create a settlement structure with significantly reduced energy consumption, which can be covered by locally recovered energy sources. Such urban neighbourhoods will be able to create energy communities, allowing cities to build new opportunities for residents and contribute to the reduction of greenhouse gas emissions in the urban environment.

In conclusion, we would like to reiterate the idea from the introductory section that, despite their negative impact on climate change so far, cities are also becoming a promising tool for effectively achieving climate goals.

16. BIBLIOGRAPHY

[1.] Competitive Cities and Climate Change, https://www.oecd.org/cfe/regionaldevelopment/44232251.pdf, 2009

[2.] United Nations, Department of Economic and Social Affairs, https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html, 05/2018

[3.] European Comission, In focus: Energy efficiency in buildings, https://commission.europa.eu/news/focus-energy-efficiency-buildings-2020-02-17_en, 02/2020

[4.] Concept of urban development of the Slovak Republic until 2030, https://www.mindop.sk/uploads/media/dc4765f0d90557fb2f4eeeed9bdf13c78f58f128.pdf, 2018

[5.] 2019 Global Status Report for Buildings and Construction Sector https://www.unep.org/resources/publication/2019-global-status-report-buildings-and-construction-sector, 12/2019

[6.] Robl, P. Program Budovy 2050, Správa o stave budov na Slovensku, 06/2017

[7.] Obnova obytných budov. Príručka pre súkromných vlastníkov, ako postupovať v súlade s princípmi udržateľného rozvoja, projekt EPOurban, Hlavné mesto SR Bratislava, útvar hlavného architekta, 11/2014

[8.] Moravčíková, Henrieta: Bratislava: atlas sídlisk 1950 – 1995. Slovart, Bratislava, 2012.

[9.] Sternová, Zuzana a kolektív: Obnova bytových domov II. Hromadná bytová výstavba po roku 1970, Jaga Group, Bratislava, 2002

[10.] Obytný súbor Karlova Ves, https://www.register-architektury.sk/sk/objekt/127-obytny-subor-karlova-ves

[1.] Drobniaková, D., Centrum sídliska Dlhé Diely. Bodka za KVB v Bratisllave. Urbanita 23, 2011, 1, s. 24-29.

RESILIENT DISTRICTS
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Design Barbora Šajgalíková
DTP Richard Watzka

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