Centre for Metropolitan Innovation in Bratislava

Model project of an ecologically and socially sustainable
Building modernisation of the Cvernovka Foundation
in Bratislava (CMI.BA), Slovakia

Final report

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Fig. 1: Street view of CMI.BA on the Nová Cvernovka campus, rendering. Authors: PLURAL

FH;P Fachhochschule Potsdam University of Applied Sciences
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Objective and reason for the project

The aim of the research project was to develop an architecturally, socio-ecologically and energy-technically sustainable concept for the conversion of the dormitory of a former chemical technical college from the 1950s to the 1960s into the first plus-energy building in Slovakia.

Today, the dormitory is used by Nová Cvernovka, an important socio-cultural centre in a northern district of Bratislava. For the existing dormitory with a total floor area of approx. 6,500 m^2, new communal as well as low-cost forms of housing (CoHousing), office and studio uses for non-governmental organisations and social innovations as well as public supplementary functions (day care centre, café) were to be considered as programmatic uses. The concept aims at an innovative, sustainable and resilient conversion of the existing building: From an energy point of view, a plus-energy building is to be realised that generates more energy than it consumes on an annual average through the use of renewable energy sources (ecological benefit); from an economic point of view, favourable rents as well as low operating and life cycle costs are aimed for (economic benefit); and through the participatory development and communal use of the residential and service areas, the conditions for a responsible and inclusive community of residents are created (social benefit). For Slovakia, the re-use of derelict buildings in consideration of high ecological sustainability goals with intensive participation of future users - here especially actors from the creative industry and residents in shared flats - represents a major social innovation.

Presentation of the work steps and the methods applied

The research project is based on a socio-ecological approach of applied and transformative research, in which methods of integral and participatory planning were used for a holistic project development. The close involvement of the foundation and the residents in the process was an important component of the strongly knowledge transfer and implementation-oriented project. The project was processed in eight work packages (WP), each of which was carried out under the leadership of the responsible project partners of the interdisciplinary team and coordinated by the FHP as the main applicant. The preparation of the overall ecological concept and the management of the integral planning (WP1), the conception and implementation of the homepage (WP2) as well as the project management and administration (WP8) were the responsibility of the Potsdam University of Applied Sciences. The development of a concept for communal forms of living and the monitoring of the participation process (WP3) were carried out by id22: Institute for Creative Sustainability. The Passive House Institute Slovakia (iEPD) was responsible for the determination of the energy status (WP4) and the conception of a plus-energy building (WP5), and the preparation of the final planning documentation for the project (A6) as well as the coordination of communication and public relations (WP7) were the responsibility of the Cvernovka Foundation.

Methodologically, in addition to qualitative interviews and quantitative surveys of the current residents of the dormitory, research, analysis and visits to social-ecological model projects were of particular importance for the development of the CoHousing concept and the ecological measures. The energy calculations for optimisation to the passive house standard were carried out with the PHPP software, and IES-ve was used for thermodynamic simulations and calculations of the PV system. The knowledge integration of all concepts as well as spatial, structural, technical and social measures into the design was carried out by the commissioned architects in the context of integral planning.

A homepage called "Building Social Ecology" serves as a central component for knowledge transfer and as inspiration for the design process. On the homepage, existing social-ecological building projects and typical design elements that occur in these projects were documented. The conceptual basis for the design of the homepage was the methodology of "A Pattern Language" by Christopher Alexander, Sara Ishikawa and Murray Silverstein (Alexander et al. 1977). In generalised form, patterns are combinable, interrelated and synergistic design elements that can serve architects, project developers and residents as a source of inspiration for the development of their own social-ecological projects.

Results and discussion

Overall ecological concept and plus-energy building: To realise the conversion to a plus-energy building, thermal upgrading of the envelope surfaces to the passive house standard including new windows, a ventilation system with heat recovery and the installation of low-temperature ceiling panels for heating and cooling are required. The planned PV system with an output of approx. 100 kW provides more than enough electricity on an annual average to operate the heat pump for heat generation, thus ensuring the PlusEnergy standard. The PV system is planned as a fully integrated design in the shed roof construction of the planned roof extension and is a visible sign for the use of renewable energies.

As green-blue infrastructures, green facades, hydroponics, a rooftop greenhouse as well as facilities for rainwater and greywater utilisation with retention areas are planned. Through the preservation of the existing building stock, a "strategy of minimal interventions" and a recycling-oriented material concept, the existing grey energy is largely preserved and the amount of construction waste and other grey energy is reduced in comparison to a new building or a more extensive renovation. Further ecological and economic benefits can be expected from the shared use of common spaces, services and objects, e.g. in the form of option rooms, cluster living or through the planned sharing offers in the mobility sector.

CoHousing and participation: In a participatory planning process with the Cvernovka Foundation and the current residents, a site-sensitive mix of housing forms was developed, which are to be implemented as micro-apartments, shared flats and cluster flats. The building structure has proven to be very suitable and flexible for the planned conversions; only minimal interventions are required for installation cores, adaptation of the interior fittings and new staircases required for fire protection.

The exchange with community representatives in Nová Cvernovka has shown the importance of effective strategies and tools to involve residents, especially with regard to digital communication and online meetings and to motivate them to continuously participate in the planning and implementation process.

Knowledge transfer and homepage: The analysis of built examples and especially the visits to already realised model projects in Berlin and Vienna were important experiences to evaluate the decisions made in the design process. Only after many years of practice can a statement be made as to whether certain spatial, technological or social solutions and innovations have proven themselves or not. The homepage https://www.buildingsocialecology.org/ documents 24 model projects and a catalogue of 27 social-ecological design patterns that have proven to be a useful tool in planning and can be used by other project developers, architects and other actors when designing their own projects.

Public relations and presentation

In October 2021, a public presentation of the results of the research project took place in Bratislava before various political leaders of the city of Bratislava, the self-governing region and other institutional representatives from Bratislava. The project documentation provided in the report annex is the basis for the further steps under licensing law. In autumn 2022, the public and the authorities will be informed about further development phases of the project.

Conclusion

The project shows that a building modernisation of the former residential home into a plus-energy building with a diverse mix of uses and communal forms of living is possible at a reasonable cost. The project has the potential to serve as a model for similar modernisation projects in Slovakia. Conflicts of objectives such as higher investment costs for ecological and energy standards ("plus-energy building") versus socially acceptable financing ("affordable housing") could not be resolved within the framework of the research.

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List of terms and definitions

This glossary only explains terms that are of particular importance for the understanding of the project report and whose meaning cannot be generally assumed. For the common definition of many technical terms, e.g. on energy-efficient and sustainable construction, please refer to further sources.

Glossary on topics of the Federal Office for Building and Regional Planning (BBR)	https://www.bbr.bund.de/BBR/DE/Service/Glossar/glossar_node.html
Glossary on resource protection from the German Federal Environment Agency (UBA)	https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4242.pdf
Baunetz-Wissen glossary with more than 4000 explanations of terms relating to construction and architecture	https://www.baunetzwissen.de/glossar/a

Certification systems (also: rating systems for sustainable building or green building certification, are used to assess the sustainability of buildings. The most common certificates are BREEAM, LEED and DGNB. BREEAM (acronym for: Building Research Establishment Environmental Assessment Method) was developed in the UK and awards according to a simple point system in ten assessment categories. The criteria take into account impacts at global, regional, local and indoor levels. Assessment categories: Management, Energy, Water, Land Use, Health and Wellbeing, Transport, Material, Pollution, Waste, Innovation. LEED (acronym for: Leadership in Energy and Environmental Design) originates from the USA and is based on the British BREEAM with the rating categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Innovation and Design Process. The DGNB system (acronym for: German Sustainable Building Council) Germany) assesses the overall performance of a building based on criteria for the assessment categories: Ecology, Economy, Social and Functional Aspects, Technology, Processes and Location. Rating in: Platinum, Gold, Silver and Bronze. It is also referred to as a second-generation sustainability rating-

Circular economy goes beyond the current linear take-make-waste economy by keeping materials in a cycle. It is not only based on the principles of waste prevention, but also emphasises the idea that waste equals food and can be harnessed in our already existing system through repair, remanufacturing and recycling processes. The use of secondary materials stabilises the stock in the long term. The outflow of waste thus corresponds to the inflow of new materials. However, to maintain this cycle, business models and strategies need to change to keep products in the loop. Nevertheless, it is a collective effort (by companies, governments and individuals) that will allow us to reinvent everything to make our planet more liveable and sustainable.

CoHousing is now used as an umbrella term for a range of housing forms based on self-organisation and community orientation. This usually implies a high degree of self-determination of the participants, combined with an interest in community building and a long-term vision of sustainability (id22: Institute for Creative Sustainability, 2017).

Community refers to a group of people with things in common. Community means that people share a place, spaces, activities and goals. It can develop organically, be expanded, strengthened or weakened.

Consistency refers to the internally contradiction-free, consistent coherence in the overall context. In the context of sustainability, the consistency strategy refers to the compatibility of anthropogenic material and energy flows with flows of natural origin.

Cradle-to-Cradle (C2C) From product to new product without loss of material quality. Materials are kept as nutrients in a closed cycle. C2C describes the development of products and production processes that avoid waste. Instead, materials are kept as nutrients in a closed loop (Braungart o.J.).

Cradle-to-Cradle Certified™ is a globally recognised but largely unknown measure of safer, more sustainable products made for the circular economy. The certification assesses five sustainability categories: Material

Health, Material Reuse, Renewable Energy and Carbon Management, Water Stewardship and Social Fairness (Braungart n.d.).

Energy concept is the representation of the interaction of all relevant parameters that influence the energy balance of buildings. This includes the natural and technically generated energy flows as well as the respective technical, structural or spatial measures such as insulation, systems for using renewable energy sources or natural or technical ventilation systems. With an energy concept, the optimisation of the overall system is intended with regard to targeted target values.

Efficiency generally refers to the ratio of a certain benefit or result to the effort required to achieve it.

Greywater is untreated household wastewater that has not been in contact with toilet waste and does not include water from kitchen sinks or dishwashers. Greywater includes used water from bathtubs, showers, bathroom sinks and water from washing machines and can be treated to produce process water for toilet flushing, garden irrigation or for washing machines.

HOAI (Honorarordnung für Architekten und Ingenieure - Fee Structure for Architects and Engineers) is a legal ordinance of the German Federal Government that regulates the remuneration of the services of architects and engineers in Germany. It comprises nine service phases and describes the mandatory and additional services to be provided thereafter.

Hydroponics is a method of plant production in which the plants do not take root in soil, but are cultivated exclusively in water. in the combination of fish and plant cultivation (aquaculture), an (almost) closed loop system is created, also known as an aquaponic system. Through their metabolic processes, the fish release nutrients into the water, which are absorbed by the plants. The nutrient-poor water can then flow back into the fish tanks, closing the cycle. This closed-loop system enables the recycling of nutrients, metabolic products, CO2 and water and thus a resource-saving co-production of fish and plants (Million et al. 2018).

Nadácia Cvernovka (Cvernovka Foundation, S.C. for short) is the long-term tenant of the Nová Cvernovka campus and has the function of principal in the project.

Nová Cvernovka (New Cvernovka, N.C. for short) is the name of the entire cultural centre in the former chemical college. The building complex consists of the former school building, the former dormitory, a connecting building and the adjacent open spaces. In the report, the term is mostly used synonymously with the conversion project of the former dormitory into the *Centre for Metropolitan Innovation* or the community of current residents.

Passive House Standard is a building standard that is energy-efficient, comfortable, economical and environmentally friendly at the same time. The passive house standard is defined by a heating requirement of ≤ 15 kWh/(m²a). This value is achieved through particularly efficient ventilation technology, minimisation of heat losses (effective insulation of exterior walls, floors and roofs) and optimisation of heat generation (best possible glazing for passive use of solar energy).

Plus-Energy Buildings (also called energy-plus-buildings, efficiency-plus-buildings, etc.) generate more energy from renewable energy sources over the course of a year than they draw from external sources. While the term "PlusEnergyBuilding" is usually used in German, the term "Positive Energy Buildings" has become more established in international discourse. Therefore, we use the term "Positive Energy Buildings" in the English translation.

Prosumer refers to persons or entities such as households, cooperatives or local businesses that both produce and consume energy or other resources (producer + **consumer**).

Rainwater management is the collection, drainage, retention and storage of rain (= precipitation from the sky) for later sensible use such as irrigation, toilet flushing or as service water. This also includes unsealing of surfaces for retention, evaporation and infiltration of rainwater.

Retention areas or retention areas serve to retain and store rainwater. The rainwater is discharged in a delayed or reduced form. This is the only way to ensure that sufficient water is available for evaporation during dry periods. Another advantage is the hydraulic relief of sewers and watercourses and thus the minimisation of risk during heavy and extreme rainfall events.

Sufficiency aims to lower the demand for energy and resources and to reduce consumption, for instance through keeping an apartment at a lower temperature or limiting the average residential space per person.

Synergy is the interaction of elements that, when combined, achieve an overall effect that is greater than the sum of the individual elements.

Systemic consensus is a decision-making procedure from sociocracy that enables a differentiated form of voting for small and larger groups. It is not based on a simple majority vote, but on determining the highest group acceptance. In this process, the respective resistance of the decision-makers is evaluated in relation to the variants available for selection, e.g. with resistance points. The variant with the lowest group resistance represents the result.

Thermal insulation is important to reduce heating and/or cooling needs. The use of sustainable energy sources such as solar panels and PV cells, heat recovery from hot water and the use of ambient heat is an important second step.

2000-Watt Society is an energy policy model developed by ETH Zurich. The concrete goal of the 2000-watt society is to reduce primary energy consumption/energy demand per person to 2000 watts and the associated reduction of greenhouse gas emissions. The overarching goal is to use energy and resources sustainably, through conscious consumption behaviour (sufficiency) and in a globally equitable manner. In addition, a transition to 100 per cent renewable energies must take place. The reduction of primary energy demand must be achieved not only through technological developments, but also through social rethinking (Baccini 1999).

Abstract

Context and project goals

Nová Cvernovka is a significant socio-cultural centre in a former chemical technical secondary school from the 1950s and 1960s in a northern district of Bratislava. The entire building complex was rented by the Cvernovka Foundation from the Bratislava Self-Governing Region in 2016 for an initial period of 25 years and has since been used as a cultural and creative centre.

The aim of the research project was to develop an architecturally, socio-ecologically and energy-technically sustainable concept for the conversion of the former dormitory into Slovakia's first plus-energy building. For a total floor area of approx. 6,500 m^2 , new community-oriented forms of living as well as low-cost living (Co-Housing), office and studio uses for non-governmental organisations and social innovations as well as public supplementary functions (day care centre, café) were to be considered as programmatic uses.

The concept is intended to be an innovative, sustainable and resilient conversion of the existing building: From an energy point of view, a plus-energy building is to be realised that generates more energy than it consumes on an annual average through the use of renewable energy sources (ecological benefit); from an economic point of view, favourable rents as well as low operating and life cycle costs are aimed for (economic benefit); and through the participatory development and community-oriented use of the residential and service areas, the conditions for a responsible and inclusive community of residents are created (social benefit).

Research questions

What planning, ecological, energy-related and social measures are required to convert the existing hall of residence into a plus-energy building with the above-mentioned programmatic uses and sustainability requirements beyond that?

What does a suitable CoHousing concept look like and what forms of participation and spatial and community-building measures are suitable for this?

Which implementation strategies (organisational, financial and political) can be used to realise the developed planning concept?

Work plan and methods

The research project is based on a social-ecological approach of applied and transformative research, in which methods of integral and participatory planning were used for holistic project development. The close involvement of the foundation and the residents in the process was an important component of the strongly knowledge transfer and implementation-oriented project.

The project was processed in eight work packages (WP), each of which was carried out under the leadership of the responsible project partners of the interdisciplinary team and coordinated by the FHP as the main applicant. The preparation of the overall ecological concept and the management of the integral planning (WP1), the conception and implementation of the homepage (WP2) as well as the project management and administration (WP8) were the responsibility of the Potsdam University of Applied Sciences. The development of a concept for community-oriented forms of living and the monitoring of the participation process (WP3) were carried out by id22: Institute for Creative Sustainability. The Passive House Institute Slovakia (iEPD) was responsible for the determination of the energy status (WP4) and the conception of a plus-energy building (WP5), and the preparation of the final planning documentation for the project (A6) and the coordination of communication and public relations (WP7) were the responsibility of the Cvernovka Foundation.

Each work package comprised several work steps with specific methods: For the overall ecological concept and the creation of the homepage, extensive literature and project research, inventories, project visits and planning discussions were conducted, among other things. A "detailed design brief" was drawn up together with the other project partners as a specification with the planning goals and targeted social and ecological benchmarks. The requirements formulated there were the starting point and guideline for all further design

planning. For the CoHousing concept, a needs assessment and evaluation of the ideas and expectations of the current residents of the dormitory, expert interviews, visits to socio-ecological model projects and a process-accompanying consultation of the foundation, the architects and the community for the development of a context-specific space and function programme were carried out. For the energy considerations, the work steps consisted in particular of the calculations of the passive house standard with PHPP software as well as the conception of the plus-energy building and the optimisation of the solar system with a thermodynamic simulation using the programme IES-ve.

Results and possible applications

Overall ecological concept and plus-energy building: The project results show that it is possible to convert the building into a plus-energy building. This requires thermal upgrading of the envelope surfaces to the passive house standard, new windows, ventilation with heat recovery and the installation of low-temperature ceiling panels for heating and cooling. A PV system with a planned output of approx. 100 kW provides sufficient electricity on an annual average to operate the heat pump for heat generation. The PV system is planned as a fully integrated design in the shed roof construction of the planned roof extension and is a visible sign of the use of renewable energy.

In the course of the conversion, green-blue infrastructures will be created in the form of façade greening, hydroponics, a rooftop greenhouse and facilities for rainwater and greywater utilisation with retention areas. As far as possible, some of the facilities will be self-built (rainwater collection, hydroponics) or innovative developments (ceiling panels made of aluminium foam) by the engineering collective ECOboaRD based in Nová Cvernovka.

Through the preservation of the existing building stock, a "strategy of minimal interventions" and a recycling-oriented material concept, the existing grey energy is largely preserved and the amount of construction waste and other grey energies is reduced compared to a new building or a more extensive renovation. An assessment of the grey energy for the planned construction measures could not be carried out. Also for the long-term consideration of the building's use and thus the consideration of a later change of use, the concept of minimal interventions and a strong flexibility of the floor plan represents an important element of the sustainability of the overall concept.

Ecological (and economic) benefits can also be expected from the shared use of common spaces, services and objects, e.g. through the multiple use of optional spaces and consumer goods, through cluster living and through the planned sharing offers in the mobility sector.

CoHousing and participation: We recommend aiming for a "strong CoHousing" model, as this involves a higher degree of community participation, cooperation and decision-making rights and responsibilities of the residents. In exchange with the Cvernovka Foundation and the current residents, a site-sensitive mix of housing types was developed, to be implemented as micro-apartments, shared flats and cluster apartments. The building structure proves to be very suitable and flexible for the planned conversions; only minimal interventions are planned for installation cores, adaptation of the interior fittings and new access cores required for fire protection.

CoHousing is a cultural practice. Nová Cvernovka can learn from other projects, but also develops its own housing cultures. CoHousing is as much about processes as it is about achieving goals. The exchange with community representatives in Nová Cvernovka showed the importance of effective strategies and tools to engage residents, especially in terms of digital communication and online meetings, and to motivate them to continuously participate in the planning and implementation process. The "social architecture" is as important as the "built architecture", i.e. the structures for decision-making and management need to be developed together with the built structures.

Implementation strategies: This project documentation serves as the basis for further steps under licensing law. After completion of the project in May 2022, the public and authorities will continue to be informed about the development phases of the project, its functional framework and environmental parameters. Media coverage will include press releases in relevant media focusing on architecture, sustainability or lifestyle with local or national coverage. The aim is to attract further sponsors and partners to contribute financially to the building conversion as well as to inspire the Nová Cvernovka community and other non-profit initiatives to continue to participate in the planning and implementation process.

Knowledge transfer and homepage: The analysis of built examples and especially the visits to already realised model projects in Berlin and Vienna were important experiences to evaluate the decisions made in the design process. Only after many years of practice can a statement be made as to whether certain spatial, technological or social solutions and innovations have proven themselves or not. The homepage provides a documentation of 24 model projects and a catalogue of 27 socio-ecological design patterns, which have proven to be a useful tool in planning and can also be used by other project developers, architects or other actors when designing their own projects.

Conflicting goals, obstacles and outlook

In the working process, questions and concerns about project implementation were repeatedly raised, which were expressed in conflicts of objectives such as covering the necessary investment costs for high ecological and energy standards ("plus-energy buildings") versus socially acceptable financing ("affordable housing"). What are the actors willing and able to afford and what are they willing and able to pay for it? What forms of ownership structures, self-management and financial responsibility and participation are desired and possible in the future? Which value orientations and lifestyles should be lived? In order to take a closer look at these conflicting goals and questions, a scenario analysis was carried out, which resulted in two "raw scenarios" for the next seven years or so, one with more, the other with less ambitious characteristics. Even if the conflicting goals could not be solved, the scenarios at least provide an outlook on the further development of the project.

A major obstacle to the realisation of the project is the current ownership situation, as the rental situation does not currently allow mortgages to be taken out for the necessary financing of the planned measures. There are financing commitments on the part of some banks, but without property rights, the necessary collateral cannot be offered.

With the present project results, all planning requirements have been fulfilled so that the Centre for Metropolitan Innovation can implement the desired project goals in practice. In particular, the joint definition of the specifications ("detailed design brief for the architects") has proven to be an important tool for project development. Due to the representative building typology, this project has great transfer potential for similar projects in Slovakia and other European countries.

It should be particularly emphasised that the present project results could only come about through the strong ambitions and commitment of the Foundation and the Cvernovka community. This commitment is one of the most important prerequisites and drivers for the intended project realisation.

1. Introduction

1.1 Project and research objectives

Nová Nová Cvernovka is an important cultural and creative centre located in the north of Bratislava in the Nové Mesto district. The building complex of a former chemical technical secondary school from the 1950s and 1960s was leased by the Cvernovka Foundation from the Bratislava Self-Governing Region in 2016 for an initial period of use of 25 years. The building of the former school has been used as a cultural and creative centre since the reconstruction work. After the successful revitalisation of the school building, which is in need of renovation, the next step is to convert the former dormitory with a total floor area of approx. 6,500 m .[2]

The subject and goal of the research project was the development of an architecturally, socio-ecologically and energy-technically sustainable concept for the conversion of the former Nová Cvernovkas residential home into a socio-cultural centre with low-cost and community-oriented forms of housing. A socio-ecological research approach was pursued here, using methods of integral and participatory planning for holistic project development. The planned building conversion aims to be innovative, sustainable and resilient:

- From an energy point of view, a plus-energy building is to be realised, which generates more energy than it consumes on an annual average through the use of renewable energy sources. (ecological benefit);
- from an economic point of view, favourable rents as well as low operating and life cycle costs are targeted (economic benefit) and
- through the participatory development and use of the residential and service areas, conditions are created for the emergence of a responsible and inclusive community of residents and neighbourhood (social benefit).

The following three programmatic uses were to be considered in the design:

- Low-cost housing with shared housing forms (CoHousing),
- Office and studio uses for non-governmental organisations and social innovation,
- Complementary public functions on the ground floor (day care centre, café).

Based on a careful analysis of the existing buildings, a concept was developed with spatial, structural and organisational measures that achieve the desired ecological goals and promote community and CoHousing practices. Even after its completion, the Centre for Metropolitan Innovation is to be a workshop with an experimental character and offer space for social as well as technological innovations. Nová Cvernovka is thus developing into a model project in which synergies between social interests such as communication and affordability and ecological interests such as resource protection and building greening are practised and demonstrated.

For the concept development, in addition to considering the state of the art in research and technology, existing social and ecological "good practice" projects were examined in which this had already been implemented. The findings were translated into a catalogue of social-ecological design patterns and documented on a homepage. This serves to provide a set of options and suggestions that can be combined to maximise synergies and support transformative prototypes that bring together sufficiency and efficiency, for example.

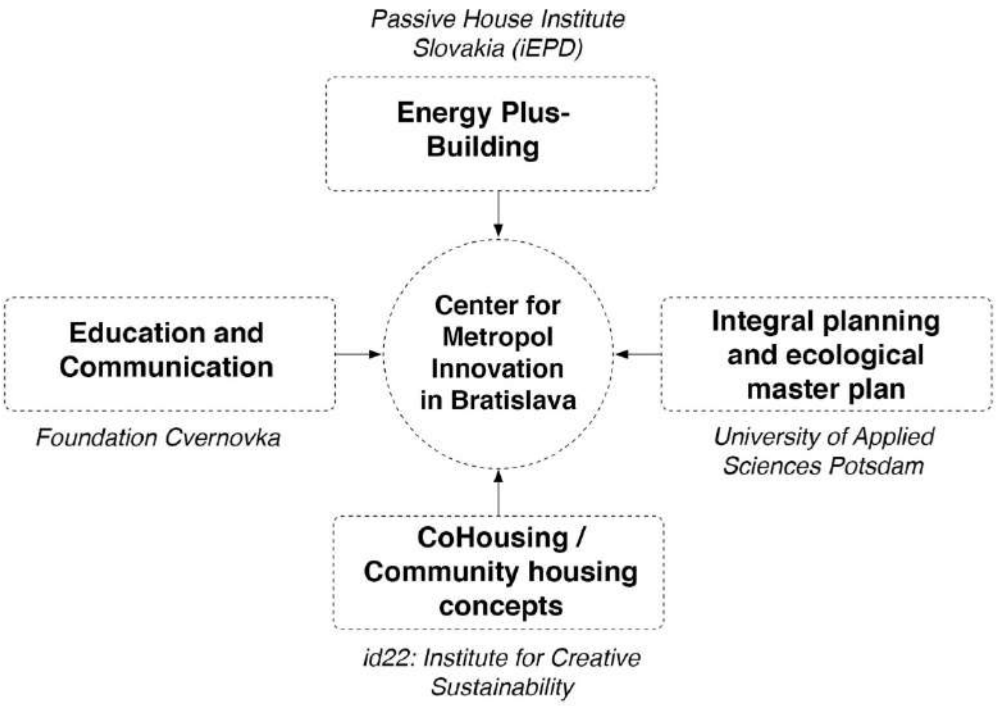
The project has above all a knowledge transfer and implementation character. Many of the proposed technical and social measures have already been successfully implemented in Germany and other countries, but they represent a new and extremely important contribution to Slovakia in terms of technology and building culture.

Successfully realised pilot projects that illustrate the technical functioning and socio-ecological effectiveness to building owners, project developers, architects and planners as well as those with political responsibility can lead to a sustainable dissemination of knowledge and ecological measures. The CMI.BA research project can therefore be classified as applied and transformative research.

1.2 Project structure and report outline

The research project was a collaboration between Nadácia Cvernovka (Cvernovka Foundation, C.F.) from Bratislava, which rented the property for 25 years and manages it, the University of Applied Sciences Potsdam (FHP) as the main applicant and project coordinator, the Passive House Institute Slovakia (iEPD) from Bratislava, and id22: Institute for Creative Sustainability (id22) from Berlin. The project partners were each in charge of one of the four central fields of action (Fig. 2).

Fig. 2: Research fields of action and project partners



Last but not least, an important informal cooperation partner was the community of residents of the residence to be renovated, who participated intensively in the project through the participation process and provided important planning impulses.

The structure of the final report follows the logic of the aforementioned fields of action, according to which the presentations of the state of research in Chapter 3, the work process and methods in Chapter 4 and the project results in Chapter 5 were also structured.

Another important part of the work was the development of a homepage for knowledge transfer, the concept and result of which are presented in Chapter 6 and Appendix A5. buildingsocialecology.org is a documentation of social-ecological (housing and mixed-use) projects and typical design elements that occur in these projects. Based on the sample projects, typical design patterns were identified that are frequently found in them and in different forms. The method is based on the book "A Pattern Language" published in 1977 by Christopher Alexander, Sara Ishikawa and Murray Silverstein.

1.3 Contribution to the environment and society

The building under study currently has a final energy consumption of approx. 250 kWh/(m^2 * year). The planned conversion of the building to the standard of a plus-energy building should reduce the final energy demand by approx. 85 % to approx. 30 kWh/(m^2 * year). By using renewable energies, especially photovoltaics for electricity generation in combination with heat pumps, the building will provide more energy than needed in the annual balance after commissioning and thus emit approx. 300-400 tonnes less CO_2 emissions per year.

Furthermore, the microclimatic situation is improved and a local contribution to climate adaptation is made through ecological open space design, which is supported by rainwater retention on the roof surfaces, as well as façade greening. The community-oriented forms of living and working promote a communal use of consumer goods and means of transport, such as household appliances or mobility services. This makes more efficient use of natural and economic resources.

1.4 Model character for Slovakia

The project has the ambition to serve as a model solution for similar modernisation projects in Slovakia. It has the potential to raise interest in sustainable solutions among the professional public, the media, architects, project developers, investors, property developers, but also among the public administration, such as mayors of municipalities, school headmasters and civil servants. The aim of the project is to become a showcase for innovative renovation and activation of existing buildings in public ownership and to raise the interest of state institutions to support more dynamic development in the field of construction and energy-efficient building design in Slovakia.

For Slovakia, the re-use of derelict buildings, taking into account high ecological sustainability goals and with the intensive participation of future users - here above all actors from the creative industry and residents in shared flats (CoHousing) - represents a major social innovation. As in other metropolises in Europe, Bratislava is also confronted with rising real estate prices. There is a tendency towards individual ownership and a lack of alternatives. The implementation of alternative forms of housing, as planned in the CMI.BA project, therefore represent an enrichment for the city's residents with potential for replication in other projects and places. Alternative forms of housing can consist of the conversion of existing buildings, publicly and state funded projects, projects with stakeholders from NGOs and the civil sector, rental flats and community-oriented living (CoHousing). The target group is primarily young people such as students and young educators ("social innovators") as well as vulnerable groups (refugees, homeless people, young people from children's homes, etc.), whereby the project is intended to have an "incubation effect".

Nová Cvernovka is already an experimental space. No similar location exists in Slovakia where such a large community comes together, works together and is part of the largest cultural and creative centre in Slovakia. Transferring the model to other Slovak cities is therefore crucial, especially since the construction method or type of building on which the project is based is widespread in Slovakia. There are already other counties in Slovakia, e.g. the Trencin county, which are interested in converting similar projects and want to learn from the participatory processes.

2. Nová Cvernovka - Context and actors

Fig. 3: Aerial view of the Nová Cvernovka Cultural Centre 2021. Photo: Ing. arch. Antonije Levičanin

The cultural centre can be seen at the bottom right of the picture, to the left (south) of it is the former Palma palm oil factory, above it (west) is the Biely Kriz residential quarter, and in the middle between them is Račianska Street (see also Fig. 6 Urban Development Zone Plan).

2.1 History of origins

Nová Cvernovka is a significant socio-cultural and creative centre located in the north of Bratislava in the Nové Mesto district at 78-80 Račianska Street. The beginning of the Nová Cvernovka project coincides with the eviction of a self-organised group of creative studios from a former 19th century yarn factory (called Cvernovka, Cverna = twine) near the centre of Bratislava, after the property was acquired by a new owner (residential developer) in 2016. In search of a new location, the community found a vacant chemistry school site in public ownership, consisting of a former school building with an adjacent dormitory and extensive open spaces. The former school building was designed by renowned Czechoslovak architect Vladimír Karfík, a student of Le Corbusier, as an administrative building for Alfred Nobel's neighbouring chemical factory and built in the early 1950s, but eventually used as a school. In the late 1950s, the student dormitory was built as an extension to the school. Since then, both buildings have only undergone basic renovation and modernisation, so the overall debt has increased in recent decades. The buildings have become outdated and inefficient compared to today's requirements. In addition, one of the buildings has been abandoned and suffered significant damage in recent years. The creative community of Nová Cvernovkas has breathed new functions and life into the old campus; they managed to renovate the interiors and establish public functions: for example, a cultural centre, CoWorking, a library, a public park, a kindergarten and much more. Currently, the campus consists of more than 130 studios and a community of almost 400 people - from designers, artists, photographers and architects to social innovators. The operation and development of the campus is community-driven, using participatory and design thinking methods, with a focus on environmental and social sustainability.

2.2 Organisational structure of the Foundation and ownership

The Cvernovka Foundation (Nadácia Cvernovka or S. C. for short) was formally established in 2015 to preserve the creative ecosystem that had grown organically in the premises of an old yarn factory. S. C. currently runs the largest independent creative and cultural centre in Slovakia called Nová Cvernovka, which is located on the site of a former chemistry school. It was founded by four members of the creative community, two of whom have remained on the foundation's management team. The Foundation also has legal bodies such as the Board of Directors (supreme body), the Supervisory Board and the Executive Board. The day-to-day operations team consists of staff working in the areas of cultural programming, communications, fundraising or building management and finance.

In 2016, the Foundation signed a 25-year lease agreement with the Bratislava Self-Governing Region as the owner of the property, which also includes a commitment to invest in the buildings. The Foundation hopes to extend the lease and amend the contract (or another model of cooperation with the public sector) to allow for long-term financing of the planned renovation works through both non-repayable and repayable funds (i.e. bank loans, equity financing or other).

2.3 The building ensemble

Fig. 4: School building of Nová Cvernovka ca. 1960, Photo: not known

The school building

The former school building (Fig. 4) was built in the 1950s and was in use until 2010. After its closure, it stood empty for six years. The interiors with classrooms, laboratories and technical rooms were significantly damaged, with most of the damage caused by thefts of heating systems and other building technical infrastructure as well as water leaking from the heating system. With the help of the community and contractors, the Foundation. managed to restore these interior spaces (repairing all surfaces, removing mould and toxic materials) and build a new common infrastructure (new heating system, electrical wiring, plumbing, etc.). The entire reconstruction of the private spaces was carried out by the studios themselves and with their own financial resources. The total investment has now grown to EUR 1.6 million and was made possible by two bank loans, a supplier loan, fundraising in the community and corporate partnerships.

In 2021, around 200 people will inhabit and use the premises of more than 73 creative and artistic studios and work spaces. There are many public uses and cultural offerings in the building and its surroundings: a multifunctional cultural centre with bar, bistro and other event spaces, a public library, craft shops and workshops, CoWorking, a community garden and a public park with sauna and playground.

The student dormitory - current use

Fig. 5: Street view of the former dormitory of Nová Cvernovka. Photo: PLURAL, 2022

The student dormitory (Fig. 5) was planned in 1955 and built as an extension to the school by the end of the 1950s, attempting to adopt the architecture of the neighbouring building. It was used for student accommodation until 2015. The building is accessed centrally via two staircases that connect the originally separate boys' and girls' wings. The building has five floors and a basement and covers an area of about 8,500 m^2 plus about 1,000 m^2 for a former gymnasium and canteen. It has about 130 rooms with shared sanitary facilities.

Since the Cvernovka Foundation took over the building, some of the interior spaces have been converted, including accommodation for people without homes ("Housing First" programme). A comprehensive renovation of the building has not yet taken place. Currently (as of March 2022), 60 long-term residents aged 18 to 67 live in the building and another 100 people work there. Every other floor is reserved for residential purposes, and in addition to the work spaces on the ground floor, there are other work spaces on the upper floors. The community consists of a diverse group of students, artists and creative workers, mainly from Slovakia, but recently the community of refugees from Ukraine and other countries has also grown. The gymnasium has been functionally transformed into an arts residency space dedicated to performing artists and dancers, and the former canteen, which has been structurally adapted, now houses a kindergarten offering an inclusive programme.

The primary goal is to transform the dormitory into an almost passive energy standard while maintaining its architectural value. This is to be achieved through innovative solutions, e.g. an overhanging façade with a smart shading system integrating PV panels or a living roof that combines spaces for social interaction, urban agriculture, the promotion of biodiversity and energy production.

Open spaces and integration into the neighbourhood

The buildings are surrounded by generous open spaces - former schoolyards and playgrounds that are gradually being transformed into public, semi-public and private zones, allowing for different types of outdoor activities, such as events, community gardening, sports and leisure activities, artistic installations or experimentation.

The surrounding park is currently being revitalised using circular design and regeneration methods. The pedestrian areas will be designed to be permeable and water-retaining, using waste material from recycled construction waste. The transformation will take place throughout the building's operation and based on ideas developed by the community.

The post-industrial district is a mix of busy streets, tramways and railways, administrative facilities, factories and residential and redevelopment areas in close proximity to the vineyards and the Carpathian Mountains. The presence of two railway stations and tram stops offers great potential for the development of ecological urban transport. The neighbouring former Palma factory is currently being converted into residential and office areas, which will help determine the character of the entire neighbourhood in the coming years and will also strongly influence Nová Cvernovkas.

2.4 Future vision of the Foundation

Already in 2017, a participatory process with the neighbourhood of Nová Cvernovka made it clear that public functions such as gastronomy and community-oriented living and working were missing in the neighbourhood area of N.C.. An important contribution to this can be the conversion and modernisation of the former N.C. dormitory, which was the subject of the CMI.BA research project.

The CMI.BA project pursued the ambitious goal of a regenerative transformation of the former student residence into an plus-energy standard building, a modular typology of community-oriented and affordable (rental) housing, and architecturally sound yet efficient and environmentally sustainable solutions. The functional transformation and physical modernisation will create a versatile space for a variety of uses, accommodating people of different socio-economic backgrounds and ages, from artists, designers and young creatives to social innovators, teachers and students.

In the future, the refurbished premises of Nová Cvernovka will offer office space and rooms for CoWorking as well as for social and cultural functions in addition to community-oriented forms of living. This complements the already existing offer of Nová Cvernovka, which mainly organises cultural events, concerts, theatre performances, lectures, discussion events, exhibitions and workshops. In the future, a park, restaurant, sports facilities, galleries, a library, a public garden and a children's playground will be built in the other parts of the area. Nová Cvernovka as a place for social and technological innovations will thus be complemented by further uses and gain in attractiveness.

In order to achieve affordability and energy efficiency at the same time, some concessions may have to be made in the final spatial solutions on the architectural level, but also on the personal level of the future tenants. Most importantly, people will have to share more spaces and functions than in traditional Slovak housing, where most of the space is privatised. In general, people will have to put up with some inconveniences; however, they will also have the opportunity to participate as a community in the reconstruction process and in shaping the building as well as the surrounding areas. The willingness to change one's lifestyle will be one of the main challenges in realising the project.

As a result, the building will produce more energy on an annual average than it consumes, be CO_2 -neutral and express the principles of transformative and regenerative architecture. The CMI.BA project will dramatically increase the energy efficiency of the former student dormitory through smart renovation measures and look for ways to use renewable energy to produce more energy than it consumes. Another challenge is to reduce energy and resource consumption while democratically and fairly involving those directly affected, maintaining affordability and fostering community.

In addition to the "CMI.BA" building section worked on in the research project, the second building section forms the "Creative & Cultural Centre" (CCC). In addition, a revitalisation of the semi-public backyard, the current parking spaces, is planned. The vision for the entire area is the further development and the narrative of an "Urban Eco Centre", in which the various projects "Creative Cultural Centre", "Centre of Metropolitan Innovation", a public park and garden as well as a "Centre of Performing and Visual Arts" (CPVA), complementing the "Urban environmental Education" project, interact on one campus.

Furthermore, Nová Cvernovka as an "Urban Eco Center" could form a new sustainable and creative quarter with its surroundings and neighbourhood in the future. This would succeed by opening up to the neighbourhood, for example with the adjacent Palma factory or ZS Vinohrady (Fig. 6).

Fig. 6: Urban development zoning plan

3. State of the art in research and technology

In the following, a brief overview of the state of the art in research and technology of the topics addressed in the research project is first given.

According to the project objectives, the three central thematic areas are:

- Ecological overall concepts
- CoHousing for community-oriented and inclusive housing projects
- Energy-efficient construction and plus-energy buildings

This overview is preceded by three notes:

First of all, we realised that there is not *one* (international) state of the art that can be applied to Nová Cvernovka, but many concepts and components from which the components suitable for implementation have to be filtered out for a context-sensitive ecological building concept. The more components are added, the more complex and expensive the project becomes, creating a conflict of objectives on the issue of affordability. The specific conditions such as use requirements, climate, social context, costs, etc. and the balancing of priorities play a decisive role in the selection of suitable components. Not every component is suitable for every context.

Furthermore, we would like to refer to the compilation of *design patterns* that we have compiled for the homepage (see Chapter 6 and Appendix A5). Many of these design patterns contain structural, technical or spatial descriptions of a "best practice", which is why they are either referred to in the following (cf. pattern x) or directly included in the text.

Finally, it should be emphasised that we have preceded the following chapters with often technological content with a theoretical excursus on social ecology. Since we describe the case studies under investigation as *social-ecological model projects* and also assign ourselves to participatory, transformative research with the project goals, it was essential to define a position for this.

3.1 Overall ecological concepts

The aim of ecological building is to design and use the environment in such a way that negative impacts on the environment and its various subsystems are minimised. This refers to the environmental media of soil, water and air, as well as ecosystems and their organisms, which includes humans (usually considered a priority).

Ecological building emerged in the context of industrial modernism as a reaction to the perception that the industrial growth model is not sustainable. Since the 1970s and 1980s, architects such as Per Krusche (Krusche et al. 1982), Frei Otto, Joachim Eberle, Dieter Schempp, Gernot Minke (Mahlke 2007), Otto Steidle, Ekhart Hahn (Hahn 1992), Manfred Hegger or Thomas Herzog, among others, have made important contributions to ecological and sustainable architecture and urban development in German-speaking countries alone. There were pilot projects on ecological building at the International Building Exhibition in Berlin in 1984-87, and the first passive house in Darmstadt by Wolfgang Feist (1991) and the energy-autonomous solar house in Freiburg (1991) can be described as milestones for later developments.

In recent years, the focus of building research has rightly been on energy-efficient construction and the development and methods of integrating systems for the use of renewable energies. But increasingly, research is also being advanced on climate-adapted building, the use of ecologically safe building materials and strategies, circular building or new forms of spatial organisation such as cluster housing. The environmental impact of building activities is mostly determined by life cycle assessments, especially in the evaluation of building materials and building operation. These are also part of certification systems such as (LEED, BREAM, dgnb), which were not looked at in more detail in this research project, as certification was not an option in the context of this project for cost reasons alone.

Ecological housing and urban development projects often focus primarily on issues of increasing energy efficiency in construction or the use of sustainable construction materials and building technologies. However, the requirements of affordability, cost- and space-saving construction methods or the promotion of social aspects such as communal or elderly-friendly living play an equally important role.

Social-ecological building claims to consider ecological and social aspects equally, integrally and as mutually dependent, and to realise sustainable projects based on this attitude. A social-ecological perspective can thus contribute to realising a more comprehensive and radical description of current challenges such as climate change and affordable housing. The planning of social-ecological projects requires the consideration and bringing together of diverse subject areas. Therefore, an overall concept that integrates all the thematic areas to be considered and creates an overview of their interactions is of central importance.

3.1.1 Social ecology

The CMI.BA research project ties in with the discourse of social ecology as it has been shaped in Germany since the mid-1980s, primarily by the Frankfurt Institute for Social-Ecological Research (ISOE). According to this, social ecology is understood as a process-oriented, inter- and transdisciplinary science of social relations of nature that is constantly evolving and oriented towards transformation towards sustainability (Gottschlich 2017: 5-6). The founders of ISOE, Egon Becker and Thomas Jahn, define social ecology as "the science of social relations of nature. It investigates theoretically and empirically their forms, changes and possibilities for shaping social practice in an integrative perspective" (Becker & Jahn 2006: 87). In this context, social relations of nature refer to "symbolically mediated material-energetic and organic patterns of regulation" (Becker & Jahn 2006: 193).

Referring back to the zoologist Jakob von Uexküll, environment is seen as a relational rather than an objective category, since an identical environmental setting produces highly different perceptions and effects from the respective species-specific or individual perspective (Becker & Jahn 2006: 143). In this respect, *environment is* also a socially constructed reality and *environmental problems cannot be* solved by a natural science or engineering perspective alone. The intention of social ecology is therefore to integrate the competing natural and social science research methodologies into a holistic perspective and to establish itself as a bridging concept between natural and social science research domains that overcomes the demarcation discourse of naturalism and culturalism. A description is called "naturalistic when natural scientific thinking universalises and attempts to also recognise cultural and social phenomena with the ways of thinking, concepts and methods of natural science; we call a description culturalistic when it treats natural phenomena like cultural-social ones." (Becker & Jahn 2006: 125).

The English term "social ecology" was coined by Milla A. Alihan in the 1920s with the intention of creating a more analytical and integrative framework about the relationship between people and their environment than the field of *human ecology* (Hummel et al. 2017: 2). The term is strongly associated with urban sociological research at the *Chicago School* and the book The City published by Robert Park, Ernest, Burgess and Roderick McKenzie in 1925. Other influences come from biologically based *systems ecology*, *cultural and urban ecology,* and *industrial ecology* (Becker 2016: 392). The latter in turn is linked to the concept of *social metabolism* (Bacchini & Brunner 1989, Fischer-Kowalski 1997).

Social ecology" from the USA combines different scientific activities than the more recent "social ecology" in Germany (Becker 2016: 391). The latter is a novel form of scientific treatment and analysis of complex problems. Social ecology sees itself as a critical science with a close relationship to institutional politics and social movements (Gottschlich 2017: 5). In the wake of the Brundtland Report of 1989, the BMBF's funding priority "Social-ecological Research", which has existed since 2000 and was decisively shaped by ISOE's framework concept, represents the transition from environmental to sustainability research at the ministerial level (Gottschlich 2017: 4).

Social-ecological research investigates how these relationships can be identified, researched, thought about and shaped with regard to hybrid crisis constellations that are constantly in flux (Gottschlich 2017: 7). The research is problem-oriented, related to concrete fields of action and takes the form of participatory research that integrates knowledge from practice. As applied basic research, this is assigned to a new type of research, also referred to as "mode 2 science" in the discourse on science theory (Becker et al. 2000: 98 ff, Schneidewind & Singer-Brodowski 2014: 77).

Since social ecology is transdisciplinary, it operates in diverse organisational forms with social actors and scientists, is directed at social non-academic problems and is implemented with a consciousness of social responsibility (Becker 2016: 394). Based on the fact that ecological and socio-economic causes and effects mutually influence and are interwoven in societal relations with nature (Liehr et al. 2006: 267), economic innovations must be advanced in addition to political and scientific ones in order to shape the relations between society and nature (Becker & Jahn 2006: 16). Here, however, economics is conceived less in terms of the market, production and growth, and more in terms of everyday life and needs (Gottschlich 2017: 7).

The 2000-watt society

The use of fossil fuels is one of the main drivers of anthropogenic climate change. In order to counteract this, enormous technological and social transformations are necessary, the implementation of which requires a strong social model that is supported by the various actors. In Switzerland, the concept of the 2000-watt society has been developed at ETH Zurich since the mid-1990s. The target for a sustainable society is defined as a maximum average energy output of 2,000 watts per inhabitant. The 2,000-watt society and the decarbonisation of energy systems are two long-term concepts that have been proposed as decisive solutions to climate and energy policy tasks (Spreng & Semadeni 2001: 5 f.).

Switzerland's annual per capita energy consumption in 2000 was about 6000 W, including net imported grey energy, while the target of 2000 watts is roughly equivalent to Switzerland's per capita energy consumption in 1960 (Spreng & Semadeni 2001: 6). The goal of a 2000-watt society, however, does not mean "reducing comfort to 1960 levels, but rather dramatically improving the efficiency of energy use and reducing energy consumption on the basis of a modern lifestyle with innovative technical solutions, management concepts and social innovations. Many things, such as zero-energy houses, car-free zones, the smallest, most fuel-efficient vehicles and highly efficient, computer-controlled production plants, are already possible today" (Spreng & Semadeni 2001: 6).

The strength of this guiding principle is that it defines a simple and objectively measurable target value that covers all areas of society's metabolism (construction and housing, energy supply, mobility, nutrition and all other areas of consumption). In this way, the development towards a more sustainable society can be reviewed and measures can be readjusted if necessary.

Many Swiss municipalities have now made this concept the guiding principle of their urban development. Many cooperative housing projects in Switzerland, such as the Giesserei and Kalkbreite, have also committed themselves to the concept of the 2000-watt society. It is implemented there through a combination of efficiency and sufficiency strategies, i.e. with appropriate structural, energy-related, design and use-related measures. In these projects, for example, the buildings were constructed as passive houses, mobility concepts with a minimum of individual motorised traffic were agreed upon, individual private spaces were reduced to a minimum and collective or shared spaces were enlarged. In order to record the results of these measures, the energy consumption in the respective project as a whole is recorded per person and not per square metre. For the evaluation of these so-called "2000-watt areas", own calculation methods and calculation aids for monitoring have been developed (Lenel 2012: 219 f.). In Germany and other countries, the application of this model is not yet so widespread, but its implementation would be very appropriate, especially in the course of neighbourhood renovation and the planning of new neighbourhoods (Keßling 2010).

Prosumers

In this context, the role of people is also changing, which is referred to by the term *prosumer*. The term consists of the combination of the terms producer and **consumer** and means, from a socio-ecological perspective, to produce at least part of what one consumes oneself. In practice, this is mostly associated with community-based, decentralised renewable energy or local agriculture projects such as urban farming. If such projects are democratically organised, they can help put control over the consumption and production of basic resources like energy and food back into the hands of the people who use and (dis)need them. Those who are both producers and consumers have a different perspective and impact on production and what is produced. Prosumption can become a driving force for innovation and change in the economic system (Ritzer & Jurgenson 2010; Hellmann 2016).

Already in the late 1980s, Block 103 (Berlin) pioneered the demonstration of resident:organised and self-managed cogeneration, solar energy and water recycling plants. In terms of food production, the Spreefeld (Berlin), ufaFabrik (Berlin) and Kalkbreite (Zurich) projects all have urban farming, food forests, edible and productive landscapes on site. These spaces not only provide food, but also promote interaction between residents and the neighbourhood. In addition, the ufaFabrik and Block 103 have children's farms.

Initiatives like the ones presented help to counter the ecologically destructive processes of industrialised agriculture by promoting small-scale and organic food production and shortening the distance from "pasture to plate". The community-based projects can strengthen community cohesion and at the same time bring people together with nature. The educational aspect is particularly important to teach children growing up in urban spaces about living with plants and animals. At the same time, however, self-organised infrastructures such as energy, water and food systems require technology that is sometimes costly and does not directly influence people's behaviour. Technological innovations, whether low- or high-tech, should be open and accessible to everyone.

3.1.2 Social-ecological model projects

Ecological and social innovations were and are mostly developed and tested in model projects. Projects have model character if they initially realise special constructional, technological, social or other innovations as prototypes either within the framework of institutional funding measures (e.g. as research objects in funding or transfer programmes) or due to civil society initiative. If these prove themselves and achieve a sufficiently large social resonance and economic effectiveness, they can become the social mainstream and set new standards.

This can be observed in the development of energy-efficient buildings, in the use of renewable energies or in the use of ecological building materials (e.g. timber construction) as well as in socio-spatial innovations, e.g. in the development of community-oriented forms of housing such as building groups or cluster housing as well as in artistic and socio-cultural centres. Long before the term "reallaboratory" became en vogue, projects emerged that, in the self-image of the actors, see themselves as models of a "common good-oriented neighbourhood development" (Heinrich Böll Foundation 2017) or address cooperative and participatory processes of building and urban production as the "New Urban Agenda" (Overmeyer 2014). Often, these projects are about re-invaluating properties that have been left vacant, derelict or demolished. Examples include the ufaFabrik and ExRotaprint in Berlin or the Samtweberei in Krefeld. In addition to the development of existing buildings, new construction projects such as the Spreefeld in Berlin, wagnisArt in Munich or the Hunziker Areal in Zurich are important model projects in which architecturally sophisticated as well as spatially, technically and socially innovative concepts have been realised. Much can be learned from the development of these projects and often the respective project developers and residents develop their concepts further for new projects. Examples of this are some cooperatives in Zurich or Vienna or various "building groups".

During the CMI.BA workshop in Berlin in August 2021, the project team visited several projects that are particularly relevant to the transformation process in Nová Cvernovka, including

Spreefeld - The building floor plans and the organisational form of the Spreefeld offer sufficient flexibility to meet the changing living needs and requirements of the residents. For example, it is possible to combine residential units into shared apartments or to divide them up. This is the strength of the project - the built structure can be adapted to the needs of the community. The building typology and the cooperative form of organisation support this.

IBeB - The IBeB project (Integrative building project at the former flower wholesale market) has residential and commercial units as well as studios or studio flats. Duplex flats offer flexible forms of living and working. The development areas essentially serve as communal areas, there are also two roof terraces for communal use. Within the framework of a conceptual process and participatory planning, planning steps were largely decided jointly. In individual cases, the architects determined the project. In the case of the ceramic tiles on the façades, for example, no consensus could be found, so that only those who were in favour of implementation participated financially. As long as the financing of individual measures is secured, decisions do not have to be borne by all. Only those who are convinced of the measure can pay for it - but this requires a financing model that is also supported by the residents.

Refugio - Refugio is one of the few projects in Germany in which shared flats with and for refugees have been realised. The only comparable project is the Grand Hotel in Augsburg. The aim is to welcome refugees, to integrate them into society through the housing offer and to empower them. It is obligatory that they contribute to the house community through volunteering and take on four hours of work per week. The volunteering as well as the working hours help to save expenses and share tasks within the community. In this way, the community as well as the project are strengthened by everyone's contribution.
In addition to communal areas such as a roof terrace and a communal kitchen on each floor, there is a public café on the ground floor. This is the central place for communication and information. Each room is equipped with a bathroom and thus offers sufficient privacy. Overall, attention is paid to a heterogeneous resident population with 50% refugees and 50% foreign students or Germans, as well as a balanced gender ratio. In

addition, the new tenants are selected by the residents of the respective floors themselves. The rent is about 400 euros per person. With the help of the rental income and the income from the café, the maintenance costs are paid to the Stadtmission, the owner of the building. The Refugio also has affordable studios with shared bathrooms and hosts some initiatives. Central elements of the Refugio are the mix of uses, the diverse residents and the volunteer work. These are favoured by the flexible building structure.

ALLTAG - The ALLTAG project is located together with CRCLR House on the Vollgut site in Berlin Neukölln. They are part of an energy network that supplies several buildings in the neighbourhood. The wood-concrete hybrid is divided into a hot and cold zone, which saves energy and heating costs, among other things. ALLTAG gives temporary residents the opportunity to live individually and self-determined while participating in and shaping the community. ALLTAG makes offers for people in special life situations who are looking for temporary housing for various reasons: People in a rehabilitation phase, girls and women fleeing violence, refugees from hostels, those affected by homophobic attacks, tourists and others. The floor plan format can combine small units into larger temporary housing communities. The subsidy-linked setting of 6.50€/m^2 for the housing units ensures affordable rents. This was supported by the purchase of the land by a foundation. The architects support the participants and residents with their knowledge and experience to also help them with self-building.

CRCLR House - The project aims at a circular building conversion. This includes, among other things, the reuse of products and the use of recycled products and renewable raw materials. This approach is particularly challenging during the planning phase. With the help of participatory building measures such as workshops on building with straw, the issue is strengthened within the community and the neighbourhood. Also in this project there was a stipulation of 6.50 €/m^2 for the housing units, which ensures compliance with the pre-agreed allocation of use, affordability, but also a certain pressure to implement, a special consideration of material (costs) in case of further economic development and increasing rents of the commercial areas. Participatory programmes and workshops can impart knowledge and place topics such as the circular economy, low-resource construction methods, ecological building materials, etc. in the community as well as in the neighbourhood.

3.1.3 Integral planning

Especially in the planning of very energy-efficient building projects, there are complex planning processes that require the early participation of all those involved in the planning process. From the beginning of the process, close cooperation is required between the project developers, the architects, all specialist planners and the subsequent facility managers. This process is called integral planning (Löhnert 2002, Voss et al. 2005) (cf. Pattern P1).

All parties involved must agree on the sustainability goals to be achieved and agree on suitable procedures within the project management in order to make the necessary planning decisions in good time. The "right" decisions must be made at an early planning stage, as these decisions have a major impact on spatial, functional, technical, economic and temporal aspects. Changes at a later planning stage are often not feasible or can only be realised with a high expenditure of work, costs and time. For example, different design variants or planning scenarios must be developed for the overall design or for partial aspects, which include structural, material, heat supply or ventilation concepts.

Despite many efforts, sequential planning processes largely prevail in practice. Although integral planning has a key function in sustainable construction, it is often not or only insufficiently applied in practice for various reasons. One of the reasons for this is that the associated higher planning and communication costs are usually not covered by conventional fee agreements. The willingness of actors to participate in the preparation and evaluation of planning scenarios is accordingly low, and the necessary decision-making knowledge is often obtained in practice through externally commissioned expert opinions (e.g. for energy concepts). The consequences of inadequate planning and implementation processes are sufficiently known as cost overruns and/or schedule overruns and can be explained very well in system theory by the so-called "rework cycle" (Prytula & Hanko 2019: 76f.).

3.1.4 Green and blue infrastructures

Blue-green infrastructures in urban development

The notion of *green and blue infrastructure* (or *blue-green infrastructure*) is closely linked at the urban level to the development of the concept of ecosystem services, which fulfil important but mostly economically insufficiently considered societal provisioning functions. "According to Brears (2018) and the European Commission (2013), blue-green infrastructure is understood as urban green infrastructure, the urban green, and urban blue infrastructure, related to aquatic ecosystems, as a strategically planned network that runs through the city. Since blue and green infrastructures are strongly intertwined, they are often referred to as blue-green infrastructure (BMUB 2017). This blue-green infrastructure can consist of near-natural and man-made elements" (Trapp & Winker 2020: 15).

Drinking water supply and wastewater disposal as well as the adaptation to or regulation of natural water regimes (rainwater management, retention areas for floods, etc.) has always been an essential part of public services and thus an important municipal planning and management task (see Tepasse 2001 for an example). With the sustainability discourse, cycle-oriented strategies became increasingly important for urban water management planning and rehabilitation of stormwater management and wastewater treatment systems (Löber 2001, Gantner 2002, Zimmermann 2005, Hiessl 2005, Herbst 2008). In addition, there is systems research on the integrated use of rainwater and / or wastewater for building-integrated food production (Buchholz 2002, Million, Bürgow & Steglich 2018), which aims to maximise (food) recycling.

In recent years, numerous research papers and guidelines on integrated "water infrastructures for the sustainable city" (Difu 217) and on open and green space development (Trapp & Winker 2020, TUM & ZSK 2020, Ludwig et al. 2021) have emerged, particularly with regard to the pressing issues of climate adaptation in municipalities. These aim not least to improve the health of urban residents (reducing heat island effects, increasing air quality, reducing noise emissions, etc.) also the general quality of life in cities. Vulnerability and resilience have become central concepts in the integrative consideration of landscape, technical and social system levels to meet the challenges of climate adaptation and mitigation (on resilience see in detail Thoma 2014, Prytula et al. 2020a:197 ff).

Green and blue infrastructures at the building level

An elementary building block for the improvement of green and blue infrastructures at the urban level are the technological and spatial systems at the building level. With regard to the greening of facades (cf. Pattern G1) or of roofs (cf. Pattern G2) as well as for rainwater utilisation (cf. Pattern G4) or for greywater utilisation (cf. Pattern G5), there are extensive research results, many established technologies and numerous guidelines.

Green facades promote health by reducing air pollution and city noise, cooling the environment through evaporation and shading, and creating ecological niches for animal life in the city. Through evapotranspiration, they improve the microclimate on and in the building and can thus contribute to greater comfort and energy savings in high summer temperatures (Berlin Senate Department for Urban Development 2010: 35). By multiplying rainwater evaporation while reducing heat, the climate balance in the city is promoted and canal systems are relieved (Pfoser 2016: 86). Green facades have the greatest effect in dense cities and hot climates. Due to the greening phases, green buildings can simultaneously regulate heat gain and heat rejection in a natural way. They are able to remove 50% of solar radiation from the street space, so they are also beneficial for pedestrian circulation. Cities would benefit from more greenery at street level, as these areas intercept most of the solar gain. At the same time, the average temperature reductions are much smaller than the peak reductions in heat islands (Pauli & Schauermann 2017: 55).

Green roofs generate positive microclimatic effects through a high rain retention potential and the reduction of surface and air temperatures. With a 40 cm high green roof structure, there is already a difference of 5 °C between the air temperature on a green roof compared to a gravelled roof. This effect is stronger with higher vegetation and larger leaf areas - and thus also an advantage of intensive green roofs over extensive green roofs. So-called blue-green roofs are a combination of greening and water storage and are particularly suitable with regard to climate adaptation. The water is stored over a longer period of time and is released for cooling in dry periods through the evapotranspiration of the roof vegetation (Becker & Neuhaus 2016: 23).

Extensive green roofs are transferable to most existing roofs. Intensive green roofs are more costly, but usually offer aesthetic, private and communally usable open spaces. In addition, they have a stronger influence on the urban climate and the energy balance than extensive green roofs due to the higher structure and plant heights. For the influence on the urban climate, the total proportion of green roof areas at district level plays a decisive role. Parameters for the strength of the temperature reduction are the density and height of the development and the proportion of green roofs. While the climatic influence of isolated green roofs is primarily limited to the roof level, the entire urban climate can be influenced in a larger network of green roofs.

Green facades and roofs can be combined with rainwater or greywater harvesting (Pfoser 2016, p. 86). The cooling effect also leads to a synergy of green facades and roofs with photovoltaics. Some plants grow better due to shading and the higher humidity under the solar modules, while these are more powerful due to the lower temperature caused by the green roof and, if necessary, additional irrigation. The combination of solar thermal energy with a green façade, on the other hand, generally reduces performance. However, this can be used as a seasonal collector during the heating period (Pfoser 2016: 85).

The importance of *community gardens* (cf. Pattern G3) or urban gardening as a participatory contribution to an identity-creating design of urban living spaces and for climate adaptation measures is well known (BMI 2014, Weeber+Partner 2021). Community gardens are places for the integration of different social groups and places where the relationships between residents are strengthened. Community gardens enable encounters that can gradually solidify into neighbourly structures and social networks. They have the potential to bring actors from different milieus and age groups into contact with each other (BMUB 2015: 8). This is because they only function through the commitment of many and only unfold through the interaction of positive contributions within the neighbourhood and the neighbourhood (Neo & Chua 2017). Nevertheless, the programmatic objective of the community garden determines who comes together in the garden and gardens together (BMUB 2015: 8). In addition, community gardens are places of education: they enable knowledge to be passed on, an understanding of natural cycles to be gained and nature in the city to be experienced. In addition, community gardens can grow healthy food locally and inexpensively and relieve urban supply structures on a larger scale (BMUB 2015: 9).

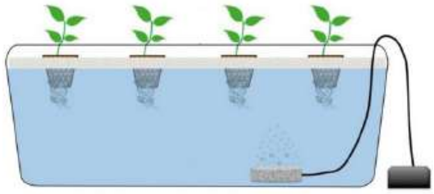
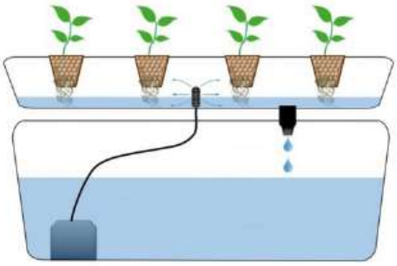
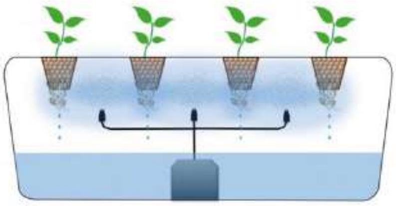
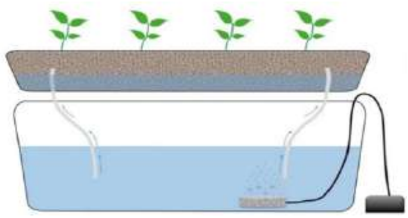
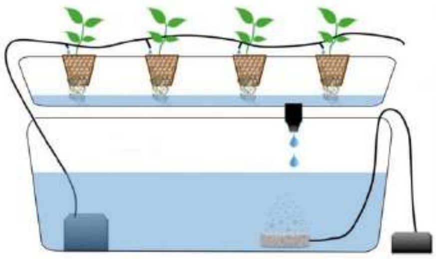
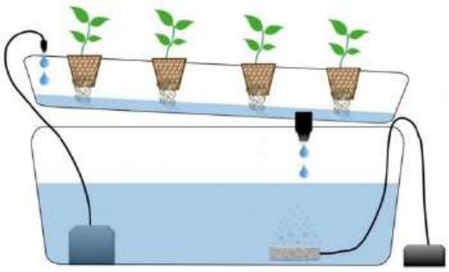
In the following, we will limit ourselves to a presentation of hydroponic cultivation systems, which have a concrete relevance for the research project in the context of integrated rainwater and wastewater utilisation for building-integrated food production (see above).

Hydroponic growing systems

Hydroponics is a method of plant production in which the plants do not root in soil but are cultivated exclusively in water. In contrast to hydroponics, which mostly uses a substrate in the form of expanded clay balls, the plants in hydroponics root exclusively in a liquid nutrient solution. The main aim of using a hydroponic cultivation system is to produce vegetables and fruits (e.g. strawberries) locally and in a space-saving way. The first significant advantage compared to conventional cultivation in the ground is a considerable saving in water consumption of 80 - 95%. This enables cultivation even in areas with a significant lack of water resources. Other advantages are the increase in crop yield, the reduction or even complete elimination of pests, the more efficient use of land and the elimination of the use of herbicides. There are several widely used hydroponic systems. They all have one thing in common - the plants are grown in a nutrient-rich water solution without soil. The most commonly used systems at present are shown in Tab. 1.

A distinction is made between six basic hydroponic systems: Deep Water Culture system, ebb and flow system, aeroponic system, wick system, drip system and the flow-through solution culture (NFT) (Krebs 2019:12) as well as the Kratky method, in which, as the simplest type of hydroponic cultivation, the plants are placed in a container with a nutrient solution without further pumps (see Table 1).

Table 1: Overview of different hydroponic farming systems. Authors: ECOboaRD

DWC (Deep Water Culture) - cultivation takes place in large tanks filled with a nutrient solution, with the plants standing on floating rafts on the surface. This is currently the most widespread cultivation system for agricultural crops, especially lettuces	
Ebb and flow- also known as flood and drainage. Plants in growing containers filled with inert substrate (usually perlite, expanded clay or mineral wool) are flooded at certain intervals with a nutrient solution, which then flows back into the reservoir. This provides the substrate with sufficient moisture and the roots receive fresh air at the same time.	
Aeroponic system - plant roots in a closed container are supplied with a nutrient solution sprayed via nozzles. It is the latest system and its results are also being tested in connection with the planned Mars colonisation. It achieves very good results thanks to the optimal access of the roots to water and air.	
Wick system - the distribution of a nutrient solution is ensured by the capillary action of the "wick". This system is most commonly used for growing indoor plants. It can be used in households as well as in commercial spaces.	
Drip system - works on the same principle as the drip irrigation used in conventional in-ground cultivation. The difference is that the inert substrate and plant food are provided again by the nutrient solution. The excess solution is returned to the reservoir.	
NFT (Nutrient Film Technique) - this system is a continuous circuit of a nutrient solution that washes around the plant roots, which also have access to the air. Due to its simplicity and excellent results, this system is gaining in importance. Therefore, we have chosen it as the most suitable alternative for integrating the hydroponic system into the CMI.BA project, with the aim of improving the well-being and comfort of the residents.	

Kratky method (named after Dr. Bernhard Kratky) - the simplest way of growing plants hydroponically, also called a passive system because it does not require pumps or air pumps. The plants are placed in a container with a nutrient solution. The plant gradually consumes the solution, creating an air bubble in the container, which also ensures that the roots have access to oxygen.	

Commercially, hydroponic systems are already being used successfully in various places, such as in Singapore since 2014 (Sky Greens) or in Berlin since 2015, Bad Ragaz since 2016 and Brussels since 2018 in connection with aquaculture production in partly building-integrated greenhouses by ECF Farmsystems GmbH (https://www.ecf-farm.de/). They are an integral part of concepts for "vertical agriculture", from which it is hoped that urban-integrated food production will lead to a better cycle closure of urban material flows despite the often high operating and investment costs (Krebs 2019, Ponweiser 2021:35 f.).

3.1.5 Circular construction

The construction industry is a particularly resource-intensive sector of the economy that requires a lot of energy and generates large material flows, transport expenses and emissions. A sustainable society requires not least circular economies and this requires the establishment of a circular economy in construction with ecologically intelligent design solutions for all products and value chains.

The potential to use reused or recycled building materials is currently largely overlooked and also hampered by legal regulations, contractual conditions and economic framework conditions. Nevertheless, the use of reused or recycled materials is an important way to reduce the amount of resources used, protect the environment and promote sustainable development in construction (cf. Pattern M1). Recycling usually means that components are broken down into their material components in order to process them into something new. However, this usually reduces the quality and value of the material (downcycling). Direct re-use or re-use of components usually requires only minor material processing before further use, but presupposes assembly-friendly construction methods and design for disassembly.

The use of material passports and the establishment of material databases supports the development towards a circular economy in the construction industry. The cradle-to-cradle concept (McDonough, Braungart 2002) aims at a comprehensive transformation of the way (building) products are produced, in which all materials are fed into comprehensive ecological or industrial circular processes without harming people and their natural environment. This requires an ecologically intelligent design of all products and value chains. Planning principles for circularly oriented building are

- Durability,
- Adaptability,
- Consistent use of natural raw materials and secondary materials and
- deconstruction capability (Theobald 2022: 51).

Furthermore, it is necessary to use urban systems more than before as storage and source of raw materials. This is called urban mining and a distinction is made between inorganic resources (e.g. gravel deposits or metals) and organic resources (e.g. wood) (Baccini 2008). Material flow analyses can be used to estimate the stocks and the utilisation potential of the regional material balance. Urban mining reduces primary resource consumption through the use of secondary raw materials and thus promotes sustainable resource use. In this way, the natural resources soil, water and air are protected (Hillebrandt et al. 2018: 10).

The prerequisite for better recycling of building materials or even complete components is that concepts for later dismantling are already taken into account during planning (cf. Pattern M2), in conjunction with the creation of a digital material passport that contains information about the composition of buildings and the condition of the materials (cf. Pattern M3). Care should be taken to ensure that components and structures with materials of different durability can be easily separated. Building with healthy, renewable materials (cf. Pattern M4) and identifying and integrating existing materials is essential for resource conservation. On the other hand, the building industry needs suitable framework conditions that also promote a competitive circular economy in economic terms. Sufficiently large material depots and markets need to be established, and liability regulations need to be adapted in order to significantly increase the reuse rate.

3.2 CoHousing: community-oriented and inclusive housing projects

3.2.1 CoHousing - term and meaning

Current debates around housing, affordability and inclusion are very dynamic and emphasise the need for new forms and options of housing. More and more people are looking for alternatives that are affordable and at the same time offer long-term security. There is a growing interest in community-oriented and cooperative forms of living and a willingness to share. At the same time, life plans and the associated needs are becoming more diverse. If one understands "self-determined living" as a human right, the question arises how to create sustainable living spaces that are accessible to all. Innovative approaches are offered by self-organised CoHousing projects that enable diverse options for collaborative and non-profit-oriented forms of living for and with their residents (cf. BBSR 2014; LaFond et al. 2017; Dürr & Kuhn 2017).

The interest in affordable and community-oriented forms of housing is also reflected in a variety of academic *studies* such as "WohnWissen" by the HafenCity University Hamburg / University of Vienna (https://wohnwissen.net/) or the diploma thesis "Gemeinschafts(t)räume" at the University of Stuttgart (Mauser 2016), *exhibitions* such as "Neue Standards. Zehn Thesen zum Wohnen" by the Association of German Architects (BDA) at the German Centre for Architecture in Berlin (BDA et al. 2016, http://www.daz.de/de/neue-standards-zehn-thesen-zum-wohnen/) and *research papers* (e.g. Prytula et al. 2020a).

In the European CoHousing movement, exemplary projects have emerged and are still emerging that show that self-determined, community housing can be affordable and inclusive. In Berlin alone, over 500 self-organised housing projects have already been realised. People involved in CoHousing design and manage their living space and living environment themselves, while being open to sharing spaces. This creates opportunities for collaborative activities that are reflected in the architecture and in a particular community formation, such as in so-called cluster housing (Prytula et al. 2020a, 2020b). In order to make better use of the potential of CoHousing projects and initiatives, there is a need for increased awareness of the benefits of sustainable and self-determined forms of housing in civil society, as well as more political support.

CoHousing means more than just living. The integration of different uses, including both private and public spaces, living spaces, spaces for work, culture, education, public services as well as gardening and energy and infrastructure projects, enables a sustainable and social use of space through synergies (cf. Pattern F1). CoHousing includes both CoLiving and CoWorking aspects and encourages people to share a variety of spaces and activities. This creates community while saving space, energy and resources. In addition, the CoHousing community can also be involved in the production of energy and food. Furthermore, CoHousing is closely linked to other functions such as childcare, communal kitchens and spaces for leisure activities.

CoHousing a cultural practice that has its roots in housing communities and cooperatives, communes, collectives and squats. These practices have evolved over the last century and have been adapted around the world. CoHousing is a term that is often interwoven with other alternative forms of housing such as community-oriented and collective living, intentional communities and ecovillages. Such forms of housing are increasingly seen as a way to address a range of challenges to community, democracy and justice that are exacerbated by investor-driven, speculative and individualised developers. CoHousing projects are a way of self-organising to build more ecologically, socially and economically resilient communities by practising a form of living together that promotes the sharing of spaces and resources beyond private ownership (Hagbert & Bradley 2017).

In the following, individual planning-relevant elements of CoHousing such as participatory planning, inclusive housing and cluster housing are described in more detail, which are also highly relevant for CMI.BA.

3.2.2 Participatory planning

An integral part of many CoHousing projects are participatory planning processes through which the future users are proactively involved in the project development and implementation (cf. Pattern P2). Traditionally, the planning tasks are defined by the client, which are then translated into a functional and spatial concept by the planning architects. In the last two decades, many people have become more interested in living in projects with a social-ecological orientation and in contributing their knowledge of the living world to the planning process (Stadt Wien 2017: 8). Participatory planning enables and promotes the participation of future users in development and decision-making processes (Stadt Luzern 2020: 6). The focus here is not on statutory participation opportunities, but on complementary, voluntary forms in which people without formal participation opportunities, such as children, can also be involved. Participatory planning mostly increases the quality and complexity of the results, but is also associated with a higher planning effort.

Participation, i.e. taking part, participating and being involved, has many meanings depending on the discipline: activating and empowering people, political, cultural and social participation, appropriation and public discussion of one's own needs, or even participation in works of art. In building projects, the participation of future users enables needs-based planning and creates a stronger identification of these users with the respective project and neighbourhood (Stadt Wien 2017: 8).

Decisions within a participatory planning process are made on the basis of different design variants and scenarios that are developed in an iterative process (see among others Hofmann 2014). This means approaching the solution step by step through multiple repetition and adaptation. In this way, ideas and changes can be incorporated during the ongoing (design) process. The result of the participatory planning process is a flexible and sustainable architecture with, for example, different types of flats ranging from small studios to family and large residential communities (see Hunziker Areal), adapted to the needs of the future residents and can even lead to the development of new structural typologies such as cluster apartments.

The process of participation comprises various steps, usually with a sequence of events and interactions with stakeholders that build on each other (City of Lucerne 2020: 20). Depending on the scope for shaping and decision-making, different levels of participation can be distinguished (participation ladder according to Sherry Arnstein 1969). A frequently used model of the participation ladder distinguishes four participation levels (SenStadtUm 2012: 28 f. after Lüttringhausen 2000: 66 ff.):

1. Information: Interested and affected persons are invited to inform themselves about a planned project and to be educated about its impacts.
2. Participation (consultation): Interested parties and those affected can inform themselves and also comment on the plans presented. They are given the opportunity to contribute ideas for implementation, but cannot decide on content.
3. Co-decision (cooperation): Those affected and interested can have a say in the development of projects. Together with those responsible for the project, goals can be negotiated and their execution and implementation planned. Interested parties have a very great influence on the planned measures and can very strongly contribute their opinions, wishes and needs.
4. decision (up to self-government): Citizens (residents, administration and others) jointly make a binding decision that is legitimised by many.

The principles for the success of participatory planning are the presence of stakeholders, voluntary participation, comprehensibility and transparency, commitment and reliability, opportunities to exert influence and rules, openness to results and acting at eye level (City of Lucerne 2020: 10). The process can be initiated by the population (bottom-up) or by politics or administration (top-down). Bottom-up initiatives often have a sustainable impact on the cityscape and urban planning due to a stronger lived social togetherness (Stadt Wien 2017: 8).

Depending on the planning task, the participation objective, the planning scale and the composition of the stakeholders, there are a variety of participation procedures for implementation, such as charrettes, open space conferences, planning for real, world cafés, future workshops or future conferences (Nanz & Fritsche 2012: 36 ff). The composition of the stakeholders to be involved results from the dimension of the planning task. In the case of architectural projects, these are usually the future residents in addition to the clients and planners. When it comes to questions of neighbourhood development, it is the citizens living in the neighbourhood and also institutional representatives, e.g. from public administrations, schools or companies.

Communication between the participants must be planned and coordinated from the very beginning, as it is an essential factor for the success of participatory planning. In this context, a target group and method-specific preparation of information, the integration of different ideas via workshops, models or simulation games as well as a precise planning of the communication processes are important (City of Lucerne 2020: 23). Diverging goals as well as incomplete or disturbed communication processes are cause for conflicts in participation processes. These can be managed through mediation or other conflict-solving procedures.

In recent years, various forms of eParticipation have been developed. These are electronic, internet-based procedures that help to involve actors in decision-making processes (BBSR 2017, BBSR 2020). Depending on the planning task, face-to-face and online formats can also be combined.

Projects planned in a participatory manner gain in quality, can motivate more commitment and can be implemented more quickly if participation is carefully implemented, since increased acceptance results in fewer objections, resistance and thus delays (City of Lucerne 2020: 6). The involvement of different actors leads to a stronger identification of the users with the project. The experiences as well as the knowledge of different perspectives can result in synergies, be collected and used for further participatory planning.

3.2.3 Inclusive housing

A society with an increasing proportion of older people needs adaptable architecture and forms of housing that meet the changing needs of use. Inclusive housing projects are barrier-free and enable largely self-determined living in old age (cf. Pattern F2). Inclusion means more than just accessibility (cf. pattern P4). Inclusive forms of housing are characterised by a high degree of mix of residents and inclusive building arrangements. Different and flexible flat sizes allow for a diverse resident structure for pensioners, families, single people, shared flats and assisted living. Barrier-free and low-barrier residential buildings with entrances without steps or thresholds, a minimum door size, sufficient space for movement in living rooms and bedrooms, kitchens and bathrooms, and a floor-level shower are also important prerequisites for enabling inclusive living (BBSR 2016).

Intergenerational and inclusive housing projects promote togetherness as well as mutual help and support in everyday life, e.g. in caring for children, physically impaired persons or senior citizens. Inclusive housing projects enable people not only in the city but also in rural areas to remain in their familiar living environment or to reorient themselves in the period after the employment phase (BMFSFJ 2012: 8). For intergenerational housing, socially acceptable rents or housing costs are needed in the long term so that personal housing remains financially affordable in every life situation. Cooperative forms of organisation play a special role here. It also requires a needs-based infrastructure for local supply and daily needs, as well as opportunities to interact with the neighbourhood (BMFSFJ 2012: 12).

3.2.4 Cluster apartments

Cluster apartments combine the advantages of a small flat with those of a shared flat and promote self-organised living together in a group through the collective use of common areas (cf. Pattern F3). They are a new form of housing in which several private housing units are combined with communal spaces. The private housing units consist of one or more rooms, have their own bathroom and are optionally equipped with a (tea) kitchen. The communally used rooms include living, cooking and dining areas as well as, if necessary, further sanitary and utility rooms or flexibly usable guest rooms, so-called joker rooms. The overlapping of usable and circulation areas usually results in spacious, communally used areas, which increases the quality of living and has a space-saving and cost-saving effect.

Cluster living is characterised by self-organised processes and a high degree of influence on the development, planning, management and maintenance of the premises. Residents of cluster apartments associate this form of living with self-organised cohabitation and the collective use of common areas consciously and permanently. Cluster living thus differs from other forms of living together, such as in student, old people's or nursing homes, which are primarily purpose-oriented and often temporary, and are structured and regulated by sponsoring organisations (Prytula et al. 2020b: 8-9). The size of the cluster dwelling is determined by the number of people living together in it and their living arrangements. A typical group size in cluster apartments is between seven and nine people, but there can also be more than 20 residents living together (Prytula et al. 2020b: 48f.). Cluster dwellings enable the realisation of exceptionally deep structures, which in turn require higher energy and cost efficiency. Buildings with cluster apartments are therefore particularly suitable for the redensification and utilisation of so-called difficult sites as well as corner situations in urban multi-storey housing.

The pioneers in the development of cluster apartments were mainly Swiss housing cooperatives. In particular, the Zurich construction and housing cooperative Kraftwerk 1 played a key role in shaping and developing the typology of cluster apartments with the Hardturm (1999-2001), Heizenholz (2008-2012) and *Zwicky Süd* (2009-2016) projects (Prytula et al. 2020b: 34). Based on the experience with large residential communities in the Hardturm project, Kraftwerk1 built the first two cluster apartments in the Heizenholz project. The flats are each rented to an association and the eight to ten members organise their own living together, furnishing, distribution of rent and cooperative shares (Thiesen 2014: 76). New members are also selected by the community, so no changes to the tenancy agreement with the cooperative are necessary in the event of a change. Within the flats, solidarity-based financing models are used to broaden the spectrum of residents and, above all, to appeal to older people. However, the majority of cluster apartments in Heizenholz are occupied by professionals aged between 35 and 55 (Thiesen 2014: 76).

The Berlin cooperative project Spreefeld was initiated in 2007 and occupied in 2014. The three free-standing buildings on the banks of the Spree form an ensemble that pioneers a large-scale community project combining new forms of housing, shared spaces and office space. The project includes two large cluster apartments with a living space of approx. 800 m² and approx. 600 m². The larger of the two cluster apartments, the "Spree-WG", is home to 21 people. It is organised as a maisonette over two floors and with a functional separation of the communal areas into a kitchen below and a living room above, to which a shared bathroom with a view of the Spree is connected. Large, communal balconies complement the living space on both floors. The private units consist of one to three rooms, often with private kitchens, whereby individual private units usually have their own bathroom. The design was essentially determined by the residents. Within the given floors, they could decide for themselves on the size and layout of the private units. The communally used rooms were planned collectively (Prytula et al. 2020b: 16 ff.).

Cluster apartments enable high residential qualities in dense urban areas that meet the diverse requirements of sustainable urban development, such as social mix, participation, affordability and the economical use of land and natural resources. In doing so, they address five key current social trends in the housing industry and urban development:

1. desire for individuality and retreat,
2. need for community,
3. desire for participation and self-determination,
4. need for affordable housing and
5. reduction of resource and land consumption.

The special qualities of cluster housing cannot be adequately represented with conventional evaluation instruments for space efficiency. For the same or less space requirement per resident, a considerably greater range of uses and "spatial luxury" are offered.

Key factors for the success of cluster housing are adaptable and adaptable spatial and social structures. This requires structural features such as sufficiently large, cleverly zoned communal living spaces that allow for parallel uses, as well as a great variety in size and floor plan organisation in the individual rooms to provide space for changing living needs. Adaptability is more likely to be realised through change of use than through conversion. Especially within larger projects, this is supported by so-called flex spaces or by relocation options.

The individual willingness to live together and a successful composition of the residential group are also decisive parameters for long-term functioning and low-conflict residential communities (Prytula et al. 2019). The central contribution of cluster housing to resilient urban development is that it provides functioning examples of a diversification of housing options and a changed housing culture.

3.2.5 Typologies of community-oriented forms of housing

id22 has compiled typologies of organisational and ownership forms of community-oriented housing on the basis of an evaluation of different socio-ecological model projects (see chapter 3.1.2, chapter 6). The collection of model projects provides a wide-ranging overview of community-oriented forms of housing. With a view to developing a suitable spatial programme for CoHousing in Nová Cvernovka, typologies were compiled and focused on the following five models (see table 2):

- Cooperative model
- "Strong" CoHousing
- CoHousing "light
- CoLiving
- Rental model

Table 2: Forms of organisation and ownership of community-oriented forms of housing

Organisational structures	**1 Cooperative**	**2 "Strong" CoHousing**	**3 CoHousing "Light"**	**4 CoLiving**
Nature of ownership	Cooperative ownership model	can be run as a cooperative or work together with a building (tenants), association	Tenant/building association, building groups, foundation, NFP provider	Investors and Investors
Description	Can be self-organised	Self-organised, community Community led	Community-oriented, development-oriented, architect:ing-oriented oriented	Development led
Participation of the residents in the planning	high	high	medium	low
Potential for social-ecological housing	high	high	medium	low
Involvement of residents in maintenance and daily management (efficiency)	medium to high	high	medium	low

Expected commitment of the residents	long-term	Long-term, 5-20 years	long-term, 1-5 years	flexible / short-term daily, weekly or monthly subscription-style contracts
Examples	WagnisArt, Munich	Spreefeld, Berlin	WIR Quarter, Berlin	The Base, Berlin

Cooperative living

The term "cooperative housing" refers specifically to the organisational and ownership structure of a project. Cooperatives can be models of so-called "tenant ownership", where ownership is mediated by residents' membership in a collective body through the purchase of shares. A member has a vote in collective decisions regardless of the number of shares purchased. Such 'tenant ownership' models can range from zero equity to limited and full equity. The first model with zero equity is often referred to as a tenant co-operative model. Despite these differences in ownership, financing and level of professionalisation, in all types of cooperative housing, residents live in a self-governing, democratically organised and collectively managed form.

"Strong" CoHousing

Strong CoHousing projects are often built on a foundation of shared alternative visions or values. For example, community-oriented living with a focus on strengthening social ties and support networks, sustainable living and/ or shared spiritual or political views. In terms of the organisational dimension, they also put more emphasis on residents' participation in the self-management of the project. This usually includes participation in the design and planning of the building as well as the subsequent operational decision-making. This is also accompanied by a high level of financial and social commitment of the residents to the project.

In terms of social interaction, "strong" CoHousing projects deliberately aim to foster a greater sense of togetherness and belonging within the resident:ing community. This is often done through supportive activities and facilities such as communal meals, festive events and work groups dedicated to specific activities, such as gardening. These events are organised according to the bottom-up principle and are decided and managed by the residents themselves. The spatial division of the "strong" CoHousing projects is therefore specifically designed to support this higher degree of community. For example, smaller private flats are compensated by larger-than-average, high-quality and well-equipped communal spaces. An example of a "strong" socio-spatial arrangement for CoHousing is "cluster housing", where private flats are deliberately arranged around communal spaces such as kitchens, dining rooms, living rooms and workshops.

CoHousing "Light"

In weaker CoHousing projects, the shared values are often less important than in "strong" CoHousing projects. In terms of the organisational dimension, a residents' association or an elected group is usually established for decision-making and regular joint meetings are held to decide on important matters of the group. In terms of interaction, they support a higher level of community and participation than conventional housing projects, but not to the extent described in the previous section on 'strong' CoHousing. This usually means that there are individual private flats as well as some communal spaces.

Rental model

The rental model for CoHousing ranges from models with a higher level of involvement in day-to-day management, such as most rental cooperatives, to models with a low level of involvement, such as CoLiving on a subscription or rental basis. As mentioned above, in the rental model, residents are still members of the cooperative and therefore have decision-making rights and obligations. However, in a subscription-based CoLiving project run by a developer, the decision-making power on organisational structure and management lies with the project owner and not with the residents.

CoLiving

While the term CoLiving may be used differently in different places, we understand it to mean a new, commercial form of community-oriented living, primarily aimed at a target market of young urban professionals in the knowledge society. These are usually operated by developers with rental or subscription models (e.g. "The Collective" in London and New York). Such a model offers flexibility and a low level of community engagement among residents. In terms of socio-spatial characteristics, they are usually characterised by much smaller private spaces combined with a range of communal spaces and facilities. In addition, the possibilities for democratic self-governance are rather limited compared to traditional strong or light CoHousing projects, which is mainly due to the centralised ownership structure.

3.3 Energy-efficient construction and plus-energy buildings

3.3.1 Energy-efficient buildings

The construction and operation of buildings represents one of the major sectors of global energy consumption, along with mobility, food, the production of consumer goods and electricity production. Energy-efficient buildings are a necessary prerequisite for realising an energy-efficient and climate-neutral city. For an analysis and balancing of building-related energy uses, a distinction must first be made between the construction and operation of buildings. The energy used for the production and transport of building materials and components is referred to as grey energy (Spreng 1994), is determined by life cycle assessments (LCA) and described, among other things, by the characteristic value of the cumulative energy expenditure (CED). The production of many modern building materials such as concrete, steel, aluminium, glass and plastics is very energy-demanding. The use of renewable raw materials, such as wood, can reduce energy expenditure and improve the manufacturing balance (cf. Pattern M4).

With regard to the energy-efficient operation of buildings, a distinction is made in the Central European climate between residential construction ("winter problem buildings") and non-residential construction ("summer problem buildings"), for which different energy concepts and constructive, spatial and technical building measures are required due to divergent requirements. In residential construction, the greater share of the energy demand is required for comfortable temperature control of the buildings in winter and for the seasonal transitional periods, as well as for the provision of hot water. The focus is therefore on reducing heat losses, optimising passive solar energy use and efficient heat supply (Feist 1998, Hönger et al. 2009). The energy demand in non-residential buildings, on the other hand, is dominated by the energy demand for summer ventilation and cooling, artificial lighting and other use-specific energy demands (e.g. operation of IT servers) (Voss et al. 2005). Optimisation of daylight planning, good summer thermal insulation and concepts for largely natural ventilation play a major role here.

In the planning and realisation of energy-efficient buildings, great progress has been made in the last 30 years through research, technological developments, new simulation methods and suitable legal and economic framework conditions. The planning principles and technologies for the design and realisation of energy-efficient buildings are well known (see Feist 1998, Voss 1997, Hegger et al. 2007a) (cf. Pattern P3). However, taking into account the principles of building physics and building technology, there are various planning approaches to achieve the goal of energy-efficient buildings and a sustainable, climate-neutral heat supply.

Passive house construction has been established as a widespread standard since the 1990s. The term *passive house* refers to a building standard that can be realised with different construction methods, building forms and building materials. It is a further development of the low-energy house (NEH) standard and characterises buildings in which a comfortable indoor climate can be guaranteed in summer and winter without a separate heating or cooling system (Krapmeier & Drössler 2001). The limit values here are a heating requirement of a maximum of 15 kWh/m^2 living space and year and a maximum primary energy requirement of 120 kWh/(m^2 a) living space and year. The basic principles of a passive house are (1) minimisation of heat loss, (2) controlled ventilation with heat recovery and (3) optimisation of solar gains. The prerequisite for the passive house is that the necessary amount of fresh air is able to transport the required heat for the maximum heating output. For the building, this means that energy losses must not exceed 10W/m^2 of living space. In 1991, the first passive house was built in Darmstadt-Kranichstein, at the same time as the energy-autonomous solar house in Freiburg. With the EU Building Directive of 2010, all EU member states have committed themselves to constructing all new buildings as ultra-low energy buildings from 2021 onwards, which roughly corresponds to the characteristic values of a passive house (EU 2010).

Other strategies include building cybernetics (e.g. Pfeifer 2002, Tersluisen 2009), low-energy concepts (e.g. Leibundgut 2007), "low tech" approaches such as "Simply Build" (Nagler et al. 2018; Nagler et al. 2021, https://www.einfach-bauen.net/) as well as combinations of these approaches, e.g. "2226" by Baumschlager Eberle Architekten (https://www.2226.eu/das-manifest/). In these strategies, different emphases are set in each case with regard to the spatial-constructive, constructive or building-technical aspects. In recent years, sector coupling (e.g. waste heat recovery from waste or grey water, alternating storage use for electric mobility and building technology) has become an important field of action that shifts the spatial balance boundaries to the neighbourhood level.

Last but not least, it is known from many studies that the behaviour of the users has a major impact on the actual energy consumption. The conceptual and technological robustness of the chosen measures therefore plays a major role, as does the knowledge of rebound effects, for example when the heated floor space or indoor air temperatures increase in energy-efficient buildings and efficiency gains are thus cancelled out. Last but not least, it must be taken into account that energy-efficient construction is only one subsystem of sustainable construction and must always be considered in connection with other sustainability goals and protected goods (Hegger et al. 2007a, 2007b).

3.3.2 Plus-Energy Buildings

Based on the experience with passive house construction and other pilot projects such as the energy-autonomous solar house (Voss 1997), plus-energy housing estates (Disch 2010) and scientific studies on climate-neutral buildings (Musall 2015), concepts for *zero- and plus-energy buildings* have also become increasingly established. In 2001, the technologies for so-called *zero-emission buildings were* described in detail, which rely on well-insulated envelope surfaces, ventilation heat recovery and solar collectors with water-based or thermochemical long-term heat storage and heat pumps (Luther, Wittwer & Voss 2001). While the long-term heat storage systems that were much studied in the 1990s usually did not perform as well in practice as calculated with elaborate thermal simulations, electricity-based solutions in combination with heat pumps have proven themselves in recent years.

Plus-energy standard = passive house standard + building-integrated use of renewable energies

Plus-energy buildings are buildings that generate more energy on an annual average than they need for their operation. As a rule, however, they are not energy-autarkic buildings; instead, summer energy surpluses from renewable energy systems - mostly electricity from photovoltaics - are fed into the electricity grid and drawn back from the grid when needed in winter (cf. Voss & Musall 2011, for definitions see also Ala-Juusela et al. 2021). The basis for a plus-energy building is the design of the envelope surfaces and the supply technology according to the Passive House Standard with characteristic values for the heating demand ≤ 15 kWh and the primary energy demand ≤ 120 kWh/(m^2 a). There are also projects that have already been realised in the field of refurbishment of old buildings. Due to specific constructional and spatial requirements in existing buildings, realisation is usually more complex. Therefore, there is still a need for research and development in this area.

Plus-energy concepts for existing buildings and thus the reduction of the final energy demand can be described using the following measures, standards and characteristic values (comparable to the passive house standard):

- Improve the thermal insulation of the building envelope surfaces to U < 0.15 W/(m^2 K) to reduce the heat demand,
- Avoidance of thermal bridges,
- compact structure,
- Highly insulating glazing and window frames, U_w < 0.8 W/(m^2 K); g-value around 50%,
- Improvement of the airtightness of the building envelope, measures for controlled ventilation (air tightness n50 < 0.6/h-1),
- Use of passive solar gains,
- Sun protection and shading - one of the most important passive measures for room conditioning and overheating prevention,
- highly efficient electricity-saving appliances for the building,
- max. specific annual heat demand of 15 kWh/(m^2 a),
- Max. specific primary energy demand of 120 kWh/(m^2 a) for space heating, hot water production and electricity consumption as well as
- Optimisation of building technology through the integration of heat pumps, photovoltaics (roof/ façade), combined heat and power or the use of wind energy in micro systems. Another possibility is the use of waste heat from waste water for heat pumps. Other building technology options for optimisation: passive air preheating, e.g. by means of a geothermal heat exchanger, heat recovery from exhaust air with a heat supply efficiency >75% and domestic hot water heating by solar collectors or a heat pump. Transmission and ventilation heat losses are largely compensated for by passive energy contributions.

However, the plus-energy standard does not take into account the grey energy required. Furthermore, the production and operation of building technology always involves additional energy demand. Therefore, their use should be kept as low as possible.

Efficiency House Plus and other research and funding programmes

With the Efficiency *House Plus* model building *with electric mobility* designed by Professor Werner Sobek in Berlin, the Federal Ministry of Transport, Building and Urban Affairs launched the Efficiency House Plus research initiative in 2011 as part of the "Zukunft Bau" funding programme, in which almost 40 newly built and refurbished mostly single-family or two-family houses across Germany were accompanied and evaluated in terms of research as demonstration buildings (BBSR 2019: 5, 21). The findings have been published as planning recommendations (BBSR 2018). The aim of the programme was to use these model projects to gain experience and solution approaches for the further development and market introduction of this building standard in residential construction.

In addition to numerous other research projects, the research project EXCESS (FleXible user-CEntric Energy poSitive houseS), which was funded within the framework of the EU research and innovation programme Horizon 2020, should be mentioned here as an example. Based on four demonstration projects spanning the Nordic, continental, oceanic and Mediterranean climate zones (Finland, Austria, Belgium and Spain), the project investigated how the technological, economic and regulatory conditions for the implementation of plus-energy buildings - here called Positive Energy Buildings - can be improved. https://positive-energy-buildings.eu/

From Energy Plus-buildings to Energy Plus-Quarter

The overall system efficiency in the use of renewable energies increases with a shift of the system boundary to neighbourhood solutions (Bossi et al 2020, Lindholm et al 2021). Leibundgut (2007) already defines the path to a post-fossil future through the complete abandonment of combustion processes in the urban context for building heat through the use of heat grids and ground source heat pumps in the neighbourhood network. In the context of energy communities, however, the balance sheet demarcation becomes more blurred. While in the past and still - e.g. in existing energy regulations such as the German Building Energy Act (GEG) - the individual building must be optimised on a parcel-by-parcel basis, the energy exchange with other buildings of the most diverse uses and ownership structures enables new synergies and economies of scale. However, energy management is also becoming more complex and requires suitable regulatory frameworks (Tuerk et al. 2021).

3.3.3 Energy efficiency in the renovation of old buildings and in new construction in Slovakia

According to the EU Building Directive of 2010, buildings constructed in Slovakia as of 1 January 2021 must also meet the "lowest energy standard A0". The legislation allows for the consideration of the so-called "cost optimum" in renovation and reconstruction, i.e. measures that are also acceptable from a cost perspective. As a result, the investor does not have to meet the specified energy and environmental targets. However, the intended project aims to achieve significantly higher energy and environmental targets: Through innovations in the technical field, the "Centre for Metropolitan Innovations" is to become the first plus-energy building in Slovakia. The building produces more energy than it consumes and can thus also supply the adjacent building.

The renovation of apartment buildings in Slovakia is reaching an above-average pace compared to the rest of Europe. The reasons for this are the good credit conditions offered by building societies, banking institutions, the State Fund for the Promotion of Housing and the typologically suitable Housing Fund. Currently, about 3% of the buildings are renovated each year. Nowadays, more extensive measures are implemented than in the past, i.e. not only the thermal-technical parameters of the walls and roofs are improved and the windows of the common rooms are replaced (the replacement of windows in the flats is done privately), but also the piping and lift systems are modernised.

The renovation of public buildings is dependent on funding opportunities from the EU and, since 2014, also from the State Environmental Fund. The availability of subsidies reduces the interest in financing the refurbishment from other sources (loans or guaranteed energy services). However, EU funds as well as Slovak state funds are limited. It is estimated that refurbishment of public buildings took place at the rate of 1% per year in the period 2007 to 2013. Refurbishment is often carried out in sub-measures where there is a lack of professional planning, e.g. for measures to improve indoor quality. A positive aspect of the Slovak subsidy programmes for the refurbishment of public buildings is that the amount of subsidies is linked to a certain energy efficiency. To date, only two buildings have been renovated to the lowest energy standard, an eight-storey residential building in Bratislava (as part of the international EU-GUGLE project) and the building of the Emila Belluša vocational school in Trenčín according to our information.

In new construction, the number of buildings with sustainability certificates (LEED, BREEAM, etc.) is increasing, which signals above-average quality. This trend is increasing especially in the area of office and industrial buildings. On the contrary, a very slow development concerns residential buildings, where just the first buildings are in the certification process. In the predominant new construction of family houses and apartment buildings, for example, the question of interior quality is often disregarded. Thus, in practice, the requirements for daylight are not met and corresponding expert reports are not required. To date, only one residential building has been built in Trnava, "Zelené Átrium", which received the certificate of the Passive House Institute and was processed by the Slovak Passive House Institute (LEED Platinum certificate).

In terms of energy consumption, the most important factor is heat consumption for space heating and hot water production. In Slovakia, about one third of the heat comes from central heat supply systems, the rest is produced in decentralised sources. The most important energy source is natural gas, followed by biomass (wood chips, pellets, firewood). The use of other renewable energy sources, e.g. by means of heat pumps, plays a subordinate role in heat production. The share of renewable energy sources in the electricity supply of buildings is somewhat higher.

Accordingly, in Slovakia, the full potential of energy efficiency is not used in the area of renovation of the old building fabric as well as in new buildings. The quality of the interior, adaptation to climate change and other principles of sustainable construction are not taken into account.

4. Working process and methods

The project was processed according to the work packages (WP) formulated in the project application under the leadership of the respective project partners:

WP 1 - Development of the overall ecological concept and integral planning (FHP)

WP 2 - Creation of a homepage with project profiles of "best practice" examples (FHP)

WP 3 - Development of housing concepts and monitoring of the participation process (id22)

WP 4 - Determination of the energy status of the existing building (iEPD)

WP 5 - Optimisation towards an plus-energy building (iEPD)

WP 6 - Preparation of planning documentation for Plus-energy buildings (Cvernovka Foundation)

WP 7 - Communication and public relations (Cvernovka Foundation)

WP 8 - Project management and administration (FHP)

The project was originally scheduled to run from 1 June 2020 to 30 November 2021 (18 months). Due to the travel restrictions imposed in connection with the COVID 19 pandemic, the face-to-face workshops could not take place as planned. As a result of the local situations with lockdowns, all project partners experienced delays in the processing of the work packages, so that in May 2021 a cost-neutral extension of the project duration by six months with a project end date of 31 May 2022 was applied for and approved.

Fig. 7: Flowchart of the (original) schedule with content dependencies of the work packages

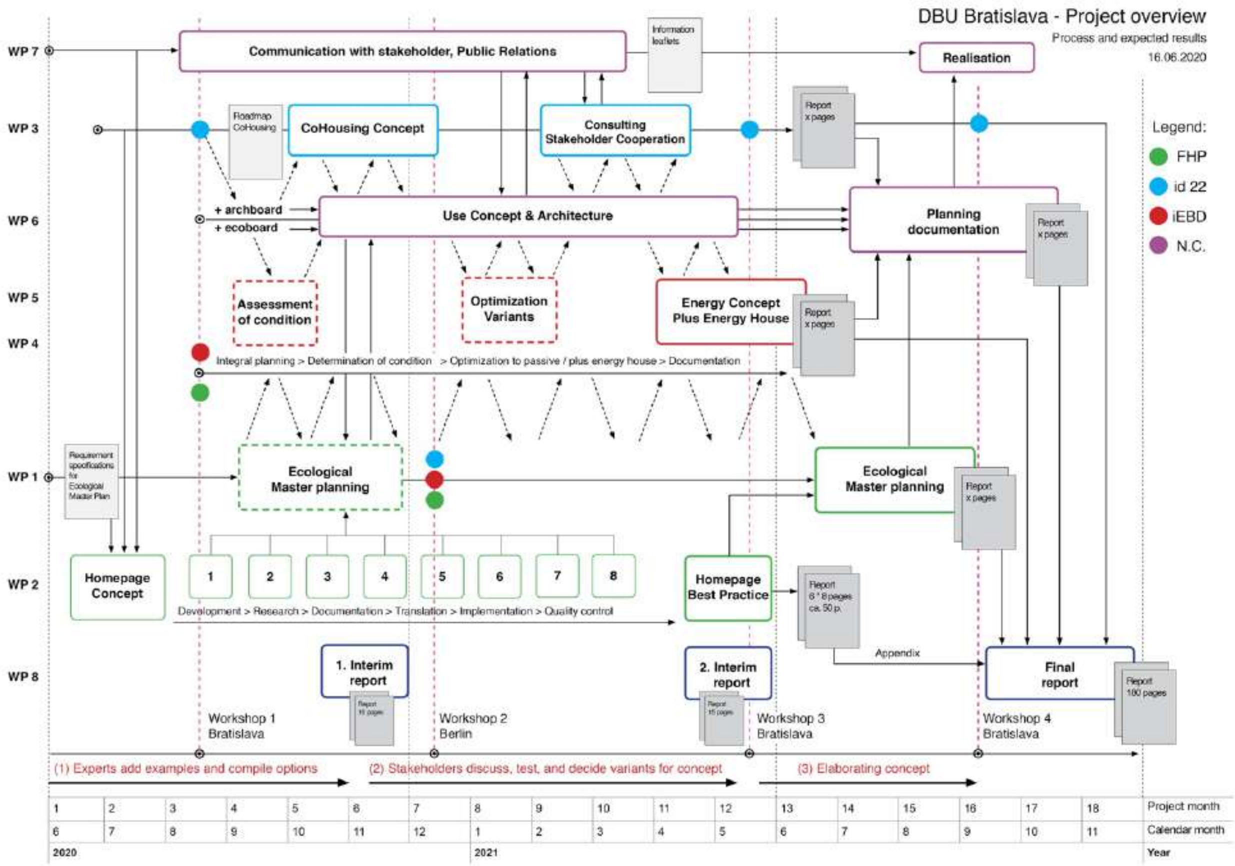


Fig. 7 shows a flow chart of the original project schedule with the content-related dependencies between the work packages. The diagram shows that the processing of the work packages did not follow a linear chronology, but were processed synchronously. This work logic corresponds to the requirements of integral planning. The diagram served the project partners to coordinate the respective work steps, as the individual sub-steps had to be coordinated with each other.

The methods and work processes used in the central fields of action are described in more detail below. The results of the work are presented in chapter 5.

4.1 Overall ecological concept

Based on the project goals defined in the project application, strategies and measures for the overall ecological concept were developed under the leadership of FH Potsdam (WP 1). The ecological project goals were further specified in the kick-off workshop and in other project meetings. The overall concept consists of sub-concepts for energy refurbishment as a plus-energy building, green and blue infrastructures as well as for the use of building materials and the handling of waste and recycling. The topic of energy was dealt with separately due to its particular scope and complexity (see chapter 3.3 / WP 4 and 5, processing by iEPD).

The overall ecological concept was adapted to the requirements and evaluated during the planning process. Integral planning served as a central tool for integrating the ecological concept into the design. In this way, all ecological, energy-related and other requirements could be taken into account and optimised at an early stage. In particular, synergies with the CoHousing concept were sought.

The development of the overall ecological concept comprised the following work steps and methods:

1. setting objectives and priorities for Nová Cvernovka

- The objectives defined in the project application were specified in joint workshops and project meetings in order to meet the actual project conditions.
- In the "Design brief for the architects", the project partners each formulated specific requirements (Annex A1). These served as guidelines for the entire further project development.
- A formal sustainability certification was dispensed with, but the requirements formulated there served as orientation for the planning standards.

2. analysis of the initial situation

- Consideration of urban planning conditions such as green spaces, traffic connections and noise emissions,
- Recording of the boundary conditions and the condition of the building such as orientation of the facades to the compass direction, existing infrastructural supply and disposal facilities for energy, heat, drinking water, sewage, waste, etc.
- Survey of existing ecological technologies and practices, e.g. recycling of construction waste, neighbourhood garden for the production of fruit and vegetables.
- Survey users' expectations and willingness to use ecological technologies or sufficiency strategies, e.g. to live more resource-efficiently or to commit to environmental goals.

3. presentation of the state of knowledge and technology on ecological construction

- Literature research, analysis and presentation of socio-ecological model projects. (see Chapter 3.1.2 and Appendix A5),
- Literature research, analysis and presentation of typical design patterns and technologies in social-ecological model projects (see chapter 6.3),
- Visits to social-ecological model projects in Berlin and Vienna in the context of project workshops.

4. selection, evaluation and implementation recommendations of the ecological strategies and measures.

- The proposals for ecological measures were discussed in regular project meetings and evaluated and prioritised according to the criteria presented in chapter 5.2.2.
  The visit to socio-ecological model projects in Berlin and Vienna was particularly informative for the Cvernovka Foundation and the architects because it allowed them to check the transferability of the proposed measures to the N.C. campus.
- Integral planning served as a central tool for the integration of all planning sub-aspects (see also chapter 3.4).

4.2 CoHousing

An important prerequisite for the architectural design was the specification of the building's use. In particular, the type and extent of flats and their spatial positioning had to be clarified in the first months of the project. For the development and implementation of low-cost housing as CoHousing, a participation process was initiated that was coordinated and scientifically accompanied by id22 (WP 3). The work programme mainly included the development of feasible concepts for community-oriented forms of living (e.g. multi-generational living, cluster housing, integrative forms of living) and their adaptation to the local situation. For this purpose, a needs assessment of the ideas and expectations as well as requirements of future users was carried out and evaluated. The task of id22 was primarily to advise on the possibilities of community-oriented living and non-speculative housing practices based on a social-ecological approach.

The work process included the following steps and methods:

- Conducting two quantitative surveys among the current residents of the hostel (referred to as the "community" in the report),
- Evaluation and assessment of the survey results,
- Expert interviews with people from and about social-ecological model project(s),
- Drawing up a roadmap for the participation process,
- In-process consultation of the architects and the community to develop a context-specific optimal mix of residential and non-residential functions and a qualitative specification of the spatial programme,
- Identify synergy effects in the environmental and social measures,
- Recommendations for the planning process of Nová Cvernovka and
- General recommendations for planning processes in CoHousing projects.

4.3 Plus-Energy Building

The main task of iEPD was to make assessments and recommendations for the selection and implementation of suitable supply concepts and systems engineering, based on the energy balance of the existing building (WP 4), leading to a plus-energy building (WP 5).

The work process comprised four steps:

1. Analysis and evaluation of the initial situation,
2. Concept for the energy modernisation of the building,
3. Concept for achieving the plus-energy standard and
4. Evaluation and optimisation of the results achieved.

The following methods were used for this:

- Data collection and assessment of the building stock with a PPHP programme,
- Concept for the energy upgrading of the existing building to a passive house,
- Concept for plus-energy buildings, thermodynamic simulation with the programme IES-ve,
- Optimisation of the roof pitch to maximise the yield of PV electricity with programme IES-ve,

- Integral planning: Participation in all design meetings and intergral development of the technical implementation.

4.4 Architectural design and project planning

The commissioning and management of the architects is a genuine client task and was carried out by the Cvernovka Foundation. The PLURAL office was commissioned for the planning services (see chapter 5.4.1). In the architectural design, the functional requirements (use of the building) were to be combined with the technological, ecological and building law planning requirements to achieve a plus-energy building. As a result, planning documentation was written that will be submitted to the approval authorities (WP 6, see Appendix A1). The planning documentation corresponds to an approval planning according to German law (according to HOAI service phase 4).

For the implementation of the design and planning process, the following work steps were carried out:

- Establishment of planning objectives and priorities for Nová Cvernovka,
- Description of a "Detailed design brief for the architects" (specifications),
- Conduct an internal competition procedure for the award of contracts to architects,
- Award of contract to architects and terms of reference,
- Preliminary design and iterative design planning by the architects, combined with planning discussions with the Cvernovka Foundation (client) and the Nová Cvernovka community (current residents),
- Integral planning as a central tool for integrating all planning sub-aspects,
- Multiple project presentations for DBU project partners and the community with feedback,
- Preparation of the planning documentation.

4.5 Public relations

Communication with stakeholders, public administrations and the public was also carried out by the Cvernovka Foundation (WP 7). The communication accompanying the project was carried out in social media (Facebook, Twitter, Instagram) as well as on the internet pages of the project partners and in workshops.

4.6 Homepage for knowledge transfer

Accompanying the development of the overall ecological concept, a homepage was developed on which short descriptions of selected social-ecological model projects and a collection of typical design elements (patterns) are presented (WP 2). Originally, the documentation of about eight model projects was planned. However, this idea was further developed in favour of the much more complex approach of developing a "pattern language of social-ecological design elements".

The analysis of the model projects and description of the design elements served to accompany the design of Nová Cvernovka and is intended to promote public interest in the project. It can also be used by other architects and project developers when designing their own projects. The original idea of documenting the progress of the project in a bilingual internet blog (German and English) was not pursued further, as this was not necessary for the project development and public relations work.

The work process to create the homepage included the following iterative steps:

- Project research and identification of approx. 80 relevant model projects, compilation of a longlist of "best practice" / "good practice" examples,
- Definition of criteria for the selection of projects that are particularly relevant for the realisation of Nová Cvernovka's objectives,
- Analysis of the model projects to identify "design patterns" that were particularly relevant for the design process of Nová Cvernovka, drawing up a list of themes such as mixed use, shared housing, participatory planning, energy use, green and blue infrastructures, etc.

- Development of the homepage concept based on Christopher Alexander's "pattern language" (Alexander et al. 1977),
- Selection and detailed description of the design patterns,
- Preparation of short project profiles for 24 projects with project descriptions and a selection of suitable images including obtaining the image rights,
- Development of a design concept for the homepage,
- Technical implementation of the homepage and step-by-step online placement of the project descriptions and design patterns as well as
- Creation of a user manual for the continuation of the website and for knowledge transfer.

4.7 Project management and communication

The project management of the research project (WP 8) was carried out by the FH Potsdam. Project management included the preparation, coordination and implementation of the project schedule, communication and coordination of work between the project partners and the safeguarding of results. The FHP was responsible for the preparation of the semi-annual interim reports and the final report with the participation of the other project partners. The reports are published in German and English.

The German and Slovakian partners communicated regularly in digital project meetings via ZOOM, the project language was English. Four joint face-to-face project meetings were planned for the project, three of them in Bratislava and one in Berlin. A kick-off and final workshop were held in Bratislava, a presentation workshop with a visit to the model projects in Berlin, and an online workshop.

A shared data server was set up for the exchange and documentation of information, project documentation, minutes and other documents. The following communication tools were used regularly:

- Regular video conferences (ZOOM), initially on a weekly basis, later usually at intervals of about three weeks,
- Process diary for documenting all work steps and agreements,
- Data platforms for collaborative document processing and data storage as well as
- Miroboard (digital whiteboard).

4.8 Project chronology

Table 3: Project chronology with important work steps and milestones

Date	Results
01.06.2020	**Project start**
June - July 2020	Online project meeting for project coordination and preparation of kick-off workshop
July 2020	Start of research on "best practice" projects, selection criteria, longlist
26.-27.08.2020	**1st workshop (in Bratislava)** - kick-off meeting, specification of project objectives
Sept. 2020	Development of questionnaires for the survey of residents
Oct - Nov 2020	Survey of the residents and evaluation of the results
07.10.2020	Publication of the design brief 1.0 for the selection of architectural firms
28.10.2020	Jury and selection of the architectural firm PLURAL for the commissioning of planning.
30.11.2020	Completion of the design brief 2.0 for the commissioning of PLURAL Architects
17.-18.01.2021	**2nd workshop (online)** - discussion of the planning status, floor plan and façade concepts, energy parameters for the existing building are available, concept for plus energy, presentation and discussion of some social-ecological design patterns Guest lecture by Werner Wiartalla, ufaFabrik
22.01.2021	Presentation and discussion of the design status with the community of N.C.
26.02.2021	Agreement on central criteria for decision-making for measures
March-July 2021	Regular feedback rounds by DBU partners with architects for further development of the design planning and implementation of the technical measures
30.06.2021	The homepage https://www.buildingsocialecology.org/ goes online.
July 2021	Preparation of workshop and excursion in Berlin, project selection, schedule coordination
10.-13.08.2021	**3rd Workshop (in Berlin)** - Visiting social-ecological projects in Berlin Planning workshop with design status on CoHousing. Energy and eco-concept Guest lectures and planning feedback with Iris Oelschläger and Silvia Carpaneto
Sep. 2021	Preparation of the workshop in Bratislava, preparation of the scenario analysis phase 1, excursion destinations in Vienna, further development of the homepage
20.-21.10.2021	**4th workshop (in Bratislava)** - presentation of project results and implementation of a scenario analysis, visit of social-ecological projects in Vienna
Dec. 2022	Final decision on technical and architectural solutions
Jan - May 2022	Editing the planning documentation
31.05.2022	Project completion
June 2022	Completion of planning documentation for building application
31.08.2022	**Submission of final report**

5. Project implementation and results

5.1 Development of the space programme, CoHousing and participation process

5.1.1 Goals for CoHousing in Nová Cvernovka

Identifying a good mix (interdependencies & strengths)

The starting point for the planning was the implementation of the spatial programme in terms of content and design. The general idea for community-oriented living developed from the existing use of the former dormitory and is based on the intention of the Nová Cvernovka Foundation to create an innovative and integrative model that combines living and working, culture and ecology.

The target was to combine residential and work uses with a spatial share of 30 to 40% each with public uses with a share of 20 to 30%.

a) Housing is to be implemented as affordable housing with a strong community focus for long-term living (CoHousing and rental housing) as well as housing for medium-term stays and short-term living for guests.
b) The workspaces should be modular, collaborative and designed for creatives, artists and social innovators.
c) The public spaces should create services and offers that complement the needs of the Nová Cvernovka campus as well as its neighbourhood.

To realise this, community involvement and empowerment is essential and offers a number of benefits. These benefits include strengthening residents' identification with their buildings and spaces, which encourages them not only to care for and own them, but also to invest time and resources in improving them. This mobilises many invaluable skills, networks and resources, including people's time and energy as well as their innovative ideas.

Considering the possibilities of self-help, residents should be involved in the remodelling of the building as well as in future improvements and renovations. An approach based on self-help strategies can support the overall affordability of the project. This means focusing on self-help opportunities, such as how the community can be involved in the reconstruction and renovation of spaces and structures - with tasks such as changing interior walls, finishing surfaces and floors, designing exteriors and much more. Self-help based, resident-built projects could also include the completion of artists' studios and work spaces.

The main goal of the conversion is to create a pleasant and inspiring environment with a community character that promotes the emergence of meetings and interactions between different (social, age) groups of people living under one roof and ultimately contributes to the improvement of their living conditions. This pilot model of CoHousing - the first of its kind in Slovakia - has the ambition to initiate or at least be part of larger changes in the way of living and development in urban areas in response to extreme individualism and the increasing unaffordability of conventional housing.

The community-oriented nature of the CMI.BA project aims to organically involve and develop the community. It is not only about being kind and fair to the building's residents and users, but also about looking for ways to empower these people so that the project and the building and its spaces - inside and out - can truly benefit from mobilised innovation, energy and resources.

The Nová Cvernovkas residential area should consist of spaces that provide short-, medium- and long-term accommodation. The existing community of residential residents has the potential to form the core of future long-term residents. On a smaller scale, the Nová Cvernovka Foundation also plans to provide social housing spaces for otherwise excluded communities and individuals (e.g. Housing First for formerly homeless people). There is the possibility of cooperation with (local) government in housing public sector workers (e.g. key housing for young teachers and social workers) or students in the form of starter homes. They are expected to become part of a social mix for long-term housing. For medium-term and short-term residents, there should be spaces for artist-in-residency programmes and artists from the cultural centre or a kind of "Fairbnb" (https://fairbnb.coop/).

5.1.2 Roadmap of the participation process

For the coordination of the participation process, id22 drew up a roadmap early on after the kick-off workshop in Bratislava. This roadmap specifies when and in which processes which partners and persons should be involved. This roadmap was updated and adapted throughout the project.

August 2020

Kick-off workshop in Bratislava: All project partners and the community were invited to give presentations and discuss the project goals and intentions with each other. The Nová Cvernovka Foundation provided a draft for the first survey. id22 and the community gave feedback and made suggestions, and the community was involved in the organisation and data collection of the survey.

September 2020

Based on the project schedule, id22 developed a proposal for the second survey, feedback especially from the Nová Cvernovka Foundation and all other partners and the community was taken into account.

October 2020

The community elected a community delegate for the jury to select the architects and for other important communication and coordination processes, especially with the N.C. Foundation. The results of the survey 2.0 were discussed and reflected upon with both the N.C. Foundation and community representatives. The aim was to integrate the results of the survey into the design brief for the architects. This provided the architects with more precise information about the needs and wishes of the stakeholders for their planning.

November 2020

Community representatives form a working group with interested community members and are consulted on the design brief, which is prepared according to the project objectives of the selected architects' vision and the results of Survey 2.0.

December 2020

N.C. gives a presentation to the general public and members of the Archboard. The aim is to create a space for public discussion, questions and comments. This step should give the community some time to develop further comments and feedback.

January - July 2021

Architectural design (by architects) to implement the social and spatial housing requirements combined with regular feedback rounds with the community. Further development and finalisation of the design planning taking into account the comments and feedback.

5.1.3 Survey of needs and wishes of current residents

In 2020, two empirical surveys were conducted with the current residents of the halls of residence. For this purpose, in-depth interviews were conducted in person. 40 people took part in the surveys, which were conducted at intervals of a few months. The content of the surveys was the internally perceived challenges and opportunities of the CoHousing project (for survey questionnaire and evaluation see Appendix A3). The demographic data and housing situation of the respondents at the time of the survey are summarised in Table 4.

Table 4: Demographic data and housing situation of respondents as of September 2020

Category	Demographic data
Total number of respondents	40 people
Gender of the respondents	65 % male 35 % female
Age of the respondents	21-25 years: 18 % 26-30 years: 37 % 31-35 years: 25 % 36-70 years: 20 %
current life situation	living alone: 75.0 % with a partner: 17.5 % with a pet: 17,5 %
Place of residence	in the former dormitory: 100 % working and living in the former dormitory: 25 % working in the neighbouring former school building: 20 %

5.1.4 Analysis of the results from the survey of needs and wishes

The housing survey 1.0 was exploratory in nature and asked about potential interest in future, possible shared housing in Nová Cvernovka. The housing survey 2.0 asked more specific questions about expectations, hopes and wishes in relation to CoHousing.

About half of the respondents already have experience with community-oriented forms of living, especially in shared flats and in hostels, but also in squats, housing groups as well as through participation in the first Cvernovka project. A total of 40 residents took part in the two surveys, whose most important answers can be summarised as follows:

Perceived benefits of CoHousing:

- Stronger community and social contacts,
- Exchange of skills and knowledge,
- Sharing resources and costs,
- the possibility to start new (ecological) projects and innovation.

Perceived disadvantages of CoHousing:

- Lack of privacy and too much noise,
- Conflicts between residents,
- lack of cleanliness and security,
- highly regimented lifestyle,
- no possibility to live here during the reconstruction,
- rising housing costs after conversion.

Most important indicators of overall quality of life:

- Environmentally friendly,
- healthy and safe environment,

- financial affordability and spaciousness.

Interest in community-oriented forms of housing

The 2020 N.C. Housing Survey, conducted among current dormitory residents, represents their preferences for housing units. 60% of the 40 respondents would prefer a housing unit consisting of one room with its own bathroom and would be willing to share a kitchen, living room and other facilities. 20% of respondents would prefer a separate flat with a fully equipped kitchen, but would be willing to share facilities such as a workshop, social room or garden. The remaining 20 % would be content with a simple room and are willing to share the bathroom and other facilities with other residents.

Interaction and privacy

The community is particularly interested in these different types of units being arranged, combined or interconnected in the building so that there is both privacy and the possibility of interaction between residents. It should also allow and encourage the possibility of social mobility (people moving between different types of housing).

Sharing

If they had the opportunity to set up a kitchenette in their private area, 50% of the respondents would be willing to share a large, well-equipped kitchen with 8 or more other residents. The other 50% would prefer to share the kitchen with about 5 other people.

Private space

Of the 40 respondents, 50% would like a private room of at least 20 m^2, 25% at least 25 m^2 and the remaining 25% would be satisfied with a room of 15 m^2.

Utilisation arrangement

The community identified certain activities with specific requirements, all of which should have a specific space in the building and would help initiate social interaction.

- Spaces for noisy communal activities and socialising (e.g. on the ground floor),
- Spaces for quiet activities, e.g. for studying and working (e.g. on the roof),
- Rooms for dirty and possibly noisy activities such as in workshops (e.g. in the basement).

Use during the conversion

To achieve the goal of social sustainability, many of the current residents prefer to stay in the building during the conversion. They point to the possibility of dividing the existing communication core (staircase) into two independent parts, allowing them to move around within the building during the different phases of the conversion work.

5.1.5 Space types for the realisation of CoHousing approaches

All of the following space types can work with a CoHousing approach. However, a "Strong CoHousing" will provide more opportunities for sharing for social and environmental reasons. Private flats reflect a “CoHousing Light” approach, where there are no or few shared spaces (e.g. in building groups), which makes sharing and thus community building more difficult. Table 5 gives an overview of space types for the realisation of CoHousing approaches that can be considered in a suitable mix for project implementation.

Table 5: Space types of community-oriented forms of housing

Room type designation	Characteristics / economic evaluation
Single unit with collective sanitary facility in the corridor	They tend to be run and managed by the resident occupier
Individual smaller units with shared kitchens, dining and living rooms, toilets and showers, as part of shared flatshares or groups of people	Most affordable
Live/work units With toilets and showers but without kitchens, with shared kitchens, dining rooms and living rooms, as part of shared flats or groups of people	Middle price segment
Cluster apartments with their own small kitchens and bathrooms, with shared kitchen and common rooms	Less affordable due to higher installation effort. Managed by the residents.
Private flats with several rooms, without directly shared common rooms	They tend to be operated and managed by the developer and/ or third party providers as "simple rental units".

5.1.6 Recommendations for project implementation

1. Gain a common understanding of the project objectives

All those involved must first agree on the overarching project goals, for which CMI.BA wants to be a model. What are the priorities? Should it be a model project in terms of affordable living and working, even if only limited subsidies are available? Why should it be a plus-energy building, considering that no other or very few other projects in the region will be able to follow this example in the near future?

2. Affordability

For the prioritisation of the renovation and conversion measures, a consensual definition of the term "affordability" needs to be developed among the stakeholders, including the categories of the target group of residents, the percentage of social housing to be included, and the relation to rental prices in Slovakia and Bratislava, taking into account future operating and maintenance costs. Furthermore, it is urgent to agree on the preferred organisational and management structures.

3. "Strong" CoHousing

A "Strong CoHousing" model should be sought for at least part of the residence. This would mean a higher level of community participation, both in terms of responsibilities and rights of the residents. This in turn would emphasise their cooperation and decision-making rights and responsibilities, and would remain true to the project's goal of working in a socio-ecological framework.

4. Create offers for temporary forms of housing

It is necessary to develop spatial and organisational offers for short- and long-term forms of housing so that potential residents are not overwhelmed with the idea of getting involved in something bigger than they are ready for. This can be reconciled with the fact that about half of the participants in the survey are willing to put in a few hours per month for (self-)management. The design and number of rooms or flats for temporary housing has an impact on planning decisions.

5. Spatial diversity and structural reversibility

In order to allow for different housing needs as well as short-term and long-term housing forms, spatial diversity and structural reversibility should serve as guiding principles for planning implementation (cf. Pattern A1). In physical form, cluster housing (cf. Pattern F3) and individual, self-contained (residential) units for community-oriented living with different levels of communal facilities are suitable to promote human (micro-) communities. This creates a mosaic of arrangements for community living, e.g. flats shared by a few people or single family units.

6. Offer communal spaces

Community is created through the sharing of ideas and thoughts, visions and goals, eating and drinking together, places and spaces, buildings, gardens and activities. Sharing has social, economic and environmental benefits (cf. Pattern C3). Community is a dynamic process that can develop organically, be developed intentionally, but also remain weak or even fall apart - depending on the level of participation and commitment of the individual. Communal spaces can be: kitchens, living rooms, workshops, terraces, laundry rooms, gardens, corridors, staircases and many more. (cf. Pattern C1). In this sense, communal balconies and terraces are preferable to individual balconies or terraces (cf. Pattern A5).

7. Minimal intervention strategy

The strategy of minimal intervention is recommended for the conversion. This corresponds to the project's overriding ecological and ecomic requirements for the careful use of resources and affordability (cf. Pattern M2). But at the same time, this keeps open the possibility of making further aesthetic qualities and ecological additions at a later stage. For this purpose, the establishment of an "innovation fund" for the construction and improvement of basic infrastructure should be considered. What needs to be clarified is what should be set as "the minimum" for the first conversion and renovation phase and what can be realised at a later stage.

8. Promote communication and self-governance

It is recommended that community representatives be identified and mechanisms for reporting, consultation and decision-making between them and other members of the community be established.

9. Initiate self-help processes

During reconstruction, costs can be saved through self-help in self-construction. Self-help processes could be organised through the coordination of so-called community facilitators (4-5 team members who work closely with the community), for example by forming groups with specific competences, skills and interests. This could mean that one group of community members is interested in developing gardens, flower beds and outdoor community spaces, another in developing and managing community spaces (cf. Pattern C5). This would further strengthen the sense of community and belonging that is characteristic of Nová Cvernovka, while also laying the foundations for self-management.

10. Take into account needs for safety and cleanliness

The concern of the residents interviewed for safety and cleanliness should be taken into account. Part of the feeling of safety can result from the fact that the neighbourhood and the surrounding community know each other well. This can be promoted by a "welcome contact point", which is maintained on the basis of voluntary project hours, and that the caretaker lives on site.

11. Continuation of the participation process and multi-stakeholder dialogues

For the implementation of the project, it is not least recommended that those involved (Cvernovka Foundation, representatives of the residential communities, architects and planners) meet regularly beyond the DBU project for meetings in which priorities are explicitly defined and scenarios for the next five, ten or even 20 years are agreed - at least as visions.

As a result of the project, the following (transferable) recommendations can be summarised:

General recommendations for the development of innovative CoHousing concept in Nová Cvernovka

1. Nová Cvernovka's CoHousing should be time and place specific, i.e. context sensitive - also in relation to Slovak housing culture and the structural and local possibilities.
2. Consideration of the interests and capabilities of the Nová Cvernovka community (Survey 2.0).
3. Learning from other good practices and model projects.
4. CoHousing is a process that depends on a clear and fair "social architecture".
5. CoHousing works with synergies between living, working, playing and gardening.
6. Nová Cvernovka's CoHousing evolves organically from past and present experiences and practices.

Recommendations for strengthening the community in Nová Cvernovka (and in other projects):

1. Low-threshold participation: Make it easy to participate!
2. Clear and fair representation of the community in matters of development and management.
3. Listen to the residents of the community: Give the community the opportunity to voice their ideas and concerns: online and offline, through community representatives and through an on-site "planning office" in the residence building.
4. Transparency in decision-making: Meetings are well prepared and all decisions are well documented.
5. Inform and educate the community so that they know the options and possibilities. Minimise frustration!
6. Facilitate community members' discussions to help them realise their dreams / visions.
7. Clear and understandable timetable for planning and decisions: Make it clear when the community can and should contribute with ideas and comments.

5.2 Planning implementation of the project objectives

5.2.1 Terms of reference and Selection of architects

In addition to the programmatic and functional requirements, the ecological and energy requirements also had to be specified in more detail. All project goals declared in the project application were discussed in detail and prioritised in the kick-off workshop. Subsequently, the DBU project partners summarised the respective functional, spatial, ecological and social requirements as well as the intended synergies for further project development into a "design brief for the architects" (see Appendix A2). These requirements were the starting point for the design planning. Representatives of the Nová Cvernovkas community were also involved in the formulation of the requirements.

At a meeting of the Cvernovka Foundation with architects working in Nová Cvernovka, the so-called *Archboard*, it was previously decided in June 2020 that three studios should apply to work on the CMI.BA project. These studios were selected on the basis of their skills, experience and presence in the Slovak architectural scene. The architecture studios participating in the competition were:

2021	http://2021.sk/
N/A	http://nla.sk/
PLURAL	http://plural.sk/

The studios were asked to submit an essay about their studio and their vision of the CMI.BA project and to include a presentation of their previous work. A jury consisting of nine representatives of all DBU project participants as well as external experts selected one of the studios to lead the architectural design of the redesign. The other two architectural studios were commissioned to comment on the design and planning progress during two presentation events. In the selection process, the architectural firm *PLURAL* was chosen and commissioned with the planning.

5.2.2 Integral planning in practice

Decisions have to be made at an early stage of planning that will have a major impact on spatial, functional, technical, economic and temporal aspects. Integral planning brings different perspectives and expertise to the table at an early stage in order to identify and reduce complexity and achieve creative solutions.

At the *content level*, integral planning enables,

- the development of solutions to conflicting objectives (combining components, adjusting objectives),
- Identify knowledge about future impacts of planning and use at an early stage,
- identifying solutions for a balance and good mix of components that enable more efficient and resilient building performance,
- the development of specific solutions (through the expertise of the respective partners)
- checking compatibility (synergy/conflict) with other objectives and components.

At the *process level*, integral planning enables,

- Integrate expertise into planning at an early stage, thereby avoiding or at least identifying at an early stage typical problems that lead to friction losses and may require costly adjustments later,
- using the specific expertise of the partners to identify specific actor logics and solutions, and
- expand their own knowledge and planning skills.

In the CMI.BA research project, some parts are "simulated" integral planning, as only the first planning phases with a limited level of detail were the subject of project planning.

Criteria for decision making

The complex functional, spatial, constructive, technical, ecological and economic requirements of the project are associated with conflicting goals, the evaluation and resolution of which are indispensable for planning decisions. In order to prioritise the strategies and measures relevant to planning, the project partners formulated eleven criteria in a planning meeting in February 2021, which served the project team and the architects as orientation for the selection of planning decisions:

1. Functionality
2. Spatial impact
3. Constructional and technical effects
4. Social impact
5. Aesthetics (beautiful, inspiring, useful to get a socio-ecological understanding?)
6. Adaptability to change
7. Economic impact
8. Is it innovative? Does it support innovation?
9. Is innovation communicated (visibility, education, imitation)?
10. What impact does it have on the city (neighbourhood, housing shortage)?
11. Impact on sustainability (criteria: efficiency, consistency, sufficiency)

5.2.3 Building stock

The building has five floors above ground with a flat roof and a partially recessed underground floor. The L-shaped floor plan is designed so that the longer side is parallel to the street. The overall dimensions of the building are 71.00 m x 28.50 m, with the street wing measuring 16.80 m and the courtyard wing 15.30 m wide. At the junction of these two wings, at the point where the support system turns, there is a joint the height of the entire building. There is also a three-storey building at the junction of the courtyard wing and the school building, but this is not the subject of the planning and documentation.

The supporting structure consists of a monolithic reinforced concrete skeleton with columns and a ribbed ceiling. The floor slab is 120 mm thick at the purlins and ribs. In the basement, the vertical bar support system was replaced by exterior and interior concrete walls. The building has long been used as an accommodation facility with the necessary social facilities. The area load during the planning and construction of the building was 1.50 kN/m^2 (accommodation rooms) according to the applicable technical standard. No significant defects or damage to the building structure were found. The technical condition corresponds to the service life of the structure and the way it has been used and maintained.

For a detailed structural assessment, the structure was archivally and on-site inspected using non-destructive methods (checking the concrete strength with a hardness tester) and, where necessary, also using partially destructive methods (exposing the reinforcement) before a structural analysis was carried out. For the assessment of the existing foundations, earth probes are carried out from the interior of the basement, if necessary. Engineering geological exploration probes can be carried out from the bottom of the excavated probes.

5.2.4 Representation of the architectural design

The design builds on the existing qualities and an assessment of realistic redevelopment possibilities. The aim is to offer new possibilities in spatial and technological terms and also to express these in an appropriate form in terms of design. The existing building volume and, as far as functionally reasonable, all constructive parts of the supporting structure, the façade as well as the interior design are to be preserved. The planned structural changes are made due to requirements of building technology (e.g. through the energetic upgrading of the façade), building functions (e.g. adding a storey), fire protection (e.g. through the integration of two new staircases) and other requirements as described in detail below.

The design solutions for determining the mix of uses, accessibility, façade design (greening, shading systems), fire protection, building infrastructure (to what extent is infrastructure created with regard to the characteristics of the mix of uses), reversibility and affordability were intensively discussed and constantly optimised in joint workshops and planning rounds.

Fig. 8: Schematic representation of the distribution of use in longitudinal section. Authors: PLURAL

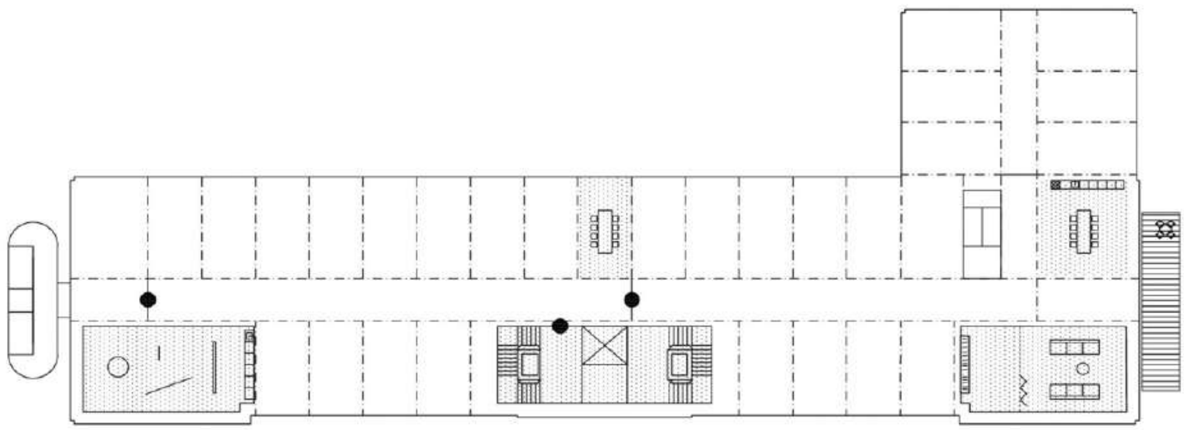
Functional programme and spatial distribution

The vertical composition of the programme is essentially based on today's organisation. On the east side, there are three floor types: working, residential and mixed-use floors The central main staircase opens up the building and allows for a variety of mixed uses. The proposed zoning is based on the programme specifications - approximately 30-40% residential, 30-40% work, 20-30% for public services and communication - and was refined during the planning process (Fig. 8).

The design is inspired by the "Old Cvernovka" and its model, which is large and flexible at the same time. The main challenge was to find an appropriate level of coexistence and mixing of the complex programme of living, working, publicly accessible spaces and social zones. Their overlaps can be potentially interesting, but the participatory process highlighted the need for a minimum of privacy for the residents, which had to be taken into account.

A flexible and open concept requires an organisational grid that allows the transformation of the object in a finer way and the preservation of the maximum of the existing construction. The internal "cell" (Fig. 9) is suitable as a floor plan unit and is suitable for different types of use. The design is based on improving the quality of social spaces and subdividing the floor plan to allow different functions to coexist without collision. We are also aware that if we build on the current layout, we will allow for continuous adaptation of the building and not expose the Cvernovka Foundation to the need for a fundamental change in the building management system.

Fig. 9: Construction grid of the building. Authors: PLURAL



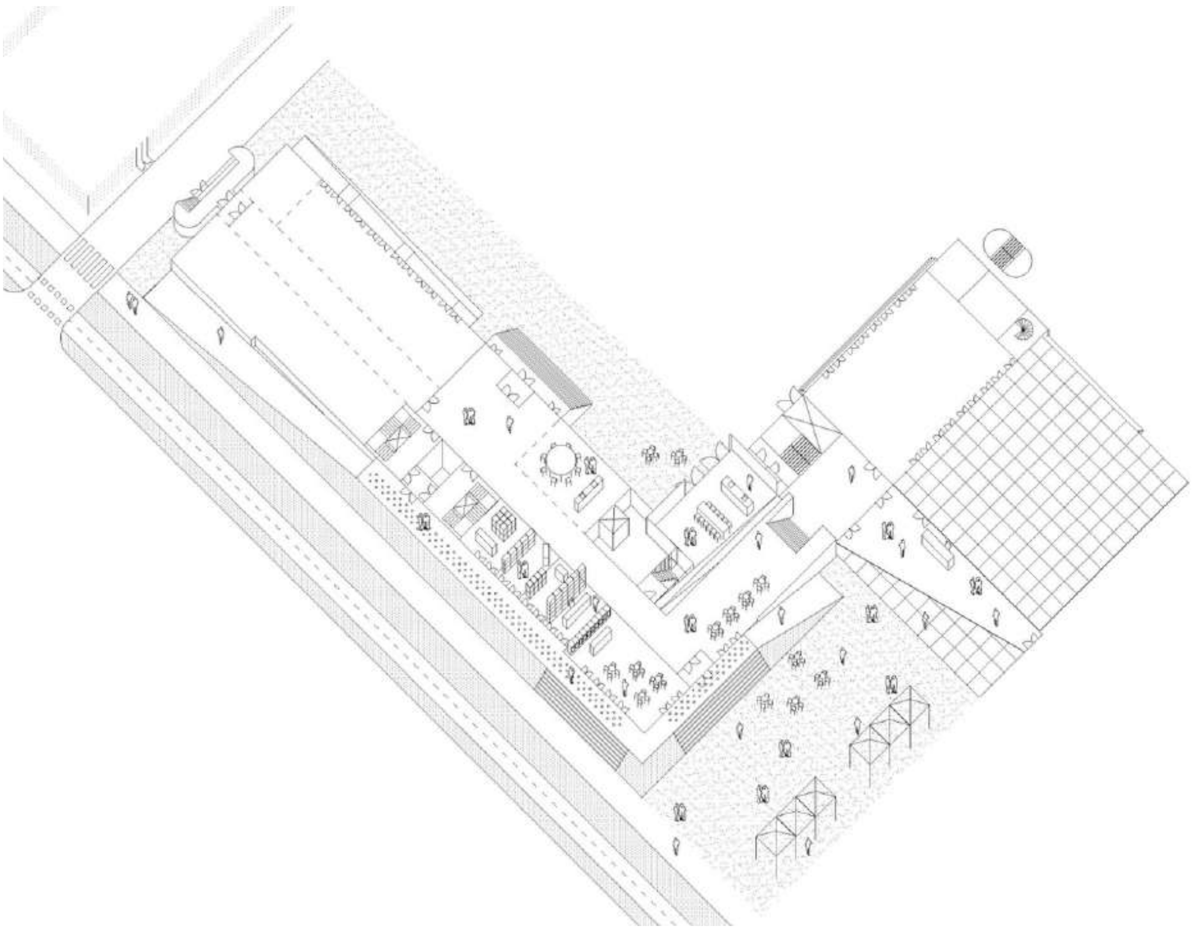
The most visible element of the design is the planned roof extension with its characteristic roof form, the shape of which is influenced by the integration of a large PV system. The new attic is designed as a large hall that can also be divided into smaller rooms depending on the use.

Entrance area with horizontal access and social functions

The ground floor is designed as a "public street" with facilities oriented towards the central corridor connected to such a ground floor in the former school building (Fig.10). Different entrances to the building allow the ground floor to be permeable in order to provide largely conflict-free access for the different target groups (residents and visitors). The building is to be interspersed with generous communication spaces. The central corridors provide access to the social rooms in the end positions of the wings. In the north-eastern part of the building, a generous area is planned for a kindergarten, but the spatial planning for this has not yet been worked through in detail. In the south-western corner of the building, a café with an adjacent kitchen area is planned: on the courtyard side, there is an optional room for variable uses. On the street side, this area is preceded by a generous staircase and ramp system to connect the building well to the public outdoor area.

The complete ground floor plan as well as all other floor plans and representations of the façades in the existing and new plans are documented in Chapter 5.2.5.

Fig. 10: Ground floor with public functions, isometry. Authors: PLURAL

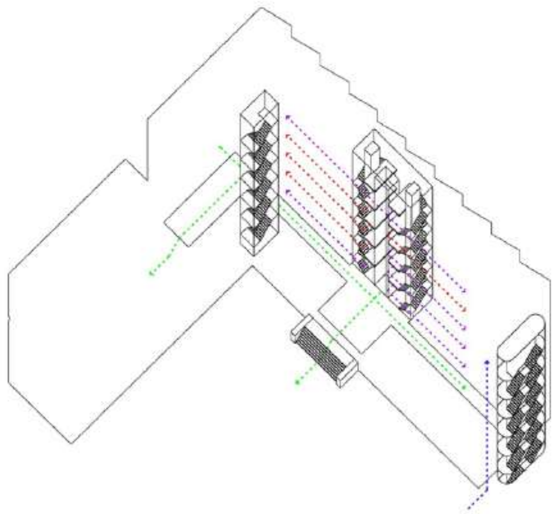


Vertical access

The existing double staircase in the currently central entrance area is retained. It is the most characteristic element inside an otherwise generic building. The division of the building into two wings by the centrally located double staircase also allows the building to be divided into two sections and continue to be occupied during the construction work. The residents have expressed their willingness to endure this inconvenience and the measure is seen as a key to maintaining the continuity of the community.

The fire safety-related need for new staircases is used for a better vertical connection of the individual floors and organisational units. They allow the building to function in different modes. We spatially connect the double staircases with a vestibule (Fig. 11).

Fig. 11: Staircase access with existing and new staircases, isometry. Authors: PLURAL



The "residential" south wing is accessed by a newly installed staircase that leads to the social rooms on the respective floors. The external staircase in the north, in turn, provides public access to the apartment-related rental spaces. The new staircase on the north-east façade is constructed with a partially transparent curtain wall over the entire height of the existing building. The steel structure will be founded on a shallow concrete foundation at a frost-free depth. Access ramps to the basement and a short staircase to an above-ground floor will be created in the rear area. The reinforced concrete structures will be erected separately and structurally separated from the existing building.

One of the most important factors of the design is to ensure relatively easy access for large loads to all areas where studios and other work spaces are located. The elevated first floor is accessed by access ramps. These open on the north side of the building, on the access road. The first ramp leads to the underground spaces where the building's storage rooms and technical security are located, and the second ramp is part of the "plinth", a raised corridor that provides access to the ground floor spaces towards Racianská Street.

Common rooms

The collectively used rooms are to be located in the corner positions of the street wing. Thus, the placement of the social spaces in the north frees up a maximum of space for private rooms oriented towards the quiet southern courtyard. The community terraces are also arranged according to this logic in relation to the social hub of the south-western wing.

Sanitary infrastructure

The installation shafts are placed in such a way that they can supply either one, two or three rooms together, thus enabling a typological diversity of housing types: From short-term flats (without major sanitary installations) to shared flats and cluster apartments to standardised multi-room flats.

Living spaces and flats

The living spaces should offer a typological and spatial range that enables short-, medium- and long-term living. Adjacent to this, sufficient social spaces are to be created to promote community cohesion among the residents. Typologically, each floor contains individual units. The system is intended to be simple and modular so that the spaces can be easily reconfigured without major structural changes. Each of these rooms, the basic unit with approx. 20 m^2, must therefore offer the possibility of installing a sanitary area and a kitchenette (Figs. 12 and 13). This has implications for the number and positioning of the installation cores of the sanitary areas (Fig. 14).

Fig. 12: Basic unit for living, photo collage. Authors: PLURAL

Fig. 13: Basic model for different flat sizes. Authors: PLURAL

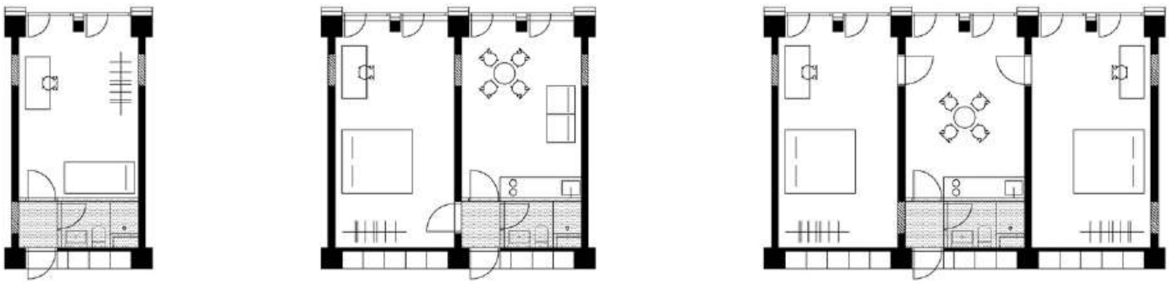


Fig. 14: Adaptability: scheme for the location of the installation cores. Authors: PLURAL

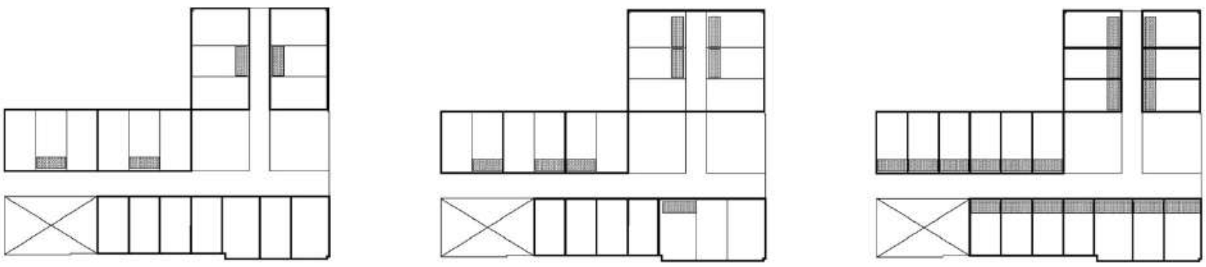


Fig. 15: Housing, view / section of a basic unit. Authors: PLURAL

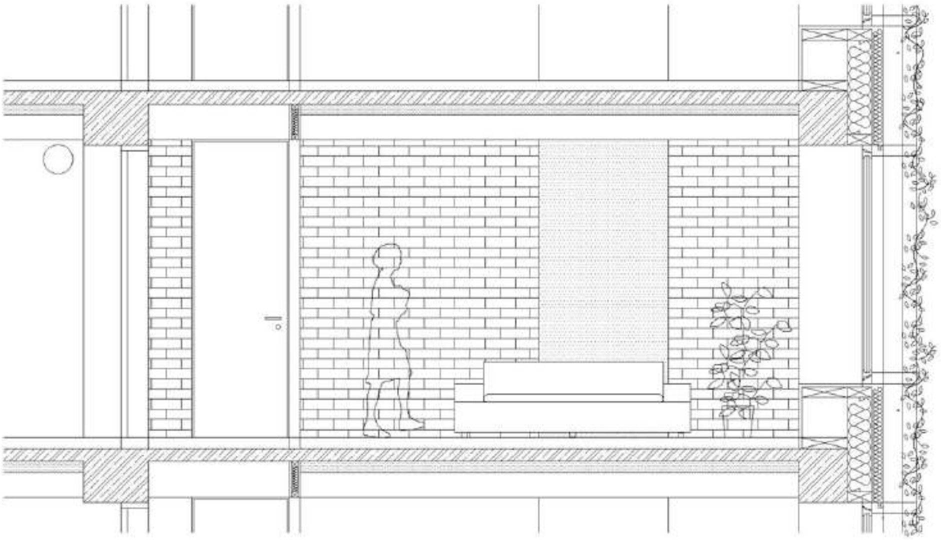
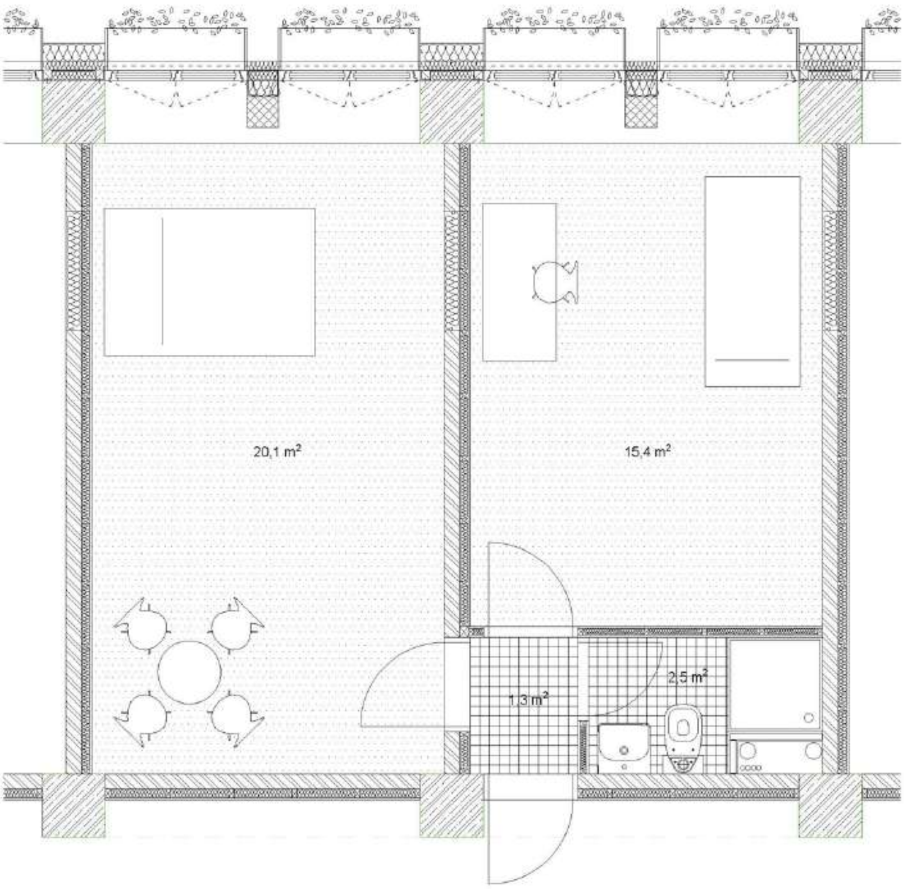


Fig. 16: Living with two rooms, floor plan. Authors: PLURAL

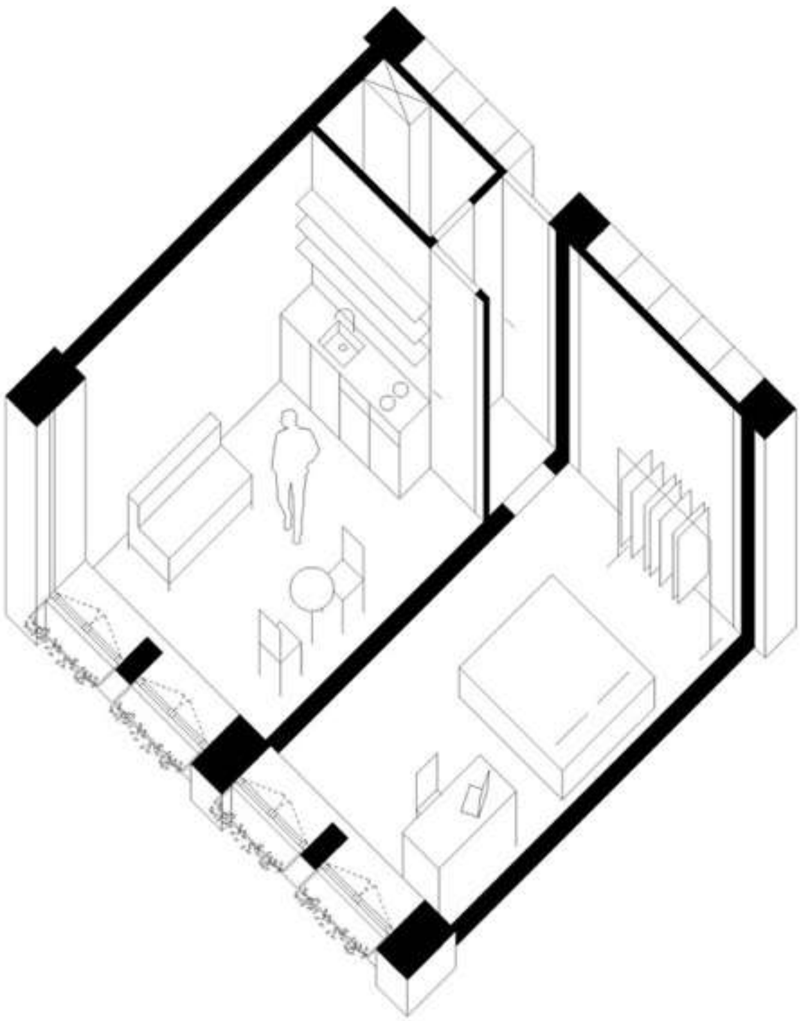


A typical two-room flat (Figs. 16 and 17) consists of two basic units ("cells") and has just under 40 m^2 of living and usable space. The rooms can optionally be connected to each other via doors or more generous openings. Loft-like living is also conceivable with a living space above two cells, optionally with a loft or loft bed.

In the flats facing the south-east (courtyard side), the existing stone parapets are to be removed and replaced by wooden constructions. The new window openings will thus be somewhat higher and more generous; French windows could also be realised as an option (see also the variant presentation in Chap. 5.3.3 Greened facades).

Despite the intention to change as little as possible, some structural interventions in the interior are also necessary. For this, mainly dry lining and materials that are easy to work with as well as to dismantle, such as wood, will be used. Where practical, openings will be prepared to allow room connections later on, so that a quick adaptation will affect the operation and comfort of the residents as little as possible. New poured floors will be used throughout the building to improve acoustic conditions. The suspended ceilings will be removed for the installation of ceiling panels for heating and cooling. The new window openings are slightly larger than previously in the existing building.

Fig. 17: Living with two rooms, isometry. Authors: PLURAL



Cluster apartments

The cluster apartments are located in the south-eastern part of the building in the spatial structure in direct relation to the social hub. The cluster apartments are divided into a more public and a private area. The communal spaces - living and kitchen areas - are oriented towards the spacious terraces on the south-east façade. The individual areas adjoin in an easterly direction and are each equipped with individual sanitary rooms. Living spaces for short-term accommodation face the street, the longer-term units face the southern courtyard. They can also be organised over two or more floors via the interior staircase (Figs. 18, 19).

Fig. 18: Cluster apartment on level 3, floor plan. Authors: PLURAL

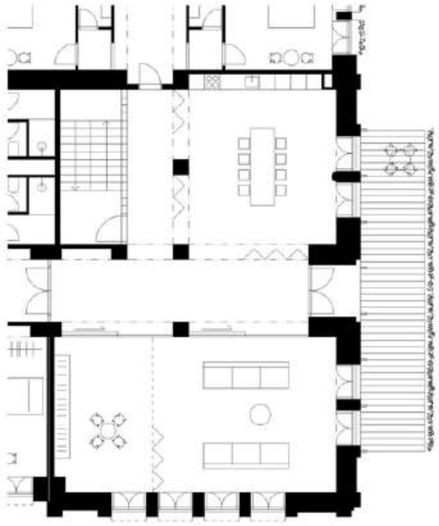
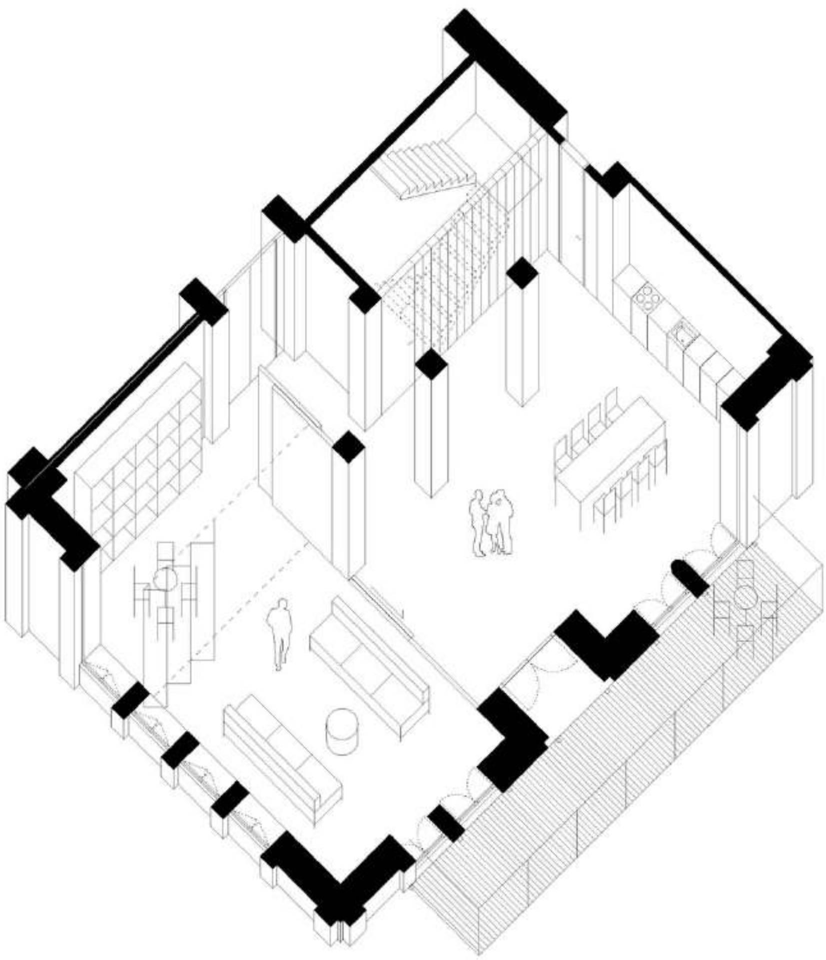


Fig. 19: Cluster apartment - shared kitchen and living area, isometrics. Authors: PLURAL

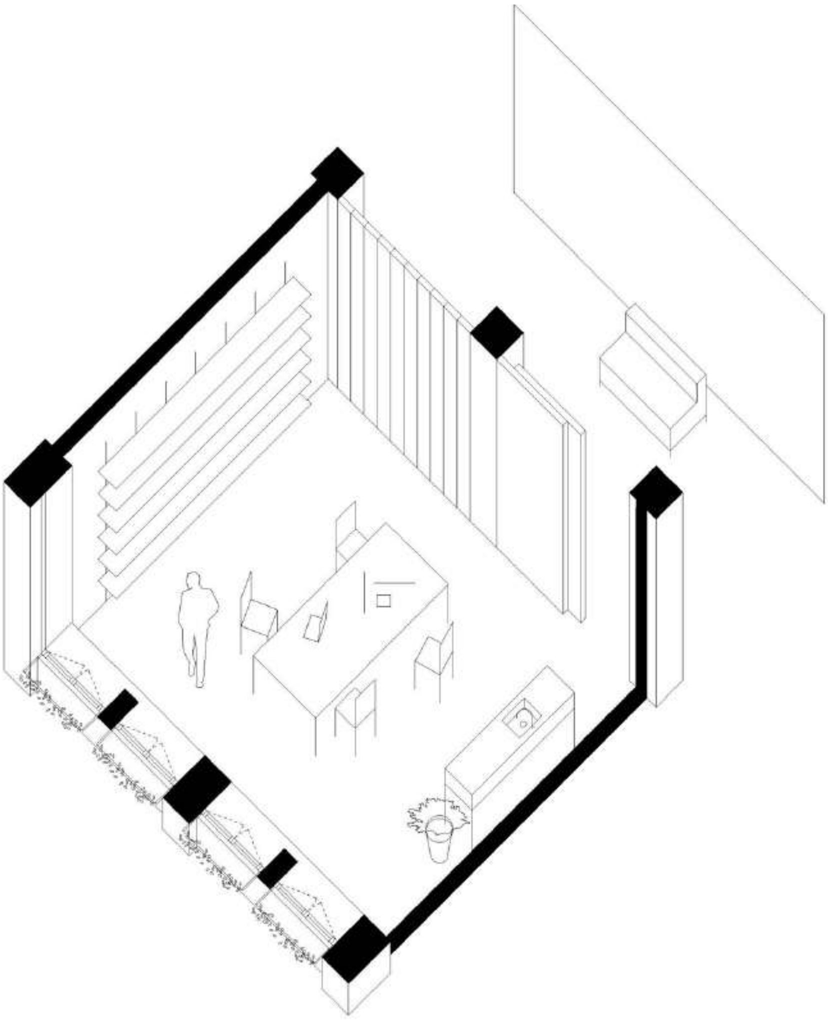


Workspaces

The workspaces and studios are designed to require as little structural intervention in the building as possible. We envision simple, loft-like spaces that tenants can either adapt according to their needs or leave in shell condition. In particular, the ceiling will be exposed for the installation of heating and cooling panels, new flooring and window openings. The installation of transparent or translucent skylights in the corridor can improve the quality of the corridor, which are not particularly attractive in their current state. Another step can be a larger opening that connects the studios and the corridor and makes it a more social space (Fig.20, 21).

Fig. 20: Office space on level 2, photo collage. Authors: PLURAL

Fig. 21: Office space on level 2, isometry. Authors: PLURAL

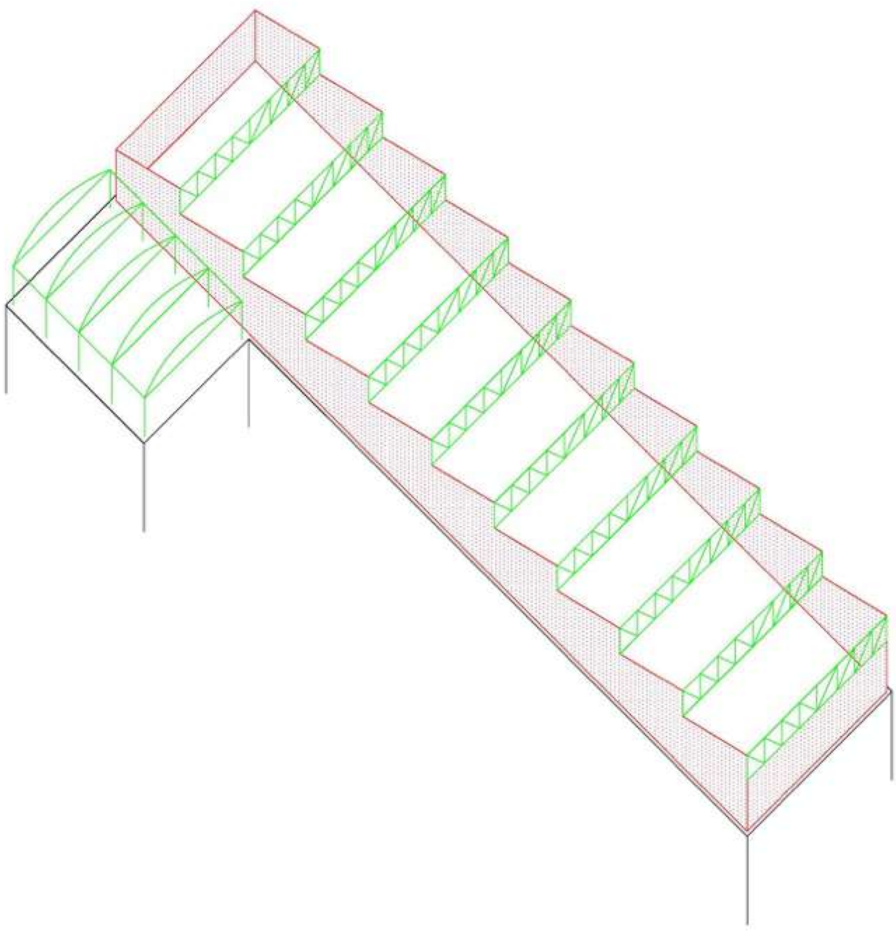


Building extension with studios

A single-storey extension will be built on the entire area of the street wing. It will be used for studios (area overload min. 4.0 kN/m^2), access will be via the staircase in the central area. The interior will be column-free and thus completely flexible. The roof will be a shed construction, taking into account the necessary ventilation of the rooms. The modular grid of the support system does not follow the grid of the existing building. The concept of the support system is therefore as follows (Fig. 22): A separate vertical structure is erected at ground level and attached to the supports of the existing building. Along the longitudinal direction of the street and courtyard façade, high beams are mounted at the periphery in the shape and height of the superstructure. In the transverse direction, the vertical parts of the monopitch roof are arranged as trusses 2.20 m high. The inclined part of the pitched roof is formed by beams connected to the top chord at one end and to the bottom chord of the truss at the other end. The large span allows for free floor plan adjustment. This allows the large hall to be used for film studios or as loft studios (Fig. 25). The clear height of 4 - 6 m is chosen so that mezzanines can be inserted. An "option room" is located in the connection to the terrace, residential staircase and the glass window, and a greenhouse is adjacent.

The entire superstructure will be constructed of timber and flat elements, with steel elements added to the extent necessary to minimise the structural impact on the existing building. In terms of load calculation, the existing building will be designed for residential purposes (2.0 kN/m^2), offices (3.0 kN/m^2) and part of one floor for services (4.0 kN/m^2). In all cases this is an increase in overload, so the existing structure will still need to be statically assessed at a later stage of the design documents.

Fig. 22**: Illustration of the construction of the roof extension. Authors: PLURAL**



Workspaces and option room

The roof extension is designed as a large column-free space (Fig. 23), for which there are various access and floor plan options for dividing the floor (Fig. 25). An exact use has not yet been defined, but it was important to the community to plan an option room accessible to all (Fig. 24). This is planned at the end of the building adjacent to the terrace, at the transition to the greenhouse. The concept of the option room already exists many times in the school building of Nová Cvernovka - e.g. on each floor with open kitchen and common rooms - and is very well accepted.

Fig. 23: Working space on level 6, photo collage. Authors: PLURAL

Fig. 24: Option room on level 6 (roof extension). Authors: PLURAL

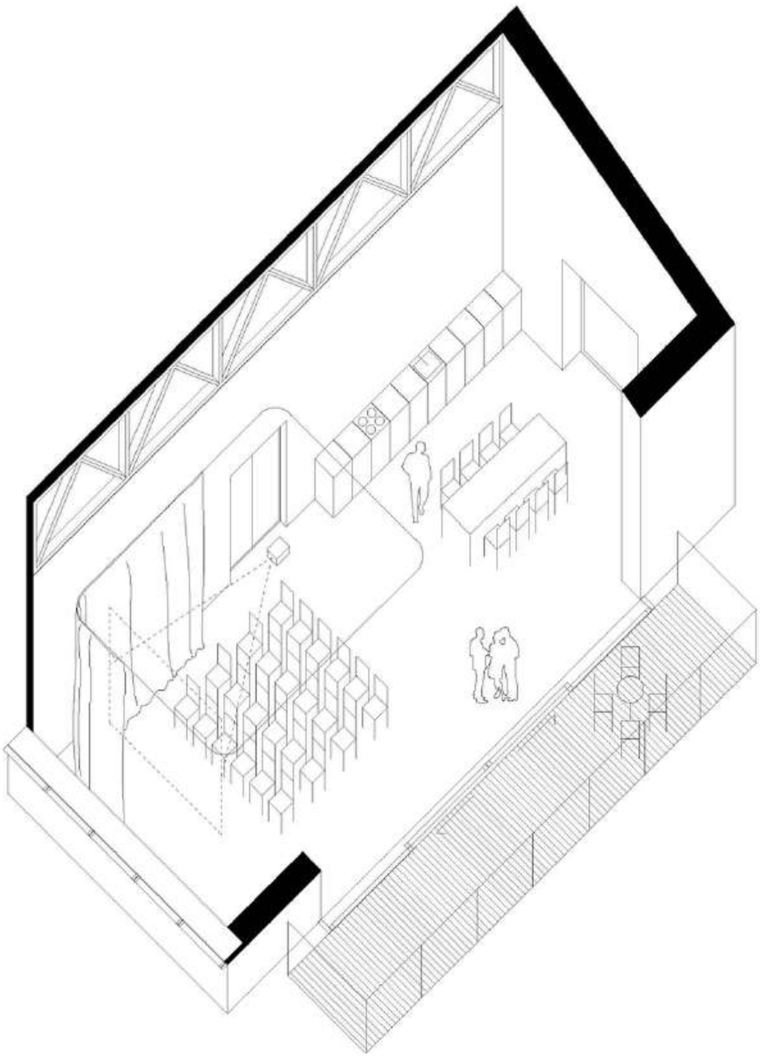
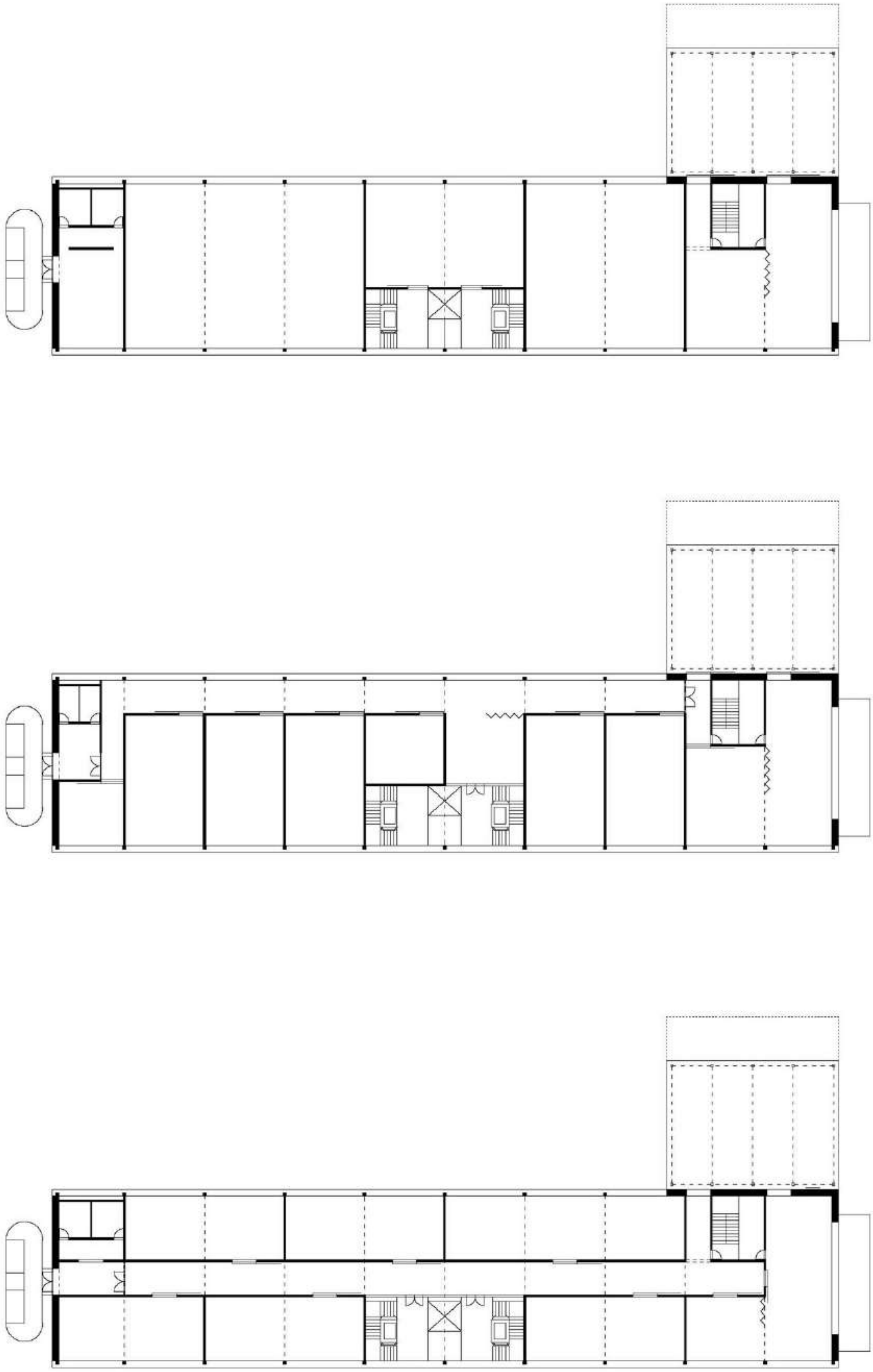


Fig. 25: Roof extension - variants for floor plan organisation. Authors: PLURAL



Facade design of the building extension

The façade design is based on the architecture of the dormitory. Modifications are made where desirable, such as in the window openings made of wood-aluminium with shading by roller blind fabric. The façade profiling is graphically traced on the thermal insulation composite system of the façade. This is intended to pick up on the continuity of the building in a natural and pragmatic way, but also to refer to its current and past image. The surface treatment is to be cement filler in a natural colouring, so that the plasticity of the structure reflects its lightness and allows the characteristic form of the shed roof to stand out. The ventilated façade with folded roof is covered with a laminated EPDM membrane.

Roof terrace, greenhouse and façade design

A terrace will be created on the remaining roof area of the courtyard wing, which will be covered with a light glass construction. The supporting steel or wooden elements will be anchored in place of the drainage supports of the existing building. Further details on their execution as well as on the redesign of the (greened) façades are described in detail in Chap. 5.3.3 Green and blue infrastructures.

Design of the open spaces in the courtyard area

The open space of the Vel'korysy courtyard in the garden area of Nová Cvernovka has an important function as a green space for the entire project. It is planned to convert it into an intimate park in the future, which will primarily benefit the residents, although a relatively large number of car parking spaces must first be provided under planning law (cf. Chap. 5.3.5 Mobility). The access road is to be separated from the rear façade and relocated outside the fence. Materials should be chosen for the parking areas that correspond to the landscape character of the park and are well suited for rainwater infiltration.

Deconstruction measures

The following interventions are to be made in the supporting structure of the building for the implementation of the planning:

- Removal of the external access stairs in front of all four façades,
- Creation of new openings in the basement walls with new steel lintels according to statics,
- Deconstruction of an interior staircase on the 1st floor,
- Manual dismantling of (selected) brick chimneys. The openings in the ceilings are closed or used as installation shafts,
- in the extension between the street and courtyard wings, part of the ceiling between the primary post floor slabs will be removed and a new interior staircase made of reinforced concrete will be built at the height of the entire building.

Inside the building, all floor and floor structures are to be removed, non-load-bearing partition beams demolished, the furniture in the social rooms dismantled and window and door coverings replaced, removed or modified. These works do not constitute an intervention in the load-bearing structure.

Heat supply, building technology and other ecological measures

The building services requirements and measures are described in detail in the following chapters.

- 5.3 Overall ecological concept and
- 5.4 Energy modernisation and plus-energy concept

and are therefore not listed here. Further detailed descriptions and calculations of the technical measures, such as fire protection, daylighting or parking space verifications, can be found in Appendix A1 - Project documentation. Calculations on the heat demand are presented in Annex A4 - Calculations on the energy concept.

5.2.5 Plan representations

Fig. 26: Site plan of the future Nová Cvernovka campus. Authors: PLURAL

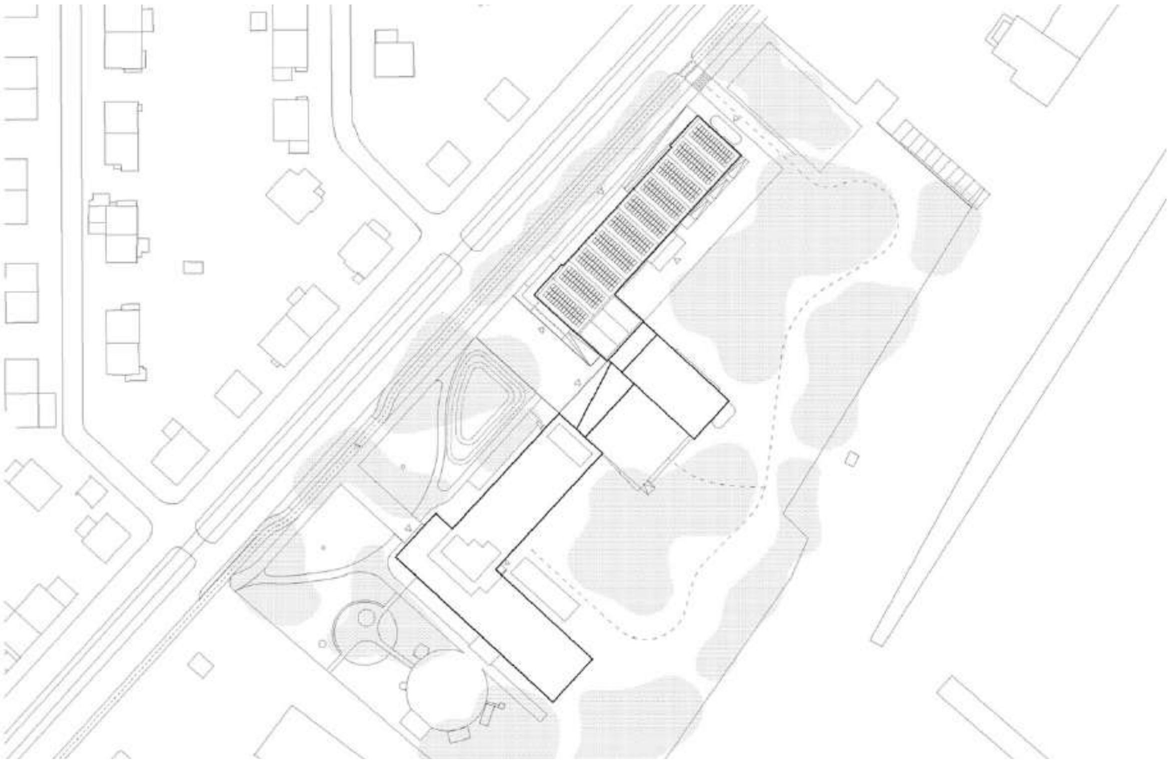


Fig. 27: Floor plan level 1 - ground floor with public functions. Authors: PLURAL

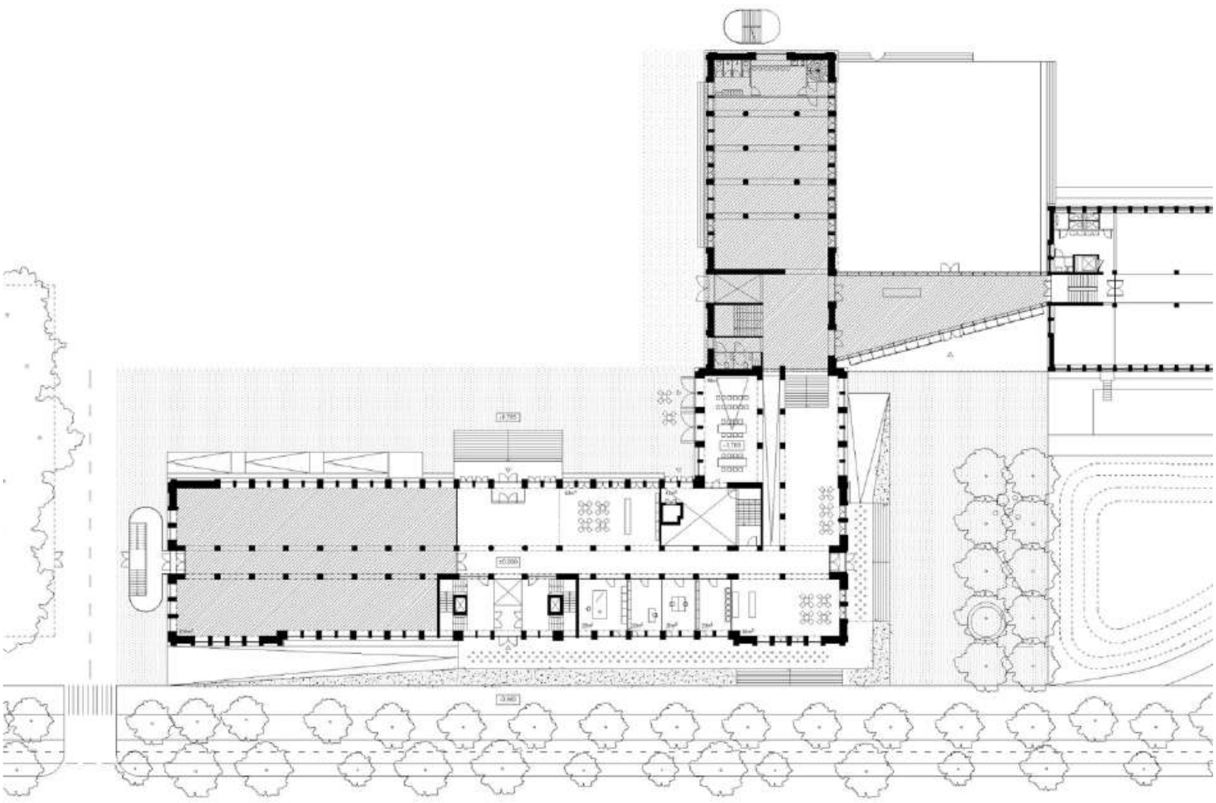


Fig. 28: Floor plan level 2 - offices and studios. Authors: PLURAL

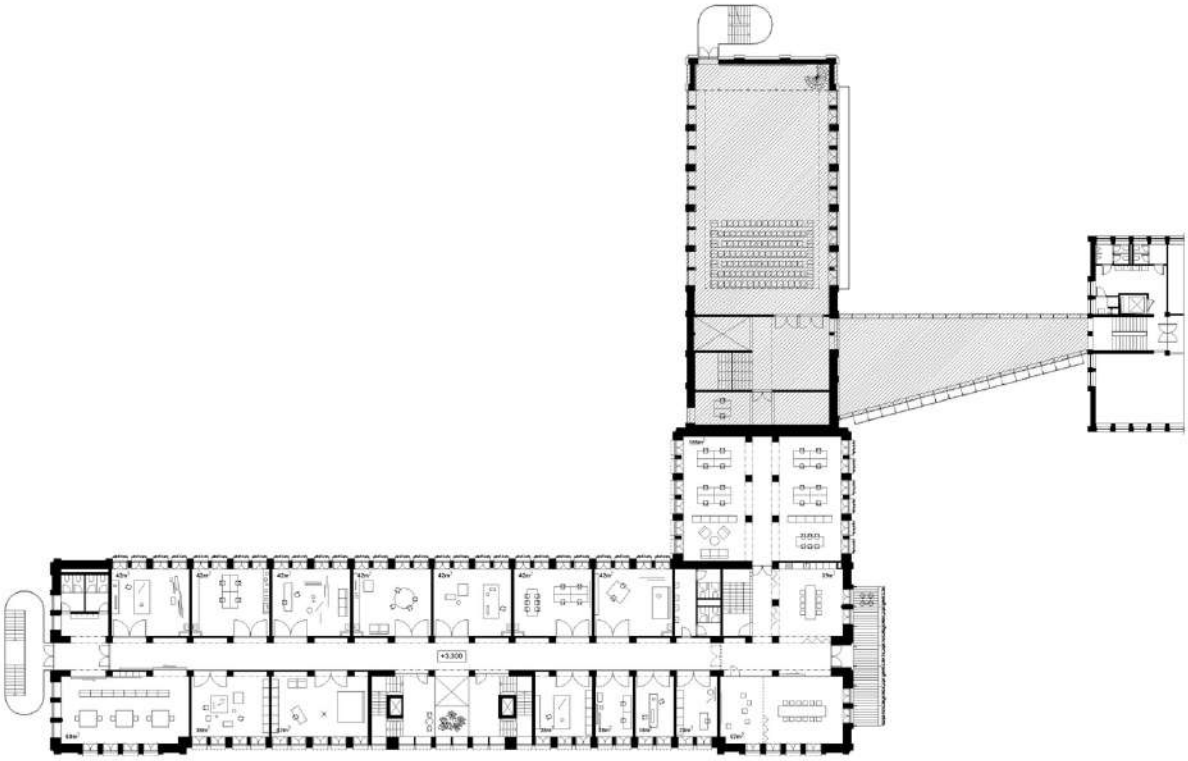


Fig. 29: Floor plan level 3 - mixed living and working. Authors: PLURAL

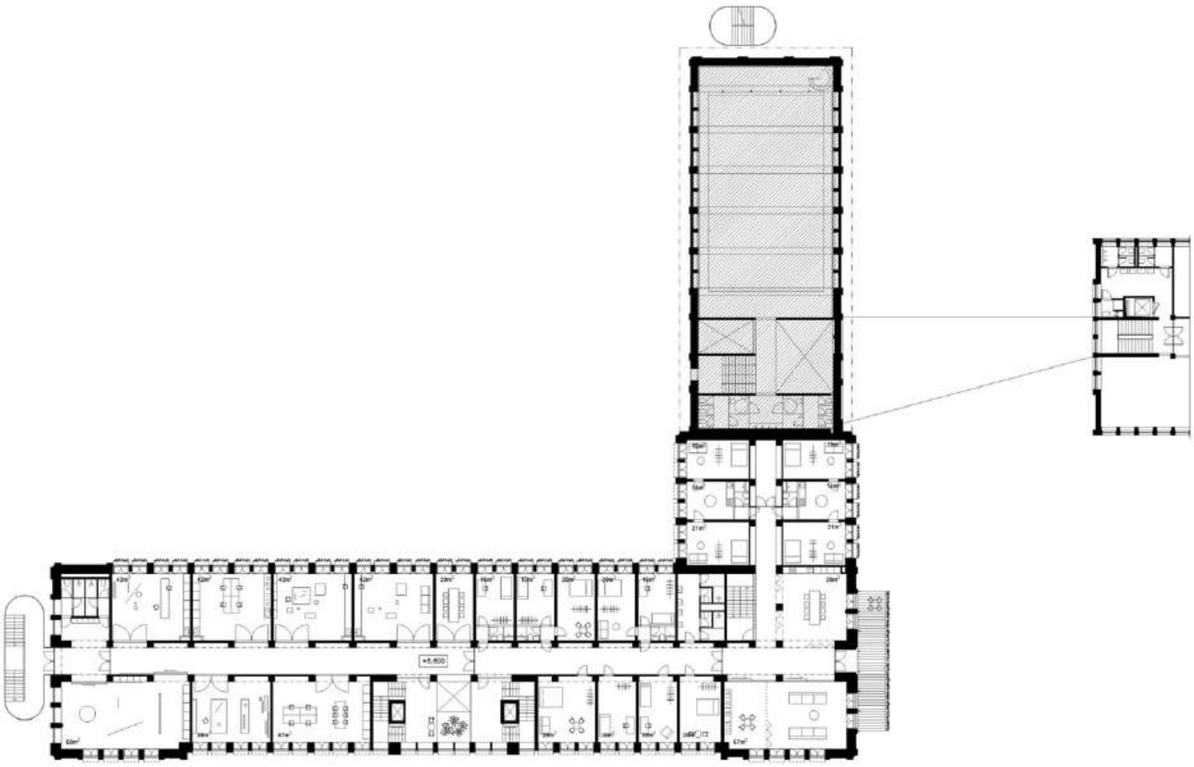


Fig. 30: Floor plan level 5 - living. Authors: PLURAL

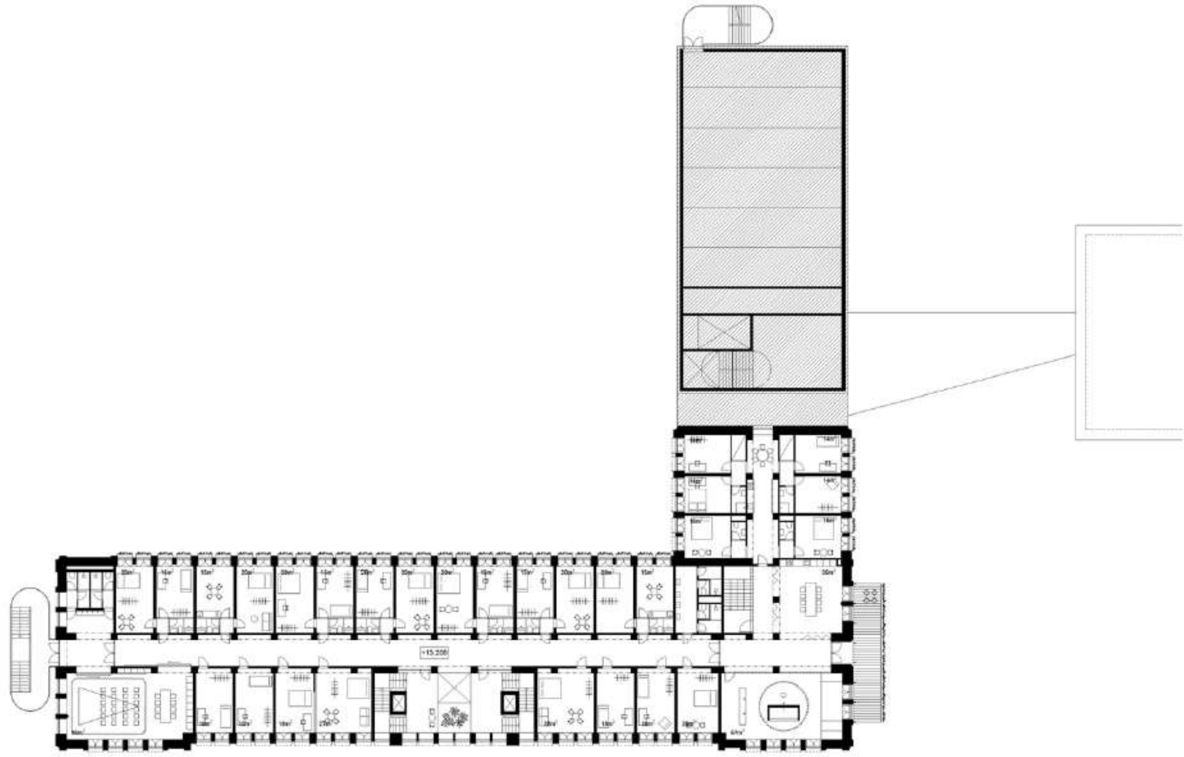


Fig. 31: **Floor plan level 6 - roof extension. Authors: PLURAL**

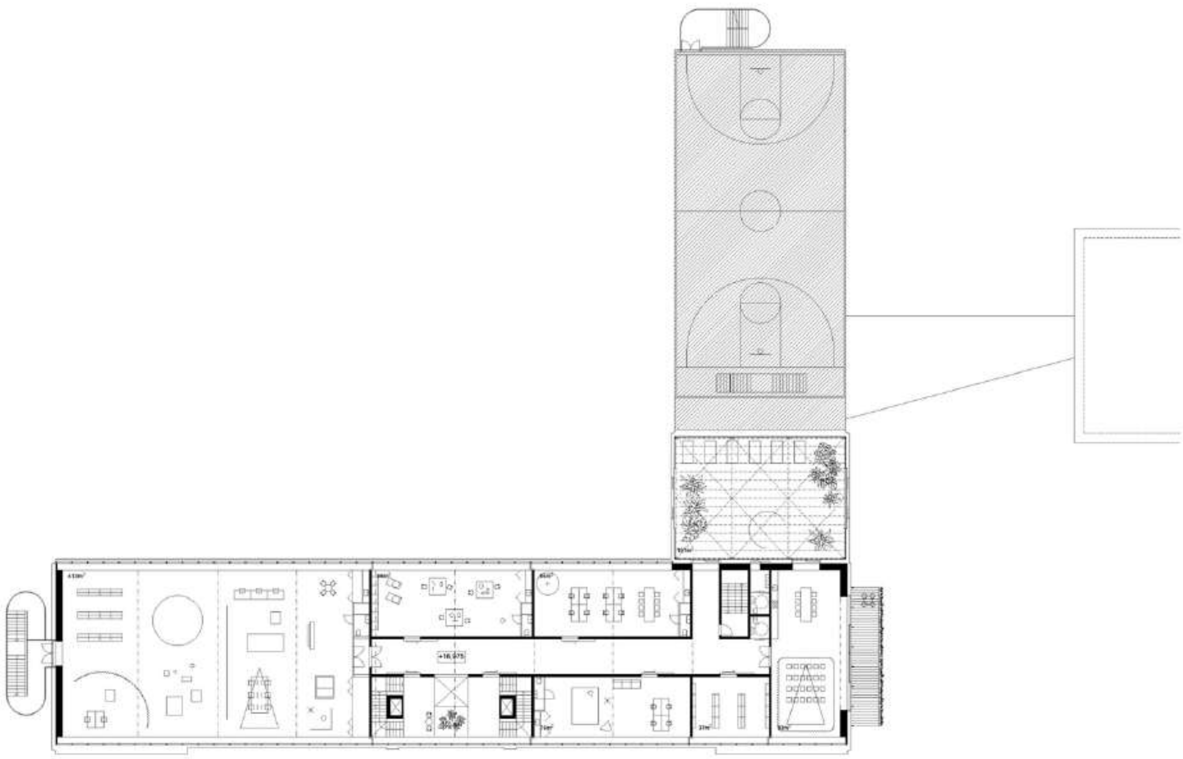


Fig. 32: North-west view (street) in the inventory. Authors: PLURAL

Fig. 33: North-west view (street) - new planning. Authors: PLURAL

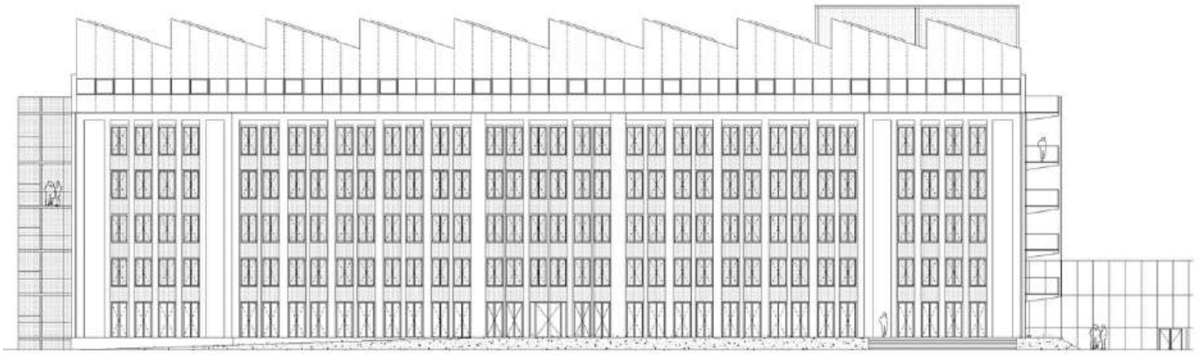


Fig. 34: South-east view (courtyard side) of the existing building. Authors: PLURAL

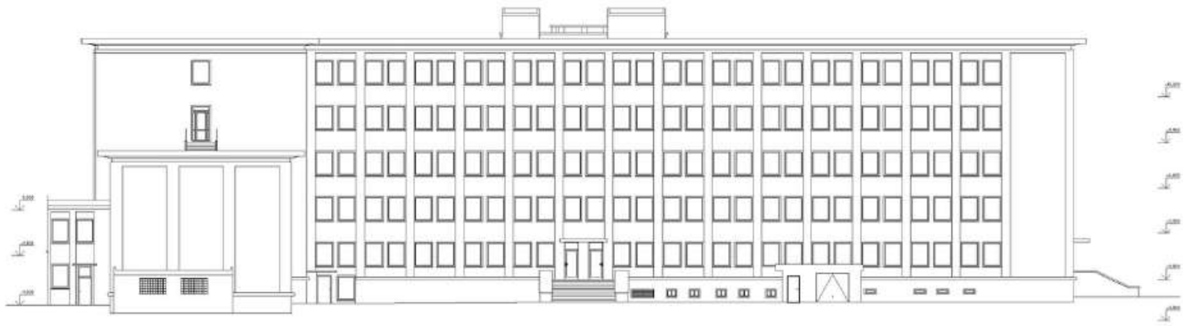


Fig. 35: South-east view (courtyard side) - new planning. Authors: PLURAL

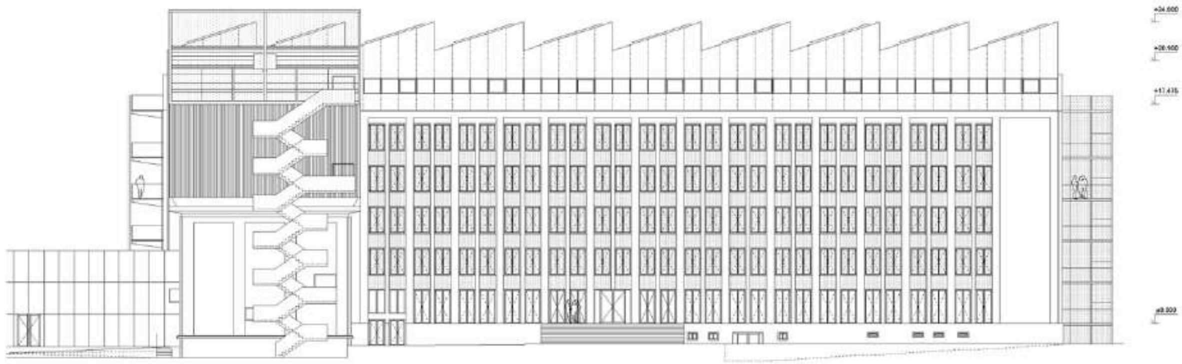


Fig. 36: South-west view in the inventory. Authors: PLURAL

Fig. 37: South-west view - new planning. Authors: PLURAL

Fig. 38: North-east view (courtyard side) in the inventory. Authors: PLURAL

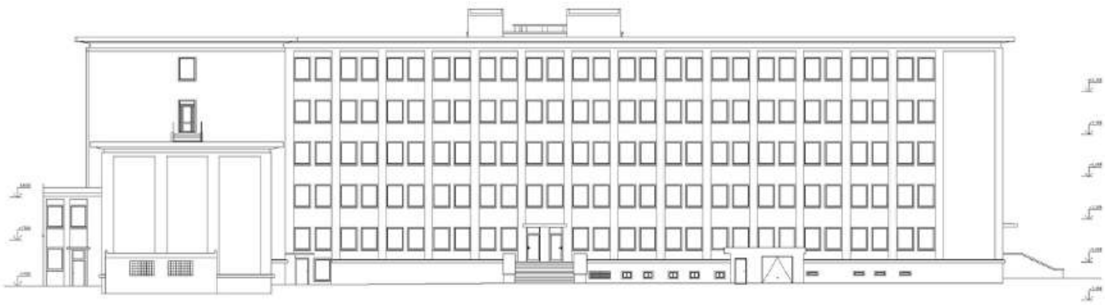


Fig. 39: North-east view (courtyard side) - new planning. Authors: PLURAL

Fig. 40: Perspective from the street side. Authors: PLURAL

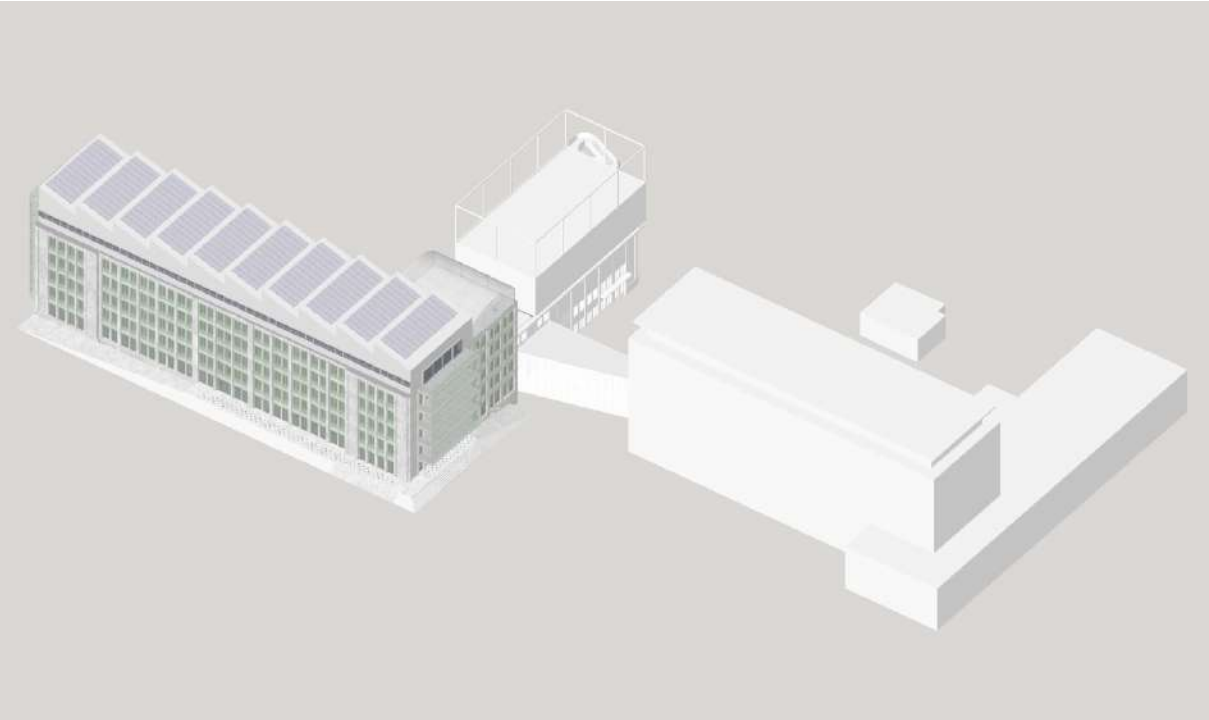


Fig. 41: Perspective from the courtyard side. Authors: PLURAL

5.3 Overall ecological concept

5.3.1 Project understanding of social-ecological building

According to the concept of *strong sustainability,* appropriate resource management rules are to be followed, taking into account local and regional factors of influence for the preservation of the natural capital stock (Daly 2002, Brand & Jochum 2000: 72). The three sustainability strategies of *efficiency*, *sufficiency* and *consistency* provide orientation for the design of sustainable development. When making planning decisions in the building sector, their effects on the entire life cycle must be taken into account.

Ecological housing and urban development projects mostly focus on energy efficiency, materials and technologies and usually do not address community and affordability issues in depth. One aim of the CMI.BA research project was to focus equally on the ecological and social dimensions of building and to arrive at integrated solutions. The focus is always on synergies: it is assumed that the integration of community and technology, efficiency and sufficiency can lead to more significant innovations than researching these dimensions independently (cf. Becker 2016: 398). A *new narrative needs* to be developed.

In accordance with the research-theoretical claim in social ecology to develop solutions for practical ecological and social problems and thereby to conceptually order the methodically generated knowledge (cf. Gottschlich 2017: 6), the social dimension was also taken into account in the development of the overall ecological concept for Nová Cvernovka, for example in the research and development of locally adapted CoHousing concepts, the investigation of relationships between social and ecological issues, and by favouring solutions that generate synergies.

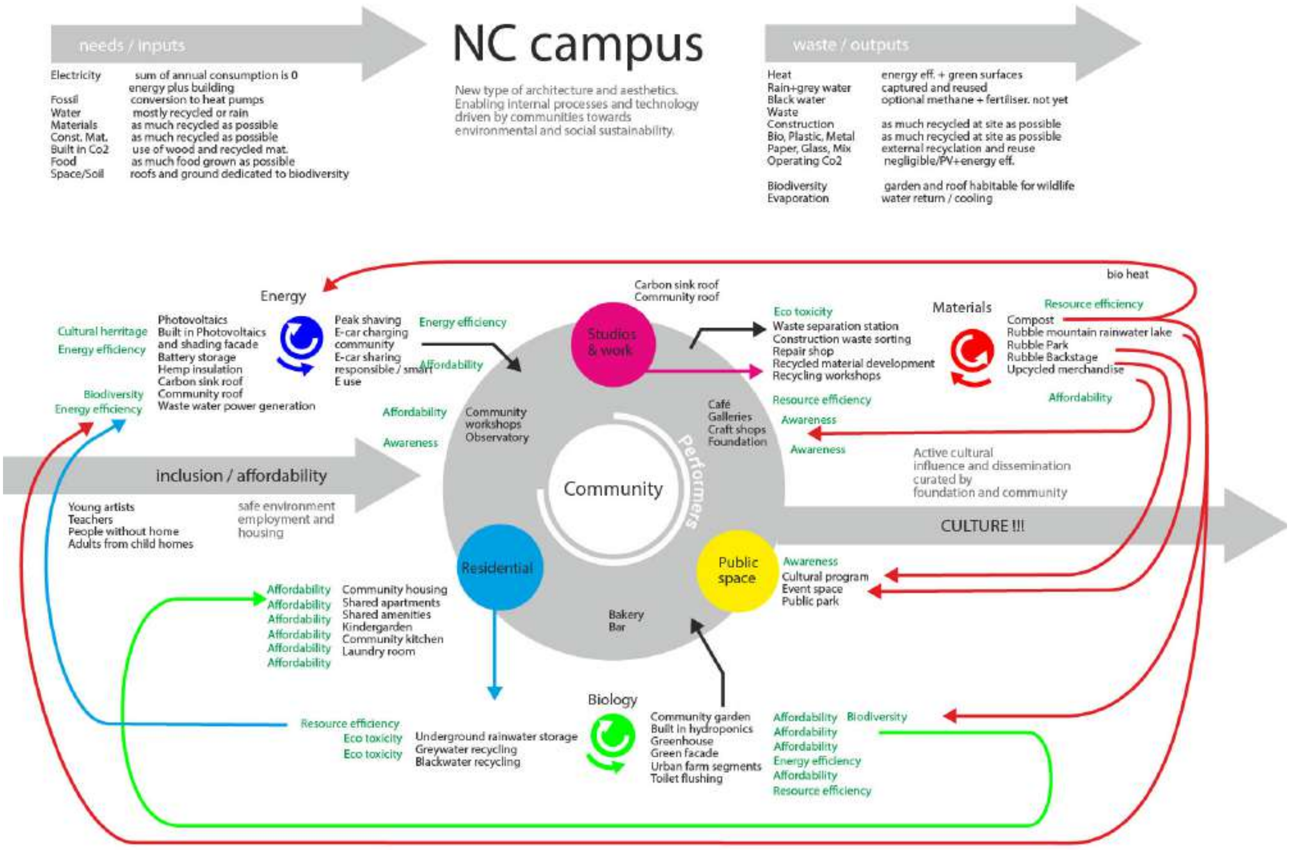
A socio-ecological perspective suggests that the issues of efficiency cannot be adequately addressed without first addressing the issues of local democracy and community. Energy efficiency and the use of renewable energy must be increased. But complementary to this, energy and resource consumption must be reduced and the quality of spaces and thus of housing and life must be improved. This can be achieved through user:inside and community-oriented forms of housing. Efficiency and sufficiency must be combined with affordability.

On a larger level, this discussion concerns the climate, the economy, democracy, housing and health. It is motivated by crises that are becoming more real every day. The conclusions set out below begin by recognising these interconnected crises. The assumption is that integrated responses are now required and to achieve this both the problems and the opportunities need to be described in an integrated way. Our questions are thus concerned with a broader task, namely the description of a new narrative. Such a new 'narrative' can be associated with a vision of 'civilisational transformation' and 'Green New Deal' programmes (Klein 2019). Nová Cvernovka is thus seen as part of a "Green New Deal" for Bratislava and as part of a European process of "ecological modernisation" as well as a new European Bauhaus, which simultaneously address efficiency and affordability.

5.3.2 Specified goals of the ecological concept

The CMI.BA project initiated the creation of an ecological concept for the entire N.C. campus. Through the discussions of the DBU partners, many circular solutions were found that can improve the quality of life and make life more sustainable both ecologically and socially. Many measures are oriented towards sustainability certification criteria for buildings, but building certification itself was not a project goal and was therefore not undertaken.

Fig. 42: Ecological concept for the Nová Cvernovka campus. Authors: ECOboaRD



For the overall ecological concept (see also graphically in Fig. 42), a common guiding principle was developed in the project, which formulates the following goals as orientation for the selection and use of suitable technologies and for the development of innovations:

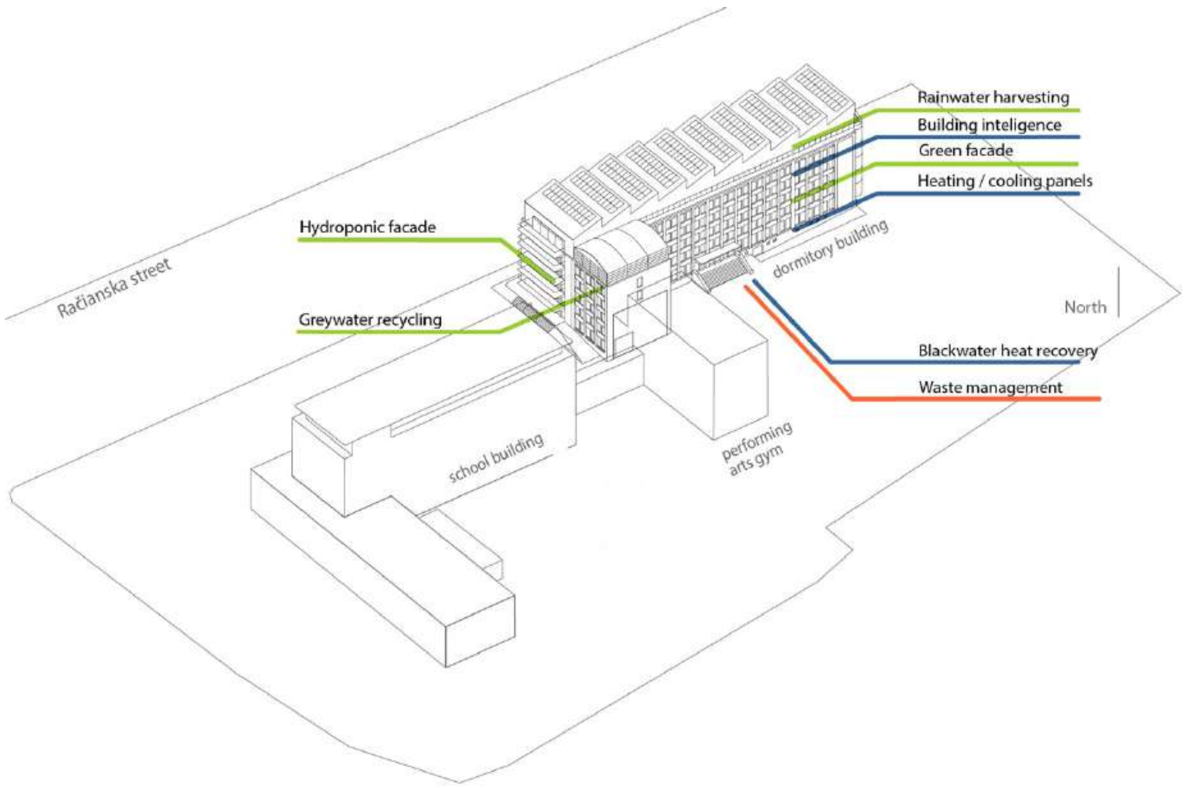
- Energy modernisation and conception of a plus-energy building,
- Minimising the operational impact on the environment,
- Integration of green and blue infrastructures with regard to climate adaptation measures and the economical use of water resources,
- Consideration of the grey energy of existing and new constructions,
- Use of ecologically safe building materials to be taken into account during conversion (human and ecotoxicology)
- Development of various planning scenarios that show different characteristics of the respective ecological fields of action (minimum / maximum),
- Develop procedures for prioritising objectives and dealing with conflicting objectives.
- Investigation of the influence of flexible building structures and "robust", maintenance-friendly solutions on costs in the life cycle (reduction of expensive conversion measures, self-help etc.)
- Cost efficiency and "affordability" of housing costs even after refurbishment.

5.3.3 Green and blue infrastructures

Efficient and effective use of drinking water and rainwater is becoming increasingly important in view of climate change and the resulting scarcity of water resources in urban areas. Green and blue infrastructures are mutually dependent or complementary, e.g. in the irrigation of façade greening or hydroponic cultures. Fig. 43 gives a spatial overview of the location of the planned measures, Fig. 49 shows a scheme with the calculation of the quantitative shares of the different water flows. After intensive consideration, we recommend the following measures for implementation for the buildings and open spaces:

- Green facades with shading systems and (partial) balconies,
- Hydroponics for growing food close to buildings,
- Rooftop greenhouse,
- Rainwater harvesting,
- Rainwater infiltration and retention areas (rainwater retention),
- Recycling of grey water (optionally with heat recovery),
- Alternative wastewater treatment (separation toilets),
- Ecological outdoor space concept and urban gardening.

Fig. 43: Overview of the location of planned green-blue infrastructures in CMI.BA. Authors: ECOboaRD



Green facades, facade insulation, shading systems and balconies

Façade greening has a cooling effect on the surroundings through evaporation, can have a shading effect and promotes local biodiversity. Various design options were discussed in detail for the treatment of the façades. Any gain in quality and comfort is associated with production costs, which increases the rent allocation for refinancing. Therefore, the costs and benefits of the measures must be carefully weighed. The costs for the balconies can be clearly allocated to individual flats and, if necessary, charged specifically to their housing costs; if the costs are too high, they can be omitted. The following design variants were discussed:

Var. 1 - Minimum solution:
Renewal of the windows, insulation of the façade and interior sun shading.

Var. 2 - Thermal comfort solution:
Design as (1), only with external sun protection

Var. 3 - Spatial-functional comfort solution 1:
Removal of the parapets and installation of French doors with external sun protection, quality gain through a generous impression of space

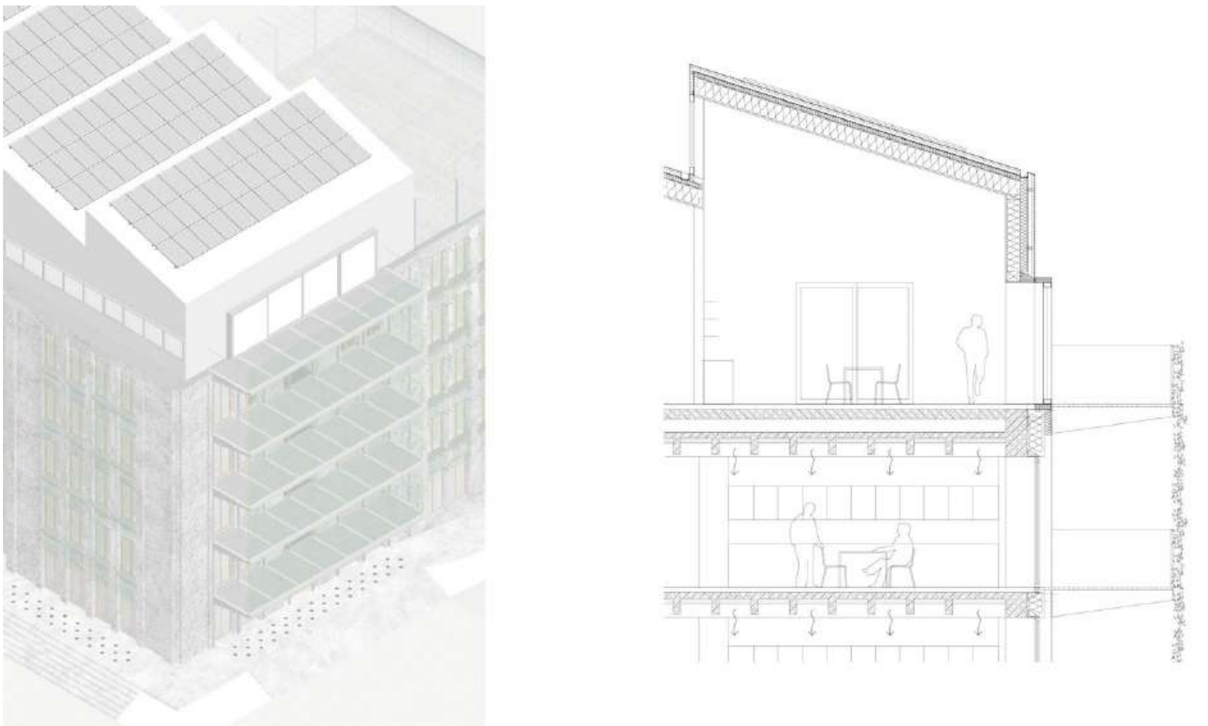
Var. 4 - Spatial-functional comfort solution 2:
Design as (3), additionally individual, somewhat wider balconies for two flats each, supplementary measures for greening the façade

Var. 5 - Spatial-functional comfort solution 3:
Lattice construction with integrated façade greening, whereby the benefits for offices and flats must be weighed against Var. 4.

Due to the different uses and orientations to the sky, different decisions were made for the façades in each case.

The **south-east façade of** the building facing the courtyard area receives a lot of sunlight in summer, which causes the building to overheat. In the area of the flats, new, sufficiently large balconies are designed as independent structures without projections to avoid thermal bridges (Fig. 44). Venetian blinds or curtains serve as external shading elements and reduce summer energy input. For the façade greening, climbing supports are fixed in the wall area with stainless steel screws. Steel cables serve as climbing aids for climbing plants rooted in the soil of the courtyard. The chosen technological solution is easy to implement and requires little maintenance and technology. There is a choice of plants suitable for the local climate and this type of cultivation.

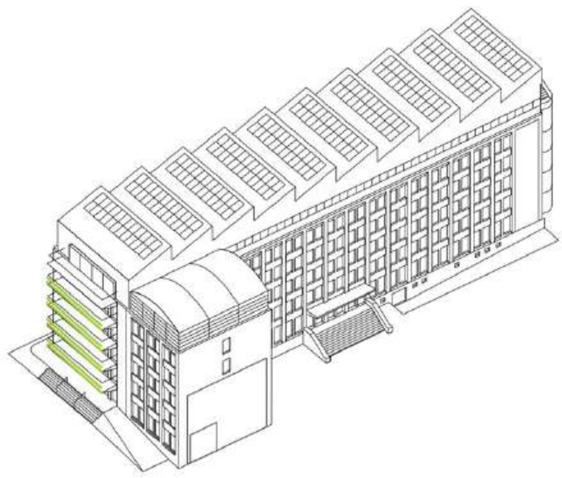
Fig. 44: Representations of the south-east façade of the building. Authors: PLURAL



Hydroponic garden

The **south-west façade faces the** same overheating problem as the south-east façade. Due to the cluster apartments planned there with communal kitchens that also serve as a meeting place for the community, each floor will have a terrace as an outdoor meeting space. These terraces will be laid out over almost the entire building width of 12.50 m with a depth of 3 m. The supports of the prefabricated steel structure are founded frost-free close to the building façade and the otherwise cantilevered terraces are designed with slender profiles. These terraces help shade the façade. At the same time, they offer the opportunity to integrate hydroponic cultivation there, where people grow their food and herbs right where they meet, cook and eat (Fig. 45).

Fig. 45**: Location of the planned hydroponic facilities for CMI.BA. Authors: ECOboaRD**



Recycled grey water is to be used as the basis for operating the hydroponics, which will be enriched to form the nutrient solution in a central system in the basement of the building (8 m^2) near the terrace. The 12.50 m long terrace with two horizontal pipes provides space for about 80 planters for lettuce, strawberries, herbs and other smaller plants.

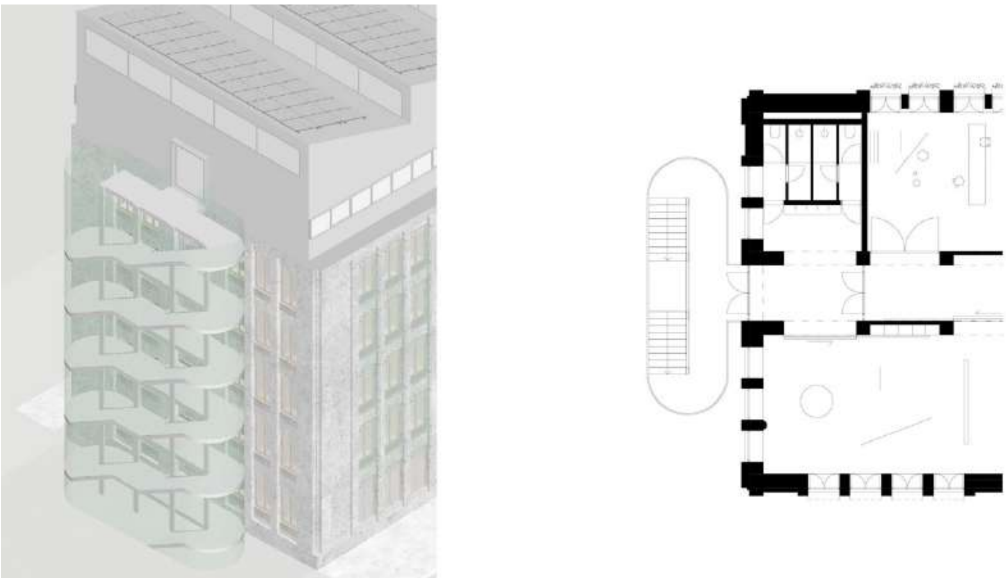
Hydroponic systems represent a sustainable and resource-saving model for producing food in the city. Vertical planting methods in particular are space-saving and can be implemented in versatile locations. If the plant is linked to the residents' grey water system, it is important to educate the residents about the networked system. Early education can prevent incidents. Since the system needs regular maintenance, it is advisable to externalise the care and maintenance or to assign the responsibility to a person from the residents or neighbourhood. In this case, tasks, responsibilities and remuneration should be clarified.

The Cvernovka Foundation works with designers who have experience with hydroponics. The community aims to design and produce the system itself and integrate it into the terrace system. This allows for easy handling for further optimisation or modification. During the excursion to Berlin in August 2021, this technology was visited at the Roof Water Farm.

The **north-west façade faces** Račianska Street and is heavily exposed to street noise. Therefore, balconies are not added here. Otherwise, the façade is treated similarly to the south-east façade in terms of shading and greening.

The **north-east façade** is supplemented with a necessary staircase (escape route) and otherwise treated like the north-west façade (Fig. 46). The staircase is constructed in an open manner and can also be greened with rope or net aids.

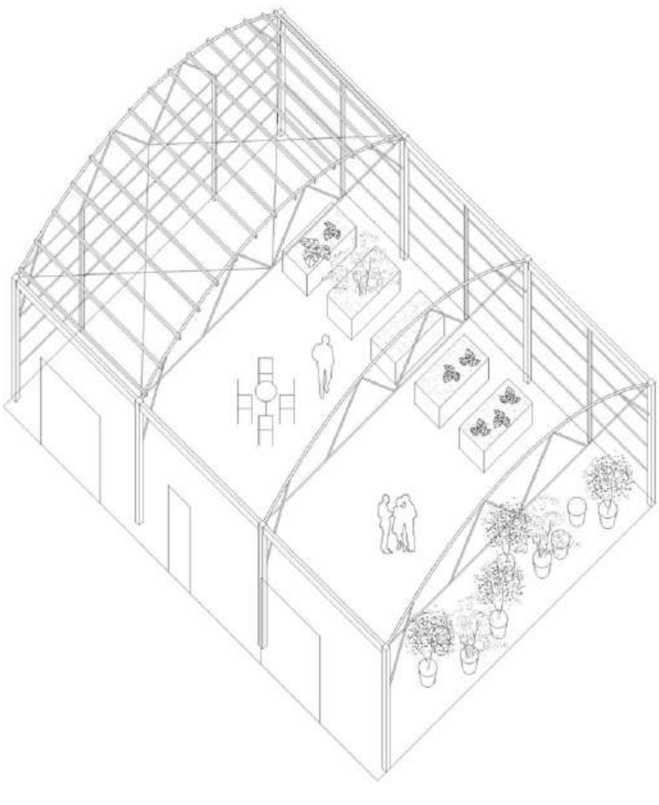
Fig. 46**: North-west façade with new staircase, perspective and floor plan. Authors: PLURAL**



Greenhouse on the roof

On a partial area of the roof between the dormitory and the school building, a greenhouse is to be built as a communal "semi-outdoor area" for various cultivation methods and further experiments (Fig. 47). In winter, this greenhouse will serve as a solar collector and in rainy summer as an interesting community space. The construction will be delivered as a system building by a construction company. The interior and functions will be participatively co-designed by the community after completion.

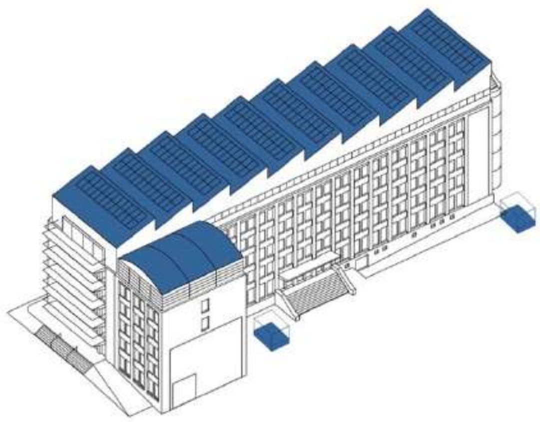
Fig. 47: **Greenhouse on the roof terrace. Authors: PLURAL**



Rainwater harvesting

The rainwater is currently discharged into the sewage system. For rainwater utilisation, it was calculated that about 1040 m3 of water can be used annually (Fig. 48). The use of rainwater for flushing the café toilets and the kindergarten on the ground floor is conceivable. However, it does not seem economical to supply all flats, especially since climate change means that the rainwater statistics for determining the water supply are no longer a reliable basis for assessment as a result of the new rainfall regime - long periods of drought replaced by heavy rainfall events. During dry periods, drinking water replenishment would be necessary anyway.

Fig. 48**: Roof surfaces on CMI.BA for rainwater collection. Authors: ECOboaRD**



Retention tanks with a total volume of approx. 38 m^3 are installed in the courtyard for rainwater collection. An emergency overflow from the tanks is routed through the property sewer to the inspection shaft at the sewer connection. The water can be collected well here, is cooled at a constant temperature and the construction measure can be realised relatively inexpensively and largely with own labour. If there is a communal laundry room, the rainwater (possibly combined with greywater) can be used for washing clothes. The system is designed by ECOboaRD and built by a construction company.

Rainwater infiltration and retention areas (rainwater retention)

Particularly for heavy rainfall events, there is a need for suitable rainwater management that is not only able to collect the majority of rainwater, but also to allow the excess to infiltrate safely into the ground. The following measures are generally suitable for rainwater infiltration (Bielefeld 2017: 152 f.):

- Green roof
- Surface infiltration
- Swale infiltration
- Swale-trench systems
- Special design elements with rainwater
- Retention ponds.

As an urban wetland element ("sponge city concept"), an urban pond offers a relatively large cooling potential with positive effects on the microclimate and biodiversity; however, as a standing water body, it would also favour an expansion of mosquito populations. If an urban pond were to be implemented, plants with a high evapotranspiration capacity such as reeds and rushes should be chosen. Other options are plant-covered water areas, evaporation beds, water-supplied greenery, floating vegetation, blue-green facades and roofs or the integration of water features and fountains.

Recycling of grey water (optionally with heat recovery)

The excursion to Berlin also included a visit to a greywater treatment plant with heat recovery. Erwin Nolde explained the potential and functioning of the treatment and use of grey water using the example of the plant built in 2011 in the passive house at Arnimplatz. The results are also documented in a DBU-funded project (Nolde 2013). Greywater utilisation has a drinking water savings potential of 30-50%, with monitoring playing a crucial role. The recording of data on consumption and maintenance of the system is done with a specially developed app and enables the assessment of maintenance needs without the need for specialised personnel to be on site - it thus saves costs and effort. The monitoring also supports improvements and further developments as well as the comfort of the users.

The reuse of grey water provides a valuable source of water for flushing and greening. For Nová Cvernovka, an application for the wastewater from the washbasins and showers as well as bathtubs in the area of the communal accommodation is a good idea. Technical solutions are already on the market and an implementation in N.C. is easily possible. Recycling is done in three stages: mechanically with a coarse filter, biologically with tanks containing media colonised by bacteria, and physically through UV disinfection. The treatment plant is placed directly at the downpipe to the first basement level and requires about 9 m^2 of space and is of a similar size to the variant at Arminplatz. The effort for the pipe installations (location of the connected bathrooms and installation shafts) is to be optimised.

The heat recovery from the grey and black water can be integrated into the heating system with a heat pump. The system's machine room must be located as close as possible under the exit of the stairs from the toilets to the first basement floor. In the case of the dormitory, two machine rooms with about 8 m each^2 are probably needed. The heat obtained in this way can be used for heating or hot water.

Alternative wastewater treatment (separation toilets)

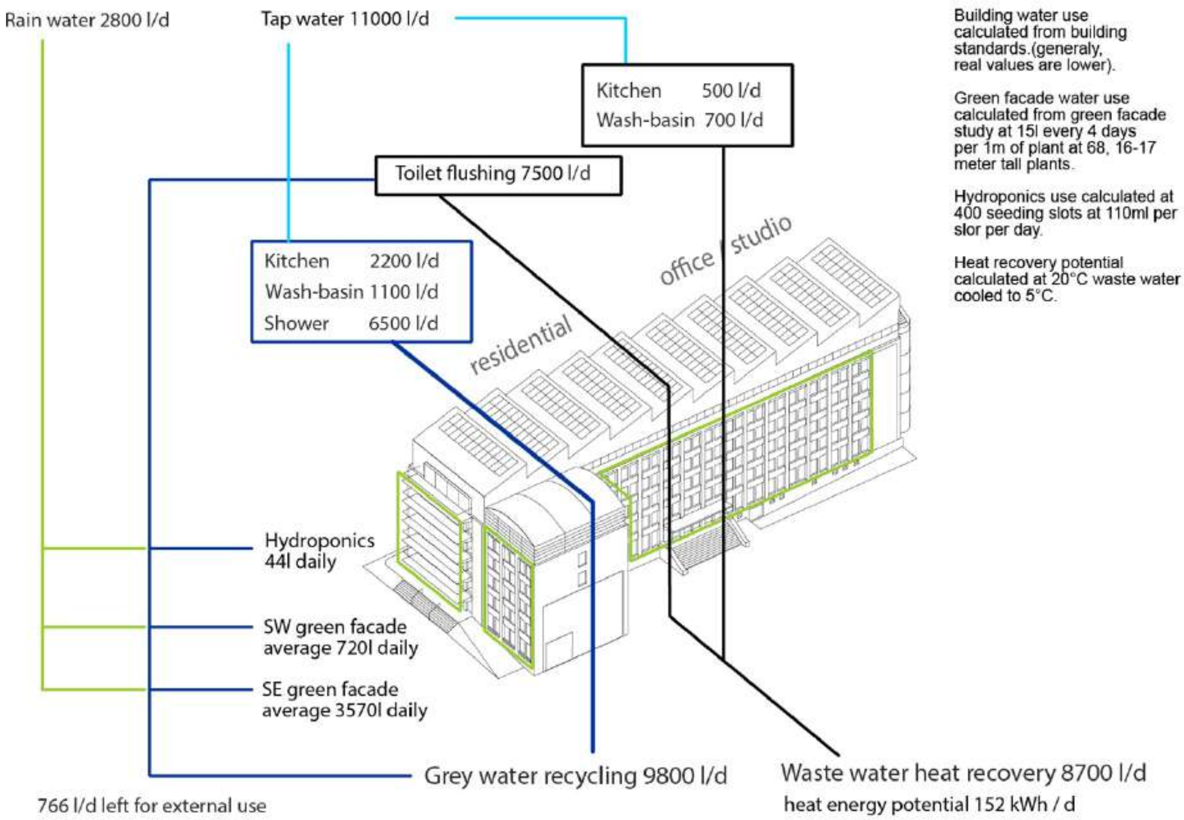
The proposed concept for rainwater and greywater utilisation can be further developed, for example by using separation toilets to utilise black water or alternatively by using vacuum toilets with biogas production. The reuse of black water is not envisaged at this stage, but can be included in wastewater management later. The possibilities for implementing these concepts were therefore not investigated as part of the research project.

"All in all, even if each of these measures does not appear to have a major impact individually, their broad effect will contribute significantly to water protection and stabilisation of the water cycle." (Bielefeld 2017: 161).

Open space planning

Since the design does not provide for green roofs, sufficient retention areas must be planned on the property. These are also needed for rainwater utilisation as overflow protection during heavy rainfall. They can be constructed as self-built infiltration troughs or with a professional infiltration system (Rigole) The number of parking spaces for cars should be reduced to the minimum in order to reduce surface sealing as much as possible. The outdoor areas should be designed as water-permeable as possible, e.g. with lawn or gravel, in order to maintain the natural water cycle. The courtyard and landscape concept provides for ecological open space design through the planting of native trees and shrubs, the promotion of wildlife habitat (e.g. installation of nesting boxes), and an expansion of the existing neighbourhood garden for urban gardening. The aim is to achieve a high level of biodiversity.

Fig. 49: Water concept (quantitative) for CMI.BA on the Nová Cvernovka campus. Authors: ECOboaRD



5.3.4 Building materials, material cycles and infrastructure planning

In the transformation of the Nová Cvernovkas building, the focus is on the most efficient handling possible in the selection and use of building materials in terms of grey energy and the ecological harmlessness of the materials (minimisation of human and ecotoxicology). Negative ecological impacts are minimised through the re-use of used, recycled and low-emission, organic and ecological materials and products. The basic planning strategies for this are described in the design patterns "Recycling, Circular Economy and Urban Mining" (cf. Patterns M1), "Design for Dismantling" (cf. Patterns M2), "Material Passport" (cf. Patterns M3) and "Use of Renewable Resources" (cf. Patterns M4).

The following measures are planned for circular construction in Nová Cvernovka:

- Conservation before new construction: strategy of minimal intervention
- Use constructions with low grey energy
- Design for (later) disassembly
- Reuse of construction waste
- Optimisation of infrastructure planning and consideration of building physics properties
- Operational waste separation and recycling

Conservation before new construction: a strategy of minimal intervention

Everything that can be preserved in the existing building and does not need to be replaced or renewed lowers the ecological and economic costs. Therefore, the *minimal intervention strategy of* the conversion provided a guideline for the planning decisions. This was already the maxim for the conversion of the school building and manifested itself in the characteristic features of an aesthetic that emerges from a successful combination and contrast of old and new design elements.

This is also where the hierarchy of different recycling strategies comes into play:

- Continued use of existing constructions of the supporting structure, the façades and in the finishes
- Re-use of used materials and products from the existing building (e.g. interior doors, sanitary elements and built-in furniture).
- Use of products made from recycled materials
- Organisation of a material exchange

Use constructions with low grey energy

The material concept for all new building parts of the façade renovation and addition is based on the above-mentioned principles. Where possible, regionally produced materials are used. Particularly for the planned roof extension, the materials used - including the supporting structure, if constructively possible - are to be largely made of wood and not steel. For the initially planned outer shell made of aluminium foil, an alternative with lower grey energy was considered.

Design for disassembly

The circular planning and construction is implemented through detachable connections that cause less or ideally no waste and thus also make maximum use of the incorporated grey energy in the long term. During implementation planning, important information for future refurbishments and conversions is to be compiled by creating a material passport.

Reuse of construction waste

The successful reuse of construction waste has already been applied to the conversion of the neighbouring former school building on the Nová Cvernovka campus. The same solution will be applied in the conversion of CMI.BA and will be extended by the production of bricks from waste, which will also broaden the spectrum of waste use.

Optimisation of infrastructure planning and consideration of building physics properties

Material and cost savings start with smart space and infrastructure planning. The programmatic mix of living and working functions led to the discussion of how much flexibility is needed in spatial zoning, as living and working spaces entail different levels of sanitary installations (discussion "minimum" and "maximum shaft"). Rooms with sanitary installations such as kitchens and bathrooms should be arranged side by side as far as possible to minimise the number of installation shafts and pipes.

If, for example, the living space is located on the entire fifth floor due to the better view and greater privacy, all installation shafts for the connections would also have to be routed through all other floors. Since the ratio of effort, costs and benefits is unfavourable (especially if grey water use with double piping is also planned), the recommendation is to optimise spatial flexibility and thus the number of shafts. For example, a vertical division can be made according to "residential and office tract".

When renovating, attention should always be paid to spatial barrier-free and wheelchair-accessible planning (corridors and doors), as these can only be changed at great expense in the future (cf. Pattern P4).

The thermal mass is to be activated during building conversion, for example by deconstructing and abandoning suspended ceilings. Materials should be used that are advantageous in storing and releasing heat with a time delay, which has a high influence on heating and cooling loads and the comfort of the rooms.

Operational waste separation and recycling

All the waste that arises must be well separated. This is achieved through easy and convenient handling. In addition, some community benefits will be introduced to incentivise residents. Plastics and metals are to be recycled to some extent on site in special workshops. An experimental solution has already been developed for the former school building by ECOboaRD. More complex workshops and separation processes are being designed for the CMI.BA, especially for plastics. Melting and casting of aluminium, brass and silver have already been tested and can be designed and implemented as workshops for the community. The plastics workshops will use the open-source know-how of established recyclers like PRECIOUS PLASTICS. Thanks to the artistic and creative community, the recycled materials can also be used for art, small architecture in public spaces or for goods sold at cultural events.

Organic waste is currently already composted and used in the community garden. Some materials such as batteries and electronic waste, paper, glass or mixed waste can only be collected separately and disposed of off-site by external companies and at best recycled.

5.3.5 Mobility

Nová Cvernovka is obliged by law (parking space ordinance) to provide a relatively large number of car parking spaces on the property. Currently, 95 parking spaces are available on paved areas on the N.C. campus. In the course of the planned conversion, a calculation was made of the number of parking spaces required (see Appendix A1 - plan documentation). According to this, the following parking spaces are required for the uses in the

- School building 68.13 Parking spaces
- and the residential building 57.57 Parking spaces

required. In total, 125.7 parking spaces must be provided for the N.C. campus. That is, 31 more parking spaces than are currently available. This will be done by adapting the existing traffic areas in the area and will partly require the creation of paved areas.

The conversion is intended to realise an infrastructure for an intelligent grid connection and the charging of e-cars. The Cvernovka Foundation is working with companies that specialise in this field (e.g. MAKERS, Greenway and others). Through the *shared mobility* approach, it may also be possible to provide fewer parking spaces for cars in the future. For example, when the *Sargfabrik in* Vienna was built in the 1990s, it was possible to reduce the provision of parking spaces to only one parking space per 10 residential units, as the legal form "residential home" allowed for a different calculation key. Especially because of the cultural centre's location close to the city centre with an excellent tram and regional train connection, efforts should be made to reduce the number of parking spaces and the associated soil sealing.

The provision of a sufficient number of bicycle parking spaces in connection with a (self-help) bicycle workshop (cf. Pattern C4) is also intended to promote the mobility turnaround required in Bratislava.

5.4 Energy modernisation and plus-energy concept

5.4.1 Analysis and evaluation of the initial situation

The first step in upgrading a building to a higher energy standard is to know its current situation. The following sections describe the assessment and calculation process.

The energy envelope of the building

First, a detailed mapping of the building was carried out. For this purpose, the geometric and building physics characteristics of the building (input of dimensions, U-values, etc.) were entered into the PHPP calculation software. The data was obtained from the current survey, but also from the original plans from 1955, when the building was constructed. Further data was provided by probes drilled into the roof and floor structure, part of the exterior walls were exposed, so it was relatively easy to determine the composition of the structures. In the PHPP, the individual layers are described in a separate sheet with the thermal insulation properties, followed by the calculation of the heat transfer coefficient, the U-value of each segment and of a specific part of the energy envelope.

Air tightness of the building structure

A very important value when calculating heat loss is the air infiltration rate through the structure. This is a determination of the amount of air that flows through a leak in the building due to wind. At this stage, it was a qualified estimate based on experience of measuring different properties. We calculated n50 = 3/h, which generates a pressure of 50 Pa on the building and again corresponds to a wind speed of about 35 km/h. The more there is leakage, the greater the exchange; the stronger the wind, the greater the air exchange. This value is determined by the so-called BlowerDoor test. This is a simulation of the effect of wind on the façade at such an air speed, with overpressure and underpressure being measured.

Heat supply

The building's heat supply for space heating and hot water is currently provided by a gas boiler running on natural gas, which prepares hot water for the radiators. The temperature of the medium is 60-70 °C and is operated by an external service provider.

Ventilation

The building is ventilated manually via windows.

Thermal bridges

The thermal bridges are appropriate to the time of construction of the building and the structure itself. Gradually, measures are proposed to improve the overall energy situation and achieve a desired state.

Results of the heat calculation

According to the calculation with PPHP, the existing building has a heating energy demand of 113 kWh/(m^2a) and a primary energy demand of 213 kWh/ m^2a with an average U-value of 1.55 W/(m^2K). By improving the U-values of the building envelope (triple-glazed windows, insulation of the envelope surfaces) and installing a building ventilation system, it is possible to install a low-temperature heating system (radiant ceiling heaters for heating and summer cooling in reverse mode) combined with a reduction of the heating energy demand to approx. 25 kWh/(m^2a) (passive house standard for reconstruction).

Table 6: Geometric and energy-related parameters of existing building and planning. Authors: iEPD

Building and energy parameters	**Areas and characteristic values**		
	Current state	Planning state	Share
Facade area	3.283,2 m^2	4.1438,8 m^2	+ 26,2 %
Window area	1.329,0 m^2	1.631,2 m^2	+ 22,7 %
Roof area	1.785,5 m^2	1.377,7 m^2	- 22,8 %
Energy reference area	8.500 m^2	9.285 m^2	+ 9,2 %
Specific annual heating demand	113 kWh/(m^2a)	21,7 kWh/(m^2a)	- 80,8 %
Specific annual primary energy demand	213 kWh/(m^2a)	68 kWh/(m^2a)	- 68,1%
Total annual heating requirement	960.000 kWh	201.489 kWh	- 79,0 %

5.4.2 Concept for the energy modernisation of the building

The energy balance is improved by the technical equipment supplied. A solution will be provided after the processing of the superstructure, the completion of the new extension on the existing roof, which is planned in passive house standard. The perimeter cladding of the entire building is to be significantly improved in terms of thermal insulation properties. The next step is to design the controlled ventilation system, which should improve the degree of air tightness and other parameters. After that, the heating demand is determined, which is one of the most important parameters to be monitored. Subsequently, additional technical installations are planned in order to be able to achieve the plus-energy standard.

Measures to achieve the passive house standard

The fundamental measures concerned solutions for achieving the passive house standard. These are measures for the fundamental renovation of the building. One is to improve the parameters of the building's thermal insulation envelope; additional insulation materials were proposed for various segments of the building. Based on consultations with the company Isover Saint-Gobain, the Clima 34 insulation material was selected with a thickness of 200 mm for the exterior walls and up to 300 mm for the roof cladding and superstructure. The project foresees the improvement of the window parameters, plastic windows with UF = 0.8 W/(m^2 k), triple insulated glazing and external shading are planned to avoid overheating in summer. Ensuring shading is also important because it is planned to build a supporting structure that will simultaneously fulfil several functions and be a load-bearing structure. External shading should be implemented as controlled shading by external blinds or shutters, but also by planting directly on the building, e.g. by climbing plants. It is very important to avoid thermal bridges that such structures could potentially cause. Therefore, the planting is designed as a self-supporting structure that is only selectively connected to the building in order to eliminate the influence of thermal bridges. A very important part is to ensure a high level of air tightness of the whole energy envelope, which will be addressed in the implementation project, especially for the replaced windows and all transitions through the thermal insulation envelope of the building. The degree of air exchange and infiltration is checked by measuring the air tightness - the so-called blow door test. The concept also provides for controlled ventilation with heat recovery. The ventilation system is designed according to the use of the premises, adapted in each case to the offices, studios, cafés and kindergarten planned in the building.

With regard to the energy concept and the associated calculation, it is also necessary to consider the energy consumption per person and not exclusively per square metre, and to include this in the calculation. Up to now, half of the consumption has been calculated for households (iEPD). In order to consider the energy demand per person, the occupancy density per square metre would also have to be recorded and compared with the actual situation.

Overview of measures for achieving the Passive House Standard

- Improving the thermal insulation of the building envelope surfaces (e.g. optimising the gable wall with a U-value of 1.9 W/(m^2 K) in its current state to 0.19 W/(m^2 K) through 150 mm thick thermal insulation with a thermal conductivity λ = 0.032 W/(m K).
- Recommendation iEPD: ISOVER Clima 034 with 0.034 W/(m^2 K) and a thickness of at least 200 mm; for the roof/slopes of at least 300 mm.
- currently planned: external flexible solar shading: according to current calculations (iEPD) heating demand of 111.25 kWh/(m^2 a) and cooling demand of 213.98 kWh/(m^2 a) (demand for electricity, heating, cooling and WRG)
- Specific primary energy demand according to iEPD calculations: 113.1 kWh/(m^2 a)

5.4.3 Technical design of the heating and cooling supply

When designing the heating system and calculating the heat losses, the calculation of the building's heat losses was carried out according to STN EN 12831 and STN EN 73 0540-2/Z1 for the Bratislava area with the following climatic characteristics, which are shown in Table 7.

Table 7: Input parameters of the climatic properties and calculation of heat losses

Input parameters and characteristic values	
Height	140 m above sea level
Calculated air temperature - winter (Te)	-11° C
Average temperature during the heating period	+4,4° C
Number of heating days	212 d/a, full heating time 16h/d
Subdued heating time	8 h/d
Temperature range	1
Wind range	2
The calculated heat loss of the building is	162 kW
Energy demand for heating	206 000 kWh/ a

The new heat supply provides for low-temperature heating with heat pumps as the energy source. Here, the heat pumps are designed as a ground/water system, i.e. they use the energy from the vertical boreholes to be constructed on the site, which will provide the necessary energy for hot water production, heating and, in the summer months, also for passive cooling. The use of this system is possible all year round, which in turn increases efficiency (Fig. 50).

The capacity of the heat pumps is calculated to be 180 kW for the preparation of hot water for heating and cooling. Heat pumps are very efficient devices that work very well with low-temperature heating systems, in this case an installation of wall or ceiling heat exchangers used for heating and cooling is considered. This is the so-called dry cooling without condensation with a mean temperature of approx. 16° C. The "aeroschool 600" model represents a solution for how these rooms can be ventilated without major intervention in the existing building. It is very important that the system can be regulated according to the needs of the users.

The overall evaluation of the energy concept also included a thermodynamic simulation, which was solved for several parts. Of great importance are the results of the thermodynamic simulation of the roof structure, where studios and offices are planned, which have a higher energy efficiency compared to the living spaces. It is very important to reduce the heat load in the summer months to determine the required cooling capacity.

Another important part of the concept is the solution of controlled ventilation, which is designed according to the type of operation or occupancy of the buildings. Therefore, the ventilation system is treated in different concepts. For the kindergarten on the ground floor, the envisaged air exchange is solved by two decentralised ventilation units with a capacity of 600 m^3 /h each. The roof superstructure, which is designed in passive house standard, is solved in a similar way. Ventilation is provided by separate ventilation units with heat recovery. The residential part is solved by a central system with regulation of the air flows for the individual residential units (Figs. 52 and 53).

Wall heating and cooling

For heating and cooling, a concealed wall system installed under plaster on selected surfaces can be used. Pipes made of PE-Xa material with oxygen barrier are installed in the ventilation grille depending on the performance requirements. In the case of dry installation, the system is installed in the form of prefabricated plasterboard with the pipes installed in the walls.

Ceiling heating and cooling

Another solution is intermediate ceiling systems, which are installed under plaster on a solid or otherwise load-bearing ceiling. Pipes made of PE-Xa material with an oxygen barrier are attached to the pipe according to the performance requirements. In the case of dry installation, the system is installed in the form of prefabricated plasterboard panels with built-in pipes.

For the interior ceiling panels, ECOboaRD is designing its own system. A major innovation is the use of foamed aluminium as an innovative material developed in collaboration with the author of the patent, Dr. Ing. Frantisek Simancfko (Fig.51). The system was originally designed for flooded buildings without central air conditioning. The effect is enhanced by using the group conversion of the paraffin contained in the foamed aluminium plates. The technology is not only suitable for removing excess heat from the building, but also as an alternative to heating. In combination with functional shading and functional roof insulation as well as intelligent control, the aim is to achieve a performance effect comparable to that of a conservative and energy-intensive compressor air conditioning system. These also produce waste heat that is released into the atmosphere, noise and vibrations.

Fig. 50: **Schematic representation of the heat supply with all subsystems. Authors: ECOboaRD**

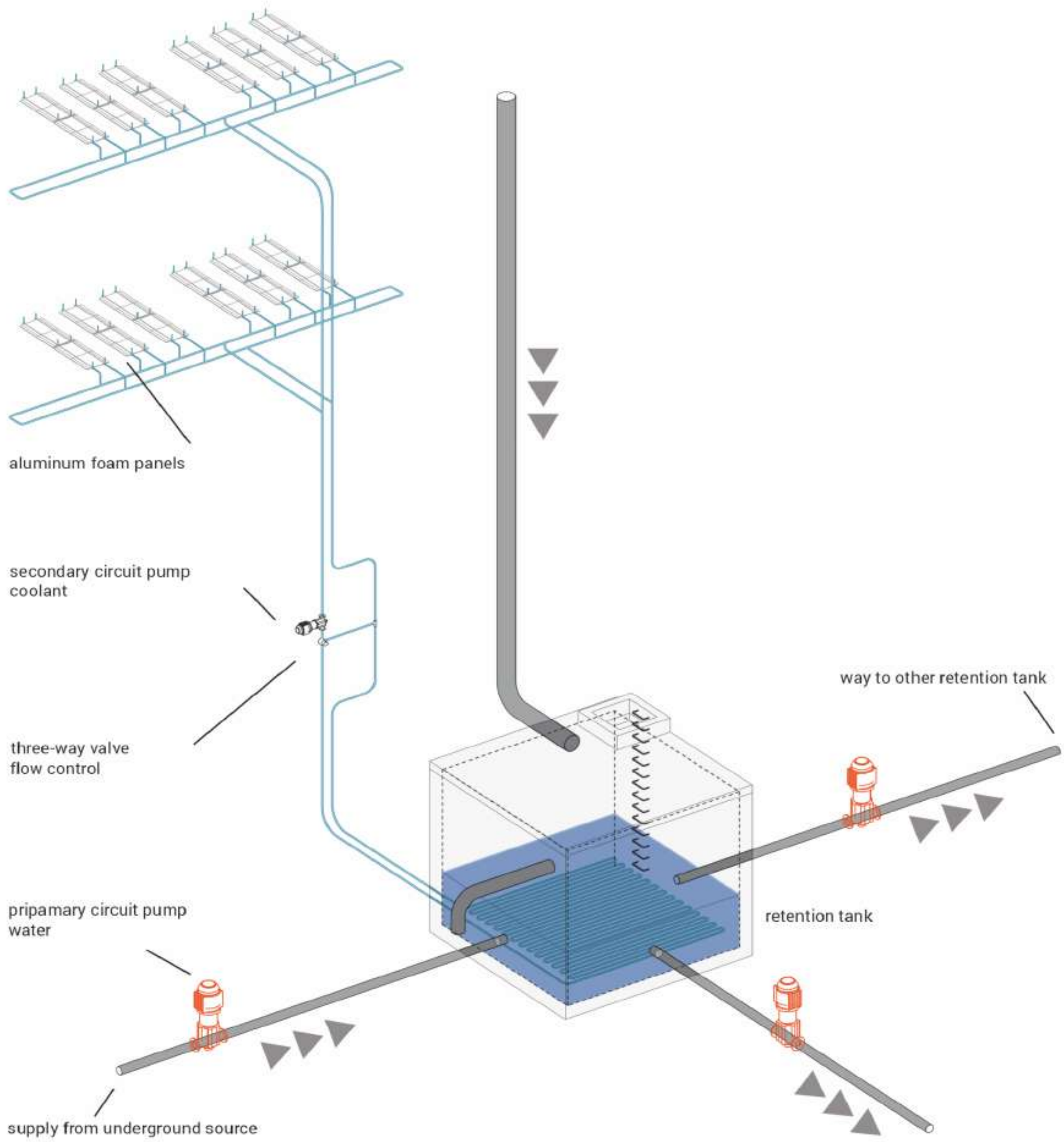


Fig. 51: Ceiling panel made of aluminium foam and system ceiling made of aluminium foam panels

Fig. 52: Heat supply - cross-section of the system. Authors: PLURAL

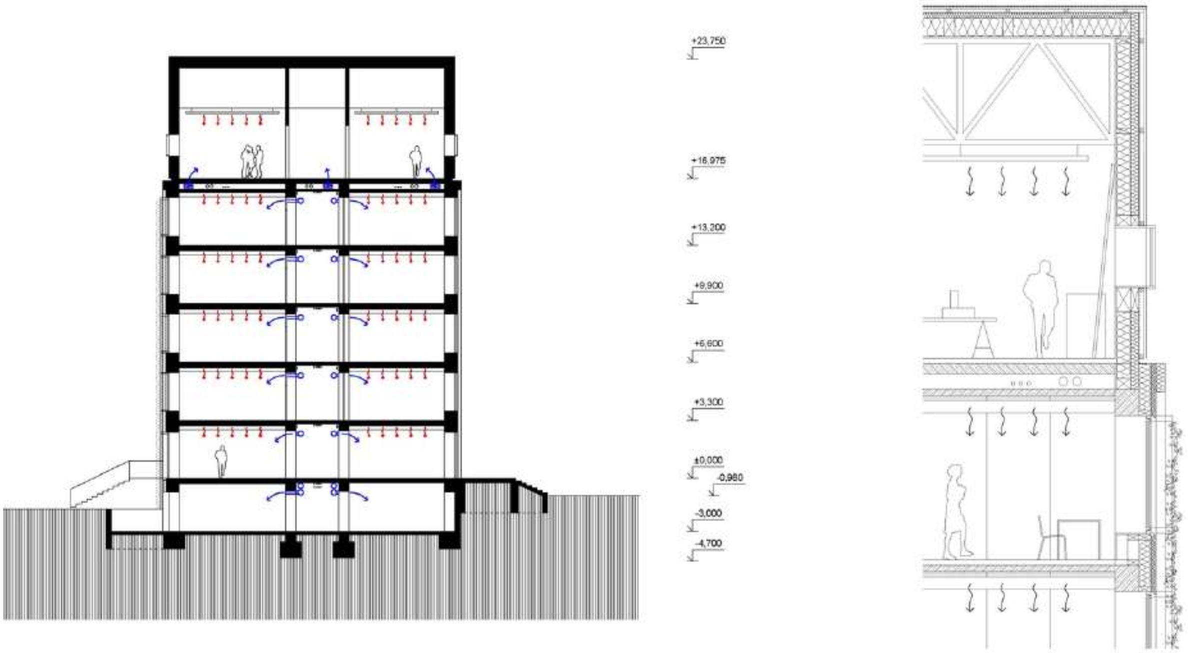
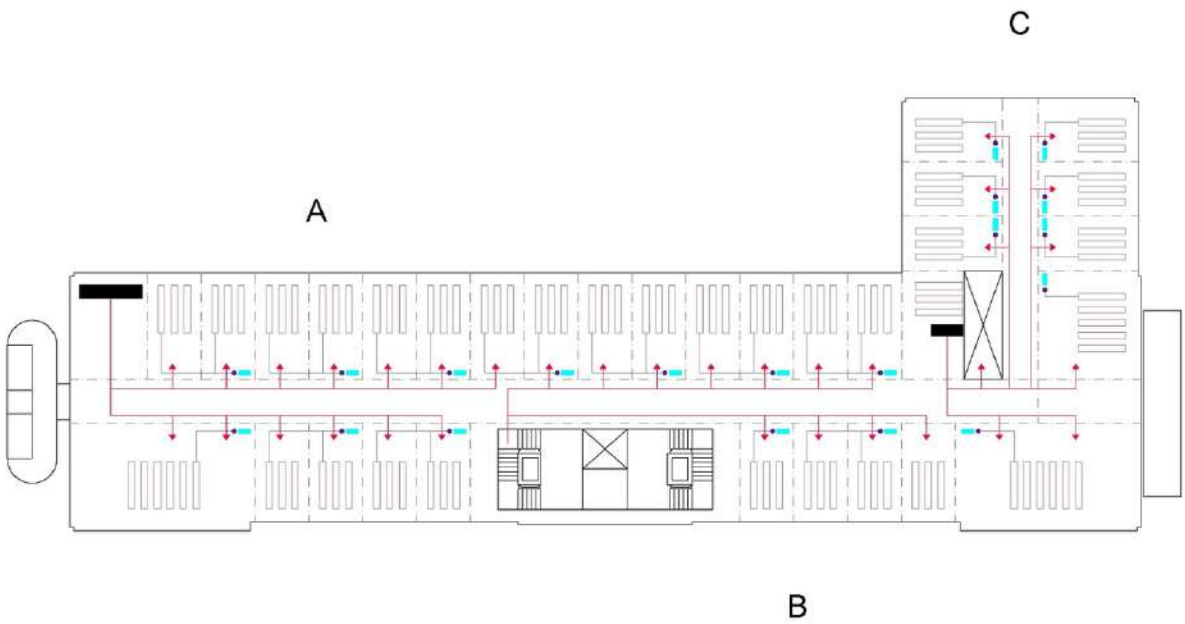


Fig. 53: Heat supply - System representation in floor plan. Authors: PLURAL



Underfloor and radiator heating

The distribution pipe for the underfloor heating consists of PE-Xa pipes with an oxygen barrier. They are inserted into the system board with a thickness of 30 mm. The individual underfloor heating circuits are controlled in the RZ distribution station. For some selected rooms, classic radiators with low-pressure hot water heating and forced circulation of the heating water are used. The radiators are connected from the floor distributor RZ or a separate branch. Vertical decorative tubular heating elements are used as radiators in the bathroom. The decorative heating elements are equipped with angle valves with thermostatic control head. An electric heating coil with 200-300 W can be added to the heating element.

5.4.4 Dimensioning the PV system for the plus-energy standard

The central component for energy generation is the installation of a photovoltaic system, which will be arranged on the sloping surfaces of the roof structure with a planned output of approx. 100 kW. The installation of 280 photovoltaic modules is planned for this - a photovoltaic power plant of this capacity enables the plus-energy standard. The electricity generated will mainly be used for cooling in summer. With passive and active cooling by heat pumps (heat recovery), a reduction of the heat load of 90 % can be achieved.

The lack of higher shading objects in the vicinity of the building in combination with the favourable orientation and inclination of the roof planes predestines the use of a large part of the roof cladding for the installation of the photovoltaic system.

For dimensioning and optimisation of the system, different roof pitches were investigated and three different PV panel models were compared. The calculation of electricity generation from PV panels was carried out with the thermodynamic simulation programme IES-ve. This calculation is not a substitute for later design or a comprehensive assessment by a PV specialist, but it does allow an estimate of the yield of the PV system on the respective property. The calculation took into account not only the basic parameters of azimuth and inclination of the panels, but also the shading caused by the surrounding buildings or the temperature dependence of the efficiency of the electricity generation due to the absorbed solar radiation. The calculation was carried out with a climatic reference year and time step of one hour. Thus, the position of the sun in relation to the PV panels at a given time is also included in the calculation (Fig. 54).

The PV module variants investigated (Fig. 55) are stored in the database of the energy simulation programme and were selected in consultation with the company Solarenergla, S. R. O. in Bratislava. However, it is also possible to select other PV modules.

Fig. 54: Calculation model for optimising the PV system and thermodynamic simulation

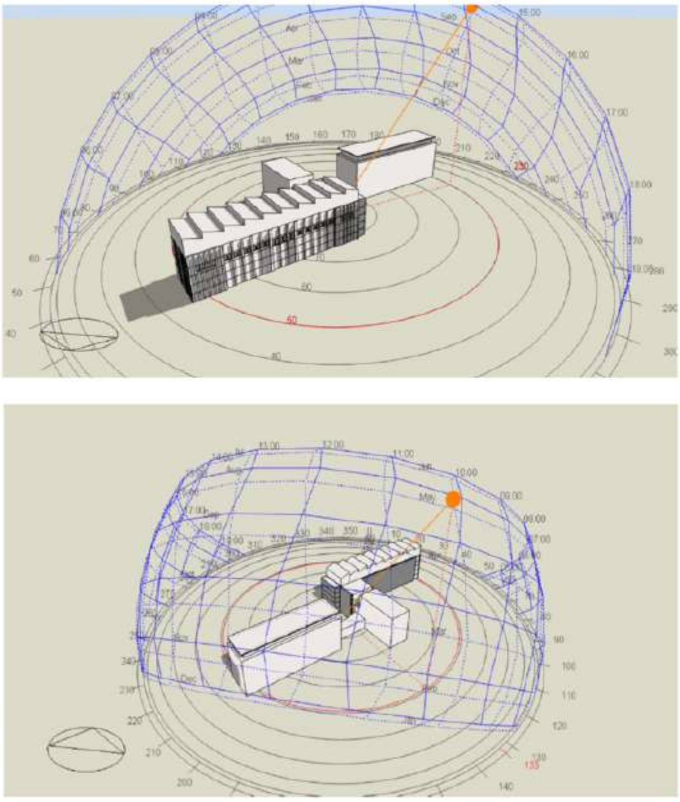


Fig. 55: Selection of PV module variants in simulation programme IES-ve, display of the module parameters

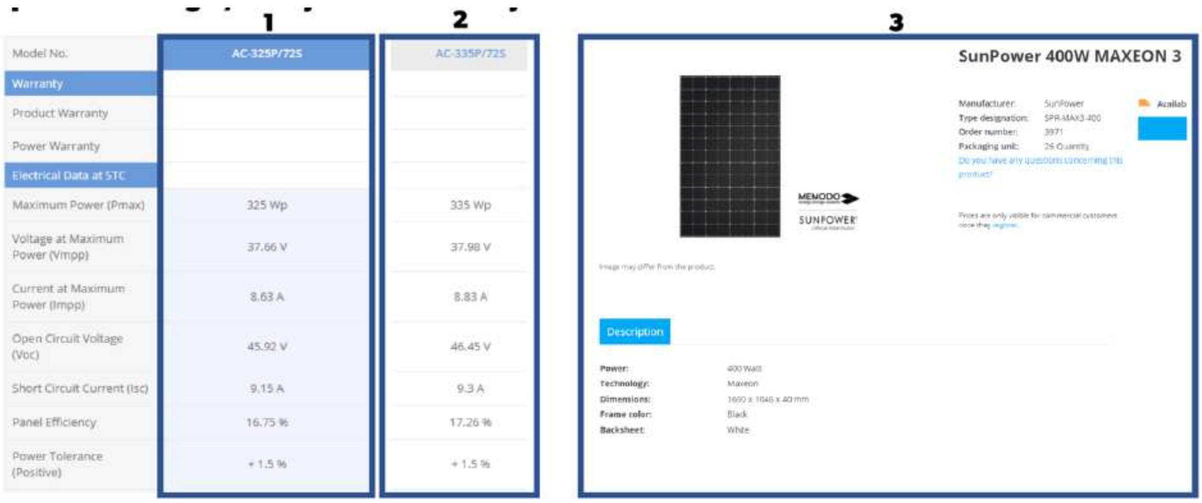
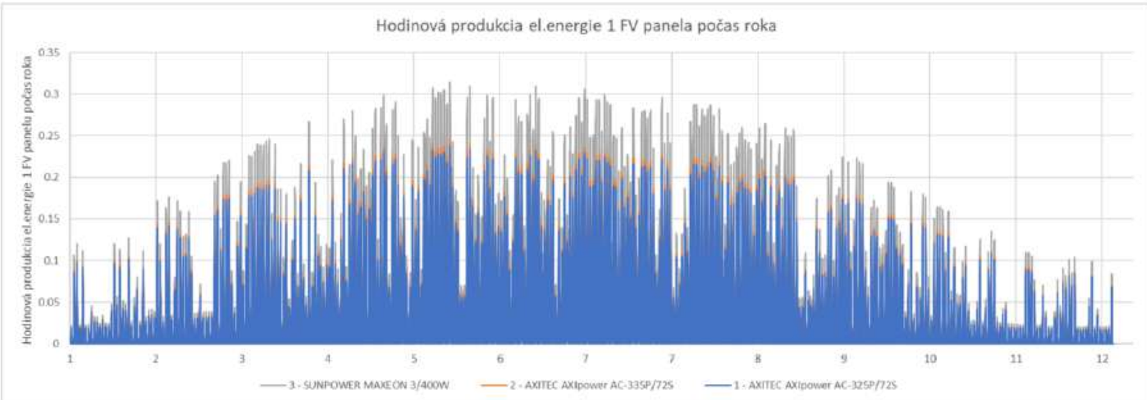
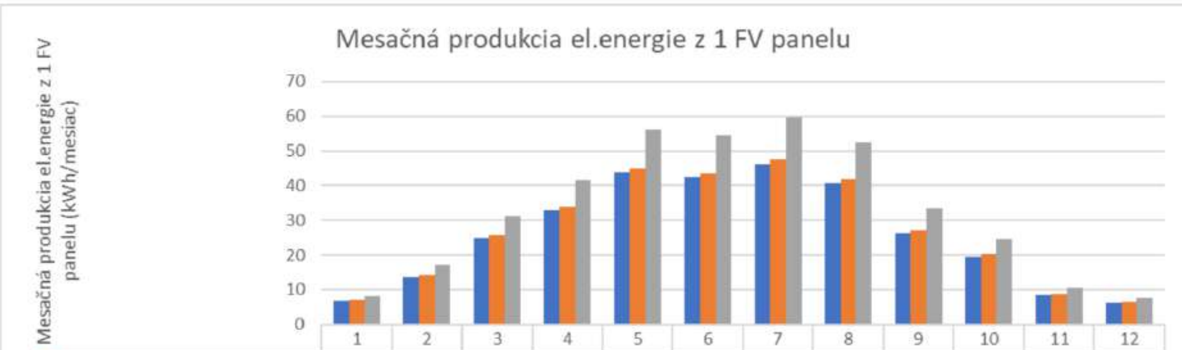


Fig. 56: Hourly electricity production of the PV panel during one year



Pozn.: Výpočet berie do úvahy azimut slnka, sklon FV panela, teplotnú závislosť účinnosti FV panela. Simulácia je spracovaná s hodinovým časovým krokom, klimatické údaje SVK_Bratislava.118160.epw

Fig. 57: Monthly electricity production of the PV panel



	1	2	3	4	5	6	7	8	9	10	11	12
1 - AXITEC AXIpower AC-325P/72S	6.7626	13.8293	24.8645	32.8628	43.7026	42.2876	46.1576	40.616	26.2683	19.5653	8.5821	6.1959
2 - AXITEC AXIpower AC-335P/72S	6.9679	14.2499	25.6206	33.8632	45.0323	43.5759	47.5633	41.8525	27.068	20.1601	8.8433	6.3859
3 - SUNPOWER MAXEON 3/400W	8.303	17.1124	31.1687	41.6435	56.0737	54.3298	59.7004	52.3795	33.4068	24.562	10.6168	7.6049

Fig. 58: Electricity generation over the course of a whole year

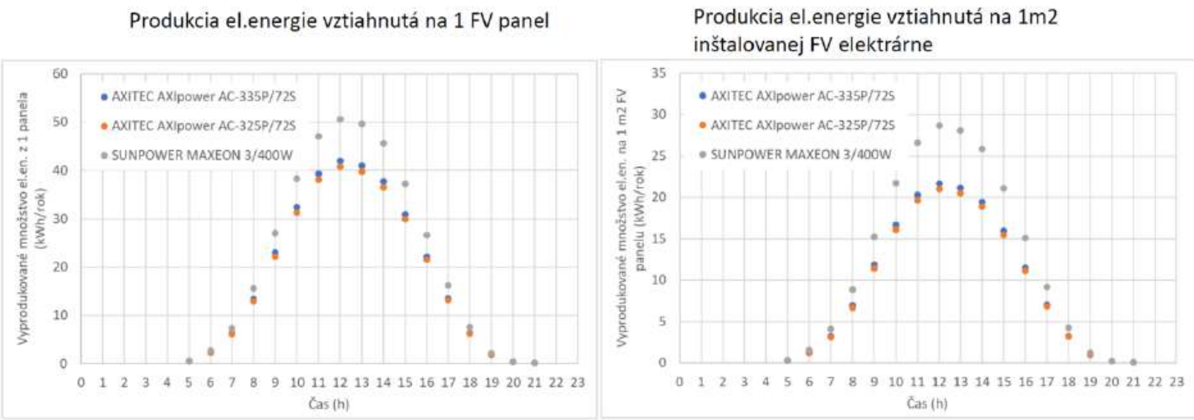


Fig. 59: Electricity generation over time - analysis of the three variants by selected months

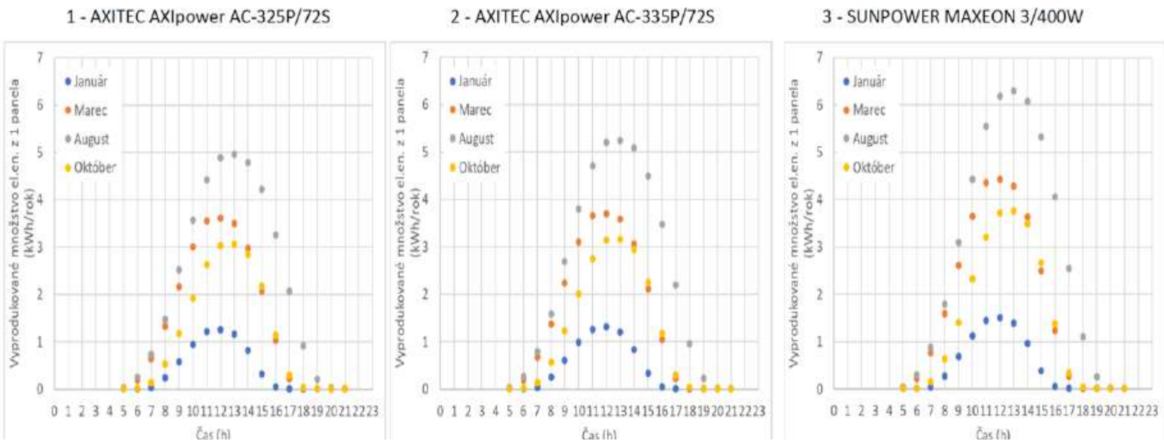
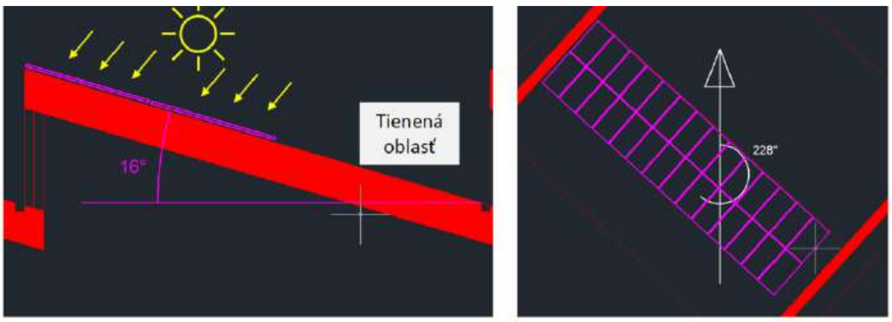


Fig. 60: Theoretical number of PV panels installed and amount of electricity generated



Predpoklad 2 panely pozdĺžne, 14 panelov v poli, spolu 28 panelov na 1 strešnej rovine, celkové odhadnuté množstvo zabudovateľných FV penelov je max. cca 280 ks, uvažovalo sa s účinnosťou meniča 95%.

Model FV panela	Ročná produkcia el.en. z 1 FV panela	Ročná produkcia el.en. z cca 280 ks FV panelov
1 - AXITEC AXIpower AC-325P/72S	311,695 kWh/rok	87 274,6 kWh/rok
2 - AXITEC AXIpower AC-335P/72S	321,183 kWh/rok	89 931,24 kWh/rok
3 - SUNPOWER MAXEON 3/400W	396,902 kWh/rok	111 132,56 kWh/rok

5.4.5 Building control and use of energy-efficient appliances

The system controls the optimal use of heating, cooling and ventilation based on data collected from the meteo station, forecasting software and the building's access systems. It makes it possible to direct the temperature to occupied rooms and not to comfortably heat and ventilate unoccupied rooms, resulting in significant energy savings.

The overall smart system will integrate and monitor the building's energy balance, consumption, energy management, renewable energy generation from PV panels, battery storage, electromobility, indoor and outdoor lighting, meteorological and hydrological data, and the access and security system.

The classic electricity grid is changing from a one-way supplier to a two-way distributor. This is necessary for the effective use of decentralised renewable energy generation. With the commissioning of the photovoltaic system on the roof, the building must be equipped for this type of grid connection. In addition, the installation of batteries is planned in order to store a large part of the produced electricity itself, to support the grid in covering peak loads and to meet the growing demand for charging electric vehicles and other e-mobility. For the time being, 6 outdoor charging columns for electric cars are planned.

In the long term, attention should also be paid to the use of energy-efficient (household) appliances, as these account for the second largest share of these building-related emissions in the passive or plus-energy standard after the CO_2 emissions caused by space heating. This is just as significant as the emissions due to the provision of hot water. Equally important is the provision of this information to the users of the building.

5.5 Transformation strategy for Nová Cvernovka

5.5.1 Conflicting goals

During the work process, conflicting goals and questions about further project development after the conclusion of the DBU project were repeatedly raised, which could only be pointed out and discussed within the framework of the research project, but not decided, as they ultimately lie in the area of responsibility of the local actors (Cvernovka Foundation, residential community, politics and governmental organisations, banks, etc.) (see below Chapter 5.5.3). Essentially, these were the topics

- affordable housing versus high investment costs for structural measures,
- Overcoming technical challenges in implementation, possibly combined with cost increases,
- Issues of ownership structures, self-governance and financial responsibility and participation,
- possible conflicts of residents in value orientation and desired lifestyles.

The permanence of these issues is an indication that they are important to the Nová Cvernovka community and foundation. Ultimately, they are also linked to how sustainable socio-ecological strategies and measures can be implemented in the long term in a self-organised way.

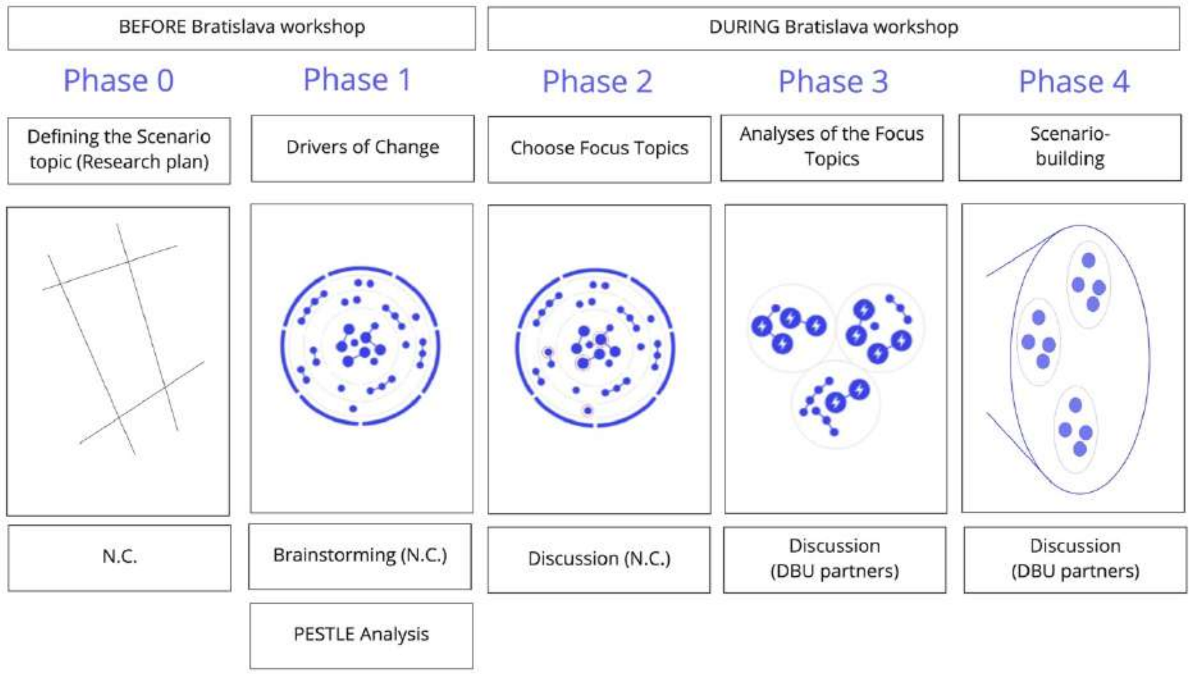
5.5.2 Scenario analysis for project implementation

In order to take a closer look at these conflicting goals and questions and to provide an outlook on the further development of the CMI.BA project, a *scenario analysis* was carried out at the end of the project in October 2021 in Bratislava, as part of the fourth workshop.

Scenario analysis is a method of futurology that can be used to depict potential future developments. A scenario is a description of possible or desirable actions or events in the future, created through a structured and rationally comprehensible path. It helps stakeholders to imagine possible futures - i.e. scenarios - and to deal with uncertainties. Possible considerations are *"What if ... ?"* or *"What is needed if ...?"*.

The process described here consisted of four phases (futurice o.J. : pp. 14-20) (Fig. 61):

Fig. 61: Flow chart for scenario analysis



First, the drivers of change are identified in a so-called PESTLE analysis (Politics, Economics, Socio-Cultural, Technology & Innovation, Legislation, Environment). In the second step, the key-topics and their possible outcomes are determined. In the third step, these are combined into different scenarios and then analysed with regard to the necessary implementation steps (pathways). Finally, the participants reflect on the process.

Phase 1: Goal definition, collection of influencing factors (PESTLE) and drivers of change

In preparation for the workshop, the members of the Cvernovka Foundation and the representatives of the residential home community had already been provided with documents by FH Potsdam to prepare the first two steps - identification of the "drivers of change" and selection of the key topics. These formed the starting point for clarifying the goals, terminology and their interpretation, which in turn formed the prerequisite for the subsequent steps. The formulation of clear goals is a condition for the success of a scenario analysis, since without goals there is no (efficient) way to achieve results.

As a central scenario theme, the participants defined the goal that Nová Cvernovka would like to become a *"model project of regenerative transformation"* through building modernisation. Through the discussion it was specified that this vision of the future includes the following topics:

- Affordability,
- Diversity,
- sustainable community,
- ecologically sustainable building,
- Plus-energy building,
- Innovations.

For the scenario analysis, the time period to be considered was set at five to seven years and the following guiding questions were formulated:

- *How can the goals of a social-ecological project be implemented and remain affordable at the same time?*
- *What forms of CoHousing and CoLiving does the community want to implement and what orientation can the model projects visited in Berlin, for example, provide?*

- *Which connections and synergies between the spatial, technical and organisational topics can be used particularly well?*

The collection of uncertainty factors and trends as drivers of change yielded the following results for the thematic areas of politics, economy and business, society and the individual, laws and the environment with regard to the context of Nová Cvernovka:

- Policy: Focus on local issues and problems such as neighbourhood and government support,
- Economy: Innovation - it makes Nová Cvernovka interesting,
- Society and the Individual: Solidarity Economy, Technology and Innovation.

Drivers of the different manifestations of public support are, for example:

a) How is rental housing presented in the general discourse? From this follows a certain understanding and perception of social housing and living for rent in the public perception.

b) A positive image can be supported through cultural activities, possibilities and opportunities. However, the volume of these activities could have a negative effect on the neighbourhood (disturbance of the peace). This in turn could result in conflicts with the neighbourhood as well as reduced support for local policies. The conclusion is that neighbourhood support is of enormous importance for the future development of the project.

Phase 2: Collection of themes and selection of key themes

The participants then collected all possible topics:

- Ownership of the building (e.g. collective ownership)
- Conservation of the people in the project
- Money/financing for reconstruction and staging
- Recovery of EU funds
- Rising prices (technology, building materials, building standards)
- Resentment in the neighbourhood
- PR & public / political support
- Increasing populism in politics
- Unity & Community / Disintegration of the current community / Fluctuation
- Ageing of society
- Individualisation of society
- Self-organisation
- Shared economy
- Affordable housing
- Innovations, start-ups and prototypes
- Shifting work to the home office
- Business model (sustainable)
- Energy independence
- Upcycling of household waste
- CO_2 -footprint of building materials
- Regulation of the energy efficiency of buildings
- rising energy prices
- Ecotoxicity of the waste water
- Heat islands in cities
- Circular economy

By organising and prioritising the relevant topics, the following overarching key themes were then identified:

(1) Public support
(2) Organisational model of the community

(3) Ownership (legal and economic)
(4) Financing model
(5) Building
(6) ecological standards
(7) Innovation (ongoing / as a process / different levels)

Phase 3: Analysis of the key issues and identification of possible manifestations

The next step was to analyse the key issues and formulate different expressions and then combine the expressions into different scenarios. For this purpose, the participants imagine which conditions will probably prevail at the end of the defined time span of seven years. By alternating combinations of different expressions of each key theme, these were then linked together to form "raw scenarios". Each combination represents a different version of the possible development of the future.

The possible manifestations of the key themes were defined as follows and are sorted from top to bottom according to the criteria from "less" to "more" desirable or from traditional to innovative solution approach:

(1) Public support

- No public support
- No neighbourly support
- Public support from the general public
- General public support
- Public support from the government

(2) Financing model

- Loan / commercial financing only
- total subsidies
- limited subsidies
- Investments and shares
- Funding from multiple sources

(3) Property

- Private property
- State property: 25 years (rented from the foundation)
- 50-year lease (long-term)
- Foundation property
- Cooperative / collective ownership
- Community Land Trust

(4) Organisational model of the community

- No organisational model / individual leasing and organisation
- Sub-projects / sub-groups with their own organisation
- Cooperative

(5) Building

- Outsourcing
- Renovation all at once
- Self-build
- Renovate step by step

(6) Ecological standards

- Current condition of the building (130 kWh/m^2 a)
- Passive house (20 kWh/m^2 a)
- Plus energy (+ kWh/m^2 a)
- be exploitative
- environmentally neutral
- be regenerative

(7) Innovation

- traditional solutions
- experimental
- innovative solutions

Phase 4: Formation of scenarios, presentation of implementation steps and reflection on the process

Starting from the current state, with the current manifestations of the key themes:

(1) No state / public support
(2) Credit only / commercial financing
(3) State property: rent for 25 years by the foundation
(4) No organisational model or individual organisation and individual renting
(5) Self-build
(6) Condition of the building (-130 kWh/m^2 a)
(7) traditional solutions

two "raw scenarios" were created collectively by combining "ambitious" and "less ambitious" expressions through the temporal allocation on a timeline with the possible outcomes for the next seven years (2022-2028), see Tables 8 and 9.

The guiding questions with regard to the temporal classification were:

- *What should be done immediately?*
- *What needs to be researched before anything else can be decided?*
- *What should be clarified before the building conversion?*

Due to limited time capacities, phase 4 could not be carried out completely within the framework of the workshop. A continuation of the method in the form of a detailed formulation and shaping of the scenarios is in the hands of the Cvervovka Foundation and the Nová Cvervovka community.

Table 8: “Raw scenario” I: Ambitious scenario

Period / target year	Results and state of the project
In 1 to 2 years / 2022-2023	Receive public support from the government
In 3 years / 2024	Funding and investment from multiple sources, e.g . community land trust and endowment property.
In 3 to 4 years / 2024-2025	Founding a (housing) cooperative
In 4 years / 2025	Modernisation was implemented step by step
In 6 years / 2027	Innovative solutions developed
In 6 to 7 years / 2027-2028	Plus-energy building realised
In 7 to 8 years / 2028-2029	Model for a comprehensively "regenerative" centre

Table 9: "Raw scenario" II: Moderately ambitious scenario (achievement of some targets)

Period / target year	Results and state of the project
In 1 year / 2022	Receive public support from the general public
In 2 years / 2023	receive some, limited subsidies
In 2 to 3 years / 2023-2024	Lease or rental contract for 50 years, realisation of sub-projects and sub-groups with own organisation
In 4 years / 2025	Outsourcing the conversion
In 5 years / 2026	Renovation in one step
In 5 to 6 years / 2027-2028	Renovation to the passive house standard
In 6 to 7 years / 2028-2029	Environmentally neutral, but only a few innovations

5.5.3 Financing and implementation concept

For the project realisation, a division into different realisation and financing phases has to be made and different financial sources, including governmental and European funding, have to be mobilised. Covering all necessary costs through a single source of financing seems rather unlikely. Bank financing is considered as one of the main sources of financing, in which case an agreement must be negotiated with the regional government as the owner of the property so that the building can be used as collateral for the loan. This requires a legal solution, a new model of cooperation between both institutions (Cvernovka Foundation and Bratislava Self-Governing Region) and the political will of the governments.

In another scenario, which can complement the above model, there is the possibility of forming a consortium of several public or private sector partners and even the community of future tenants. This could reduce the financial burden of the initial investment of the Cvernovka Foundation as well as at the same time create the possibility of drawing funds from European guarantee schemes for banks, thus reducing or even avoiding a mortgage burden on the property. The project is also interesting for external actors because of its connection to the New European Bauhaus. For example, representatives of the area of the former palm oil factory "Palma" adjacent to Nová Cvernovka have shown an interest in cooperation, as Nová Cvernovka has already improved the image of the surrounding area and district. There may also be support from the public side, although a suitable funding programme still needs to be found for this.

In any case, the realisation will have to take place in several steps. The basic division into the realisation of two separate construction phases will be clarified in the further building permit procedure and in the preparation of the detailed documentation. The idea behind this division is to keep the existing tenants:inside community together without having to move out, which would probably lead to a dissolution of the community. The further realisation phases of the project will ultimately depend on the amount of construction costs and funds to be raised. The discussion about the expected construction budget and its impact on the final rent for the future tenants is still ongoing, as the community and the foundation do not yet have a common understanding of the term "affordability".

5.5.4 Communication strategy

The communication strategy is aimed at different target groups, always focusing on a topic that is relevant to them. To this end, different communication tools and formats have been and will be used. The main message must be understood in a local context. The CMI.BA project serves as a case study for the transformation of an old 20th century building to achieve the plus-energy standard and minimise CO_2 emissions. The chosen integral planning process during the elaboration of the architectural study differs from the "business as usual" concept of linear planning. The stakeholders of the process focused on proposing appropriate space typologies and a socio-ecological model for a future CoHousing, a pilot project for community-oriented living on a rental basis. In addition, representatives of the existing community of the dormitory were involved in the decision-making process so that they had the opportunity to comment on the architectural and content outcomes of the project during the notified project milestones. A similar procedure has not been tried out to this extent and in this structure anywhere else in Slovakia and therefore represents a key differentiator in the project's communication with the public.

The task of communication therefore focused on preparing comprehensive information about the project and its goals in an understandable language, especially for the general public. The biggest challenge is to make the topics of ecological sustainability, social ecology and rental (community) housing clear to many people who do not know what to think of these terms and, moreover, have historically negative associations with some topics - especially rental housing and housing cooperatives.

For professionals and people who are more interested in these issues, it will be very interesting to see how the project develops and is implemented in terms of energy efficiency and affordability, as it can be challenging to achieve both in practice. This target group will be addressed with more specific details from the project, especially with the final report of the DBU-funded research project and the homepage available here.

Another target group is people from the city and regional administration who need to know the technical and financial parameters of the project. It is equally important to create a match with their official policy and strategy in order to gain their political or financial support. In October 2021, the results of the research project were presented to various stakeholders in Bratislava. Representatives of the city of Bratislava, the Metropolitan Institute Bratislava (MIB), the local government of the region (owner of the property), the neighbourhood (Corwin, OZ Biely Kríž / Nobelova), the Nové Mesto city district office, representatives of financial institutions such as Slovenská sporiteľňa a.s. and Slovak investment holding, representatives of the Slovak government for the European Economic Recovery Plan of Slovakia, representatives of the New European Bauhaus Initiative and members of the architecture jury.

The final form of the project documentation with visualisations from the architectural study and summary information has been available since June 2022. This serves as the basis for further steps under licensing law. After completion of the project in May 2022, the public and the authorities will continue to be informed about the development phases of the project, its functional framework and the environmental parameters. As part of the media coverage, further press releases will be carried out in relevant media focusing on architecture, sustainability or lifestyle with local or national coverage. A brochure with key information about the CMI.BA project will also be produced, targeting the public and citizens of the municipality. Three main objectives are pursued with the further public relations work:

1. Attract further sponsors and partners to contribute financially to the reconstruction of the building,
2. To inspire the community of Nová Cvernovka and other non-profit initiatives on how to proceed with the re-use of the abandoned spaces; and
3. To strengthen the position of the Cvernovkas Foundation in fulfilling its mission and to increase awareness of the DBU's priority activities.

6. Homepage for knowledge transfer: Inspiration through good practice

6.1 Theory and practice of pattern languages according to Christopher Alexander

What is a "pattern language"?

Pattern language is a concept that originally goes back to the mathematician and architect Christopher Alexander. In his book "A Pattern Language. Towns, Buildings, Construction", published in 1977 together with Sara Ishikawa and Murray Silverstein, 253 different patterns are described that represent spatial, architectural, social, cultural or technical structures and are arranged according to the three scaling levels of town, building and construction (Alexander et al. 1977).

Pattern theory provides a method for solving problems by preparing reusable solutions for use (Leitner 2016: 16). Designers, developers and drafters use it as a stimulus and as a solution model, as well as to question, develop and refine solutions already found. The pattern language facilitates communication between developers by providing a uniform vocabulary of terms for recurring problems and their solutions. Just as in a natural language words are linked together as individual, meaning-giving elements by the rules of a grammar in order to convey complex meaning, in a pattern language individual patterns are linked together by a system of references to other patterns to form a more highly aggregated system context.

Based on these cross-references, it is possible to carry out planning in a form that Alexander calls unfolding. The patterns at the highest level - i.e. those that are to be considered first in planning - deal with the planning of cities. Patterns further down the hierarchy deal with spatially smaller structures, down to parts of individual spaces or construction elements whose interconnections form a complex network. Alexander emphasises that the cross-references are as important as the patterns themselves.

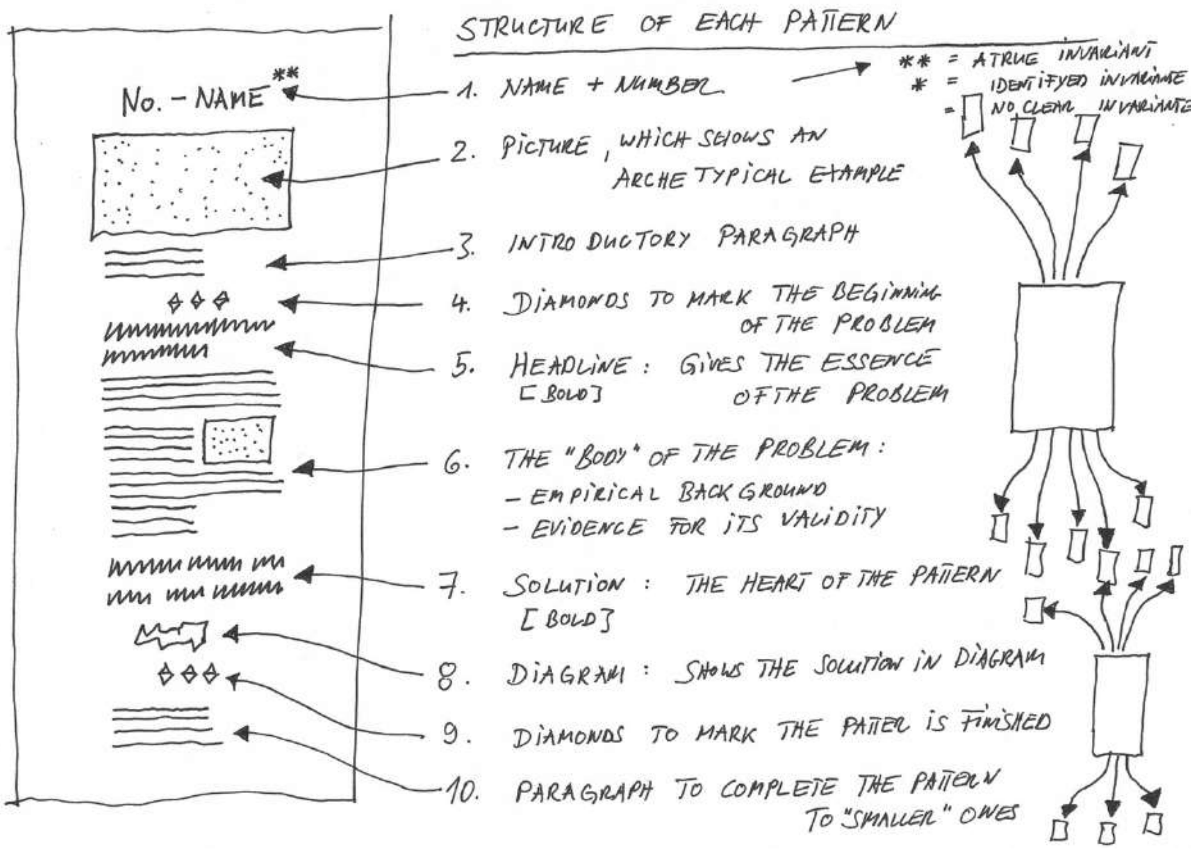
The patterns are only the results of the preceding arguments and trains of thought. Understanding these trains of thought also makes it possible to draw further or different conclusions for the concrete case. In rational ways, Alexander traces those qualities of the built environment that are often considered irrational.

How are the patterns described?

In the introduction to his book, Alexander gives a precise description of how the patterns are constructed: "The elements of this language are entities called patterns. Each pattern describes a problem that occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use that solution a million times without ever doing it the same way twice. For simplicity and clarity, each pattern has the same format. First, there is a picture that shows an archetypal example of this pattern. Second, after the picture, each pattern has an introductory paragraph that sets the context for the pattern by explaining how it helps complete certain larger patterns (...). After the heading is the main body of the problem. This is the longest section. It describes the empirical background of the pattern, the evidence for its validity, the different ways the pattern can manifest itself in a building, and so on.

Then follows (...) the solution - the heart of the pattern - which describes the field of physical and social relations required to solve the stated problem in the stated context. This solution is always given in the form of an instruction - so that you know exactly what you need to do to build the pattern. The solution is followed by a diagram showing the solution in the form of a graph, with labels indicating the main components (...)" (Alexander et al. 1977: X f.) (see Fig. 62).

Fig. 62: The basic structure for describing a pattern. Author: Michael Prytula, 2021



With what intention was the pattern language developed?

Alexander said: "Architects themselves build a very, very small part of the world. Most of the physical world is built by all kinds of people. It is built by developers, it is built by do-it-yourselfers in Latin America. It's built by hotel chains, by railway companies, etc. etc. How could you possibly get a handle on all the massive construction that is taking place on the earth and somehow?

Make it good, that is, let it be generated in a good and living way. This decision for a genetic approach was not only due to the scale problem. It was important from the beginning because one of the characteristics of any good environment is that each part of it is extremely adapted to its particularities. This local adaptation can only be successful if people (who know the local area) do it for themselves. In traditional society, where lay people either built or laid out their own houses, their own roads, etc., adaptation was natural. It happened successfully because it was in the hands of the people who used the buildings and roads directly." (Alexander 1996).

A central theme for Alexander is the proper design of *centres*: "Centres, wholes and boundaries occur everywhere in the natural world because spatial differentiation is ubiquitous. Different spatial zones support different kinds of life.' According to Alexander, the strength of a centre is a measure of its organisational quality and its contribution to aliveness. This is why he emphasises that in the creative design process, centres must always be created with great care (Leitner 2007: 31). The patterns Alexander has described are not arbitrarily chosen, but they describe spatial, structural, organisational, social or aesthetic centres, which - if they are implemented in a networked way in the design - create and promote living structures.

General applications of the pattern language methodology

"Scientifically and epistemologically, pattern languages are tools for structuring complex knowledge across several phases of a design process. They thus serve a situated knowledge production. They record derivations of empirical observations of individual successful solutions and generalise them as design recommendations. At the same time, they are a design tool and help architects, designers or concept developers to plan new individual solutions. The design process as creative work then consists of the connection of patterns to pattern sequences, which in their combinatorics enable good solutions. A pattern language is thus both a cognitive instrument and a tool that helps designers to make structural decisions within complex tasks that take into account specific concrete needs as well as existing experiential knowledge." (Hamann et al. 2018: 8)

While the formalised concept of a pattern language has been received rather cautiously in architectural or urban design contexts, the concept is applied in many complex engineering tasks. It was and is particularly influential in software development. An overview of some model languages, especially in the context of urban development, is given in Table 10.

Table 10: Examples of the application of the concept of pattern languages

Name of the sample language	Internet link
Pattern language by Christopher Alexander	https://www.einemustersprache.de/index.php
City Shapes	http://stadtgestalten.net/
The world of the commons	https://www.band2.dieweltdercommons.de/index.html
Social-ecological building	https://www.buildingsocialecology.org/
A Pattern Language for Pattern Writing	https://hillside.net/index.php/a-pattern-language-for-pattern-writing

6.2 Conceptualisation of a pattern language for social-ecological design elements

The starting point for the conception of the homepage was the insight gained from the research and analysis of relevant socio-ecological projects that should provide transferable knowledge for the CMI.BA research project, as there is no such thing as the "perfect example project". Each of the projects analysed has particular qualities, but they can be very different in terms of different objectives such as energy efficiency, affordability, mix of uses, ecology or social intentions and contain different "good elements". Therefore, in the conception and design of the homepage, we decided to follow the methodology of Christopher Alexander's Pattern Language, as this concept came closest to the intentions of the research project.

The aim of the homepage was thus no longer to describe "the perfect project", but to present "good practice projects" and to extract relevant design or design elements from them - we call them "patterns" - which in combination lead to good practice. The criteria for selecting the patterns were, on the one hand, that they make a significant contribution to a quality environment, a functioning way of living (and working) together and a sustainable and careful use of natural resources (energy, water, materials, etc.). On the other hand, the patterns should have a certain representativeness. If they are recurrent and can be found in many projects over a long period of time, it is reasonable to assume that they have proven their worth for social-ecological projects.

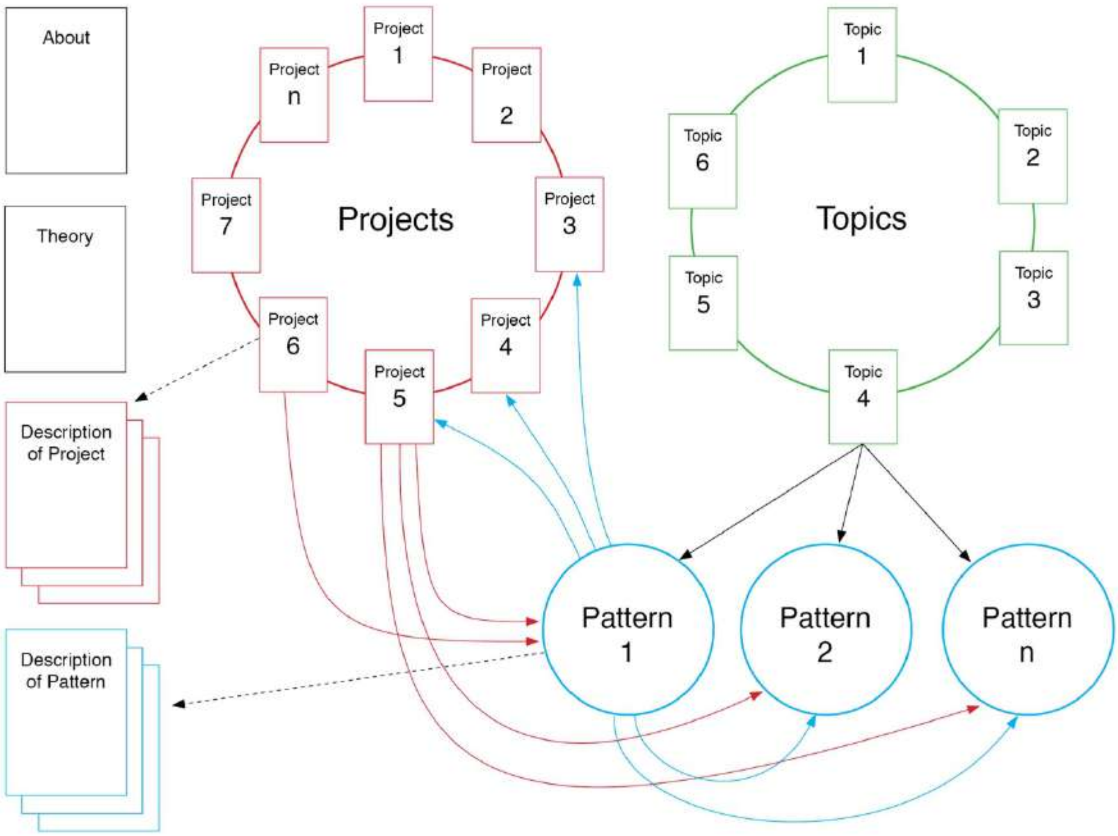
6.3 Structure and elements of the homepage

The homepage comprises individual pages sorted according to the following categories:

- Projects: Project documentation
- Patterns: Social-ecological design patterns
- Theory: Explanation of concepts
- About: Description of the homepage

These categories are also set up on the navigation bar and can thus be selected specifically. By using hyperlinks as cross-references between project documentation and patterns as well as between the patterns themselves, users of the homepage have the possibility to gain a more complex system understanding of social-ecological projects than if only project descriptions were available (cf. Fig. 63). For the design of the residential building of Nová Cvernovka, a large number of the identified patterns were used, such as the mix of uses, architecture of encounter, option spaces, rue intérieure, cluster apartments, roof garden, community gardens or green facades.

Fig. 63: Concept for categorising and linking patterns. Author: Michael Prytula, 2021



Project documentation

Based on extensive project research, we selected 24 projects and documented them with basic information such as project data, technologies and spatial and social characteristics. The projects are predominantly from Germany, Austria and Switzerland - individual projects are located in the UK and Spain - and makes no claim to be representative, let alone complete, documentation of relevant projects (see Tab. 11).

Table 11: Overview of the social-ecological model projects on the homepage

No.	Project name	Location	Country
1	Spreefeld	Berlin	DEU
2	Lime width	Zurich	CHE
3	Hunziker area	Zurich	CHE
4	Sargfabrik (Coffin factory)	Vienna	AUT
5	ufaFactory	Berlin	DEU
6	c13	Berlin	DEU
7	Rommelmühle	Bietigheim-Bissingen	DEU
8	Intergenerational housing complex	Vienna	AUT
9	Neighbourhood WIR	Berlin	DEU
10	Werkpalast Lichtenberg	Berlin	DEU
11	Südstadt School Housing Project	Hanover	DEU
12	Foundry	Winterthur	CHE
13	Heating wood	Zurich	CHE
14	The Collective Old Oak	London	UK
15	Möckernkiez	Berlin	DEU
16	La Borda	Barcelona	ESP
17	CRCLR House	Berlin	DEU
18	Artists' Studios Erlenmatt East	Basel	CHE
19	wagnisART	Munich	DEU
20	IBeB -Integrative Building Project at the Former Flower Market	Berlin	DEU
21	Solar direct gain house N11	Zweisimmen	CHE
22	Circle House (Lisbjerg)	Aarhus	DNK
23	Stadterle	Basel	CHE
24	Gleis 21 (Track 21)	Vienna	AUT

For an overview of other projects, please refer to the homepages listed below, which we used for project research as well as other data sources:

- Homepage and database on sustainable settlements, neighbourhoods and buildings in Europe by Holger Wolpensinger, https://sdg21.eu/
- Reference buildings of the Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe e. V.). , https://referenzbauten.fnr.de/
- Timber Building Atlas Berlin-Brandenburg by the Natural Building Lab of the TU Berlin, Prof. Eike Roswag-Klinge, https://holzbauatlas.berlin/

Social-ecological design patterns

Through the project analysis and evaluation of expert interviews and other sources, we identified typical design elements and selected a total of 27 design patterns for a detailed description (see Tab. 12). The samples are written according to a consistent outline structure based on Alexander's outline (see above): title, teaser, problem, general description, examples, findings and synergies, and sources. By means of hyperlinks, the patterns refer to other patterns as well as to relevant projects in which they can be found.

The design patterns are assigned to six themes:

- A - Architecture and spatial design
- C - Community
- F - Functions
- G - Green and blue infrastructures
- M - Material
- P - Planning processes

Each theme comprises between three and five patterns, whereby in principle both the themes and the patterns can be supplemented by further examples. The topic of energy is only described in one pattern. Energy-efficient building is such a complex subject area, encompassing a multitude of subsystems, design and construction topics that would have to be described in a separate pattern language. This was not feasible within the given project framework. At least the most important principles are summarised in Pattern P3 - Planning Principles for Energy Efficient Building.

Theory

The theory section briefly describes the pattern language methodology (cf. chapter 6.1) and some key terms that are particularly relevant for understanding the project and homepage, such as *CoHousing*, *social ecology*, *prosumer* or *synergy*. This section has a framing character, is written in an essay style and can be supplemented by further theory modules.

About / Über - Description to the homepage

The homepage is completed by a section describing the purpose and goals of the homepage itself as well as the context of the Nová Cvernovka research project with short descriptions of the project partners.

The title of the homepage "building social ecology" was agreed upon by the team through systemic consensus, a method for decision-making in groups that originates from sociocracy (Rüther 2018: 37 and p. 370). In our understanding, this name best expresses the intentions of the project.

Table 12: Overview of the design samples on the homepage

No.	Catalogue no.	Sample designation
1	A1	Flexible floor plans
2	A2	Architecture of the encounter
3	A3	Compact structures with atriums
4	A4	Rue intérieure
5	A5	Community terrace
6	C1	Jointly used areas
7	C2	Option rooms
8	C3	Sharing offers
9	C4	Open workshops and repair cafés
10	C5	Self-organised working groups
11	F1	Mixed use of housing, work and culture
12	F2	Inclusive housing
13	F3	Cluster apartments
14	G1	Green facades
15	G2	Green roof
16	G3	Community gardens
17	G4	Rainwater harvesting
18	G5	Greywater use
19	M1	Recycling, circular economy and urban mining
20	M2	Design for disassembly
21	M3	Material passport
22	M4	Use of renewable raw materials
23	P1	Integral planning
24	P2	Community planning
25	P3	Planning principles for energy-efficient construction
26	P4	Barrier-free design
27	P5	Design for easy maintenance

7. Conclusions and outlook

7.1 Reflection on the work process, methods and results

Not all goals could be achieved within the time frame; priorities had to be weighed and compromises had to be made in some cases. In the following, a reflection on the work process, on the methods used and the results achieved in the work process will conclude. This reflection was differentiated according to challenges and opportunities as well as, in part, according to the fields of action or work steps examined.

Challenges

Complexity of the intended project goals and the work process

The overall objectives of the project are ambitious and show considerable complexity: Bringing together social and ecological as well as economic and cultural interests and requirements requires a high degree of handling skill. It involves a strong mix of uses and a variety of people and groups involved in the planning process.

On closer examination of the working process, the implementation of consistently participatory planning during a pandemic - with the associated recurring and asynchronous closures and restrictions - proved to be a considerable challenge, with all participants affected by unforeseen delays and setbacks, starting with direct, day-to-day communication. In addition, the planning discussions between the partners in Bratislava and Berlin were conducted in English, German and in Slovak, which made the translation (e.g. also of minutes and reports) and localisation of responsibilities another time-consuming challenge.

Conflicting goals in the implementation of environmental and social objectives, in particular plus energy and affordability

Among the main challenges of the project were the constant negotiations between the intentions formulated as a vision and the financial constraints that limit the funds available for investments and renovations. In addition, the lack of model projects and success stories in the region is another difficulty in assessing and planning what is actually feasible in Bratislava and Slovakia in general - both in terms of people's mindset and the legal and regulatory context.

Participation process

The exchange between planners and community representatives has shown the importance of effective strategies and tools to engage residents and community members, especially in online meetings and to motivate them to participate on an ongoing basis. In the context of the ongoing Covid19 pandemic, the challenge was compounded by the need to design and implement most participatory processes online. In addressing this challenge, the importance of providing clear, accessible and consistent communication channels about the progress of the project was emphasised in the interviews. In addition to providing and implementing a clear organisational structure for potential residents as well as community members, this paves the way for a basic level of interest and participation. Building on this, dividing community members into sub-projects according to their interests, preferred housing type or way of engaging with the project could prove to be an effective way of organising the community's resources, skills and time.

Development and integration of the ecological concepts and measures

In addition to the primary goals of increasing the energy efficiency of the building and additional energy generation from renewable sources, many other ecological questions regarding the integration of green-blue infrastructures or approaches to a circular economy were examined. The challenge - and in some cases also an excessive demand - lay in the integral approach, which takes equal account of the ecological, social and economic dimensions. Not all conceivable concepts could be dealt with in depth. With the support of the project partner iEPD for the concept for energy optimisation and the Plus-energy building, and with the participation of ECOboaRD for other ecological topics, only the more planning-relevant concepts could be worked on in depth. Their implementation is elementarily dependent on further project funding, only then can the practical relevant results be evaluated.

Knowledge transfer and implementation of the homepage

The current status of the homepage with 24 projects and 27 samples gives a comprehensive overview of social-ecological projects. Conceptually and due to the bilingualism, the work took a lot of time; at the same time, many more projects and patterns could - and should - be recorded and presented. It is in the logic of pattern languages that they are never "finished", but describe the result of a respective situational project status. However, we have attached importance to the fact that with the compilation of the patterns presented here, we have at least captured the most important elements of social-ecological projects from our point of view.

Opportunities

Socio-cultural communities as innovation ecosystems

Nová Cvernovka has a highly motivated community made up of the people who live and work there, supported by the competent and dynamic management team of the Cvernovka Foundation and dedicated architects. The spatial environment of the existing architecture combined with this "innovation ecosystem" of living, working, art, culture and social engagement produces a wide range of innovations and experiments. The buildings are in good condition - apart from energy standards - and can support a variety of spatial developments. Nová Cvernovka has developed a strong identity in recent years as a place and a group of people interested in and capable of innovation, cooperation and communication.

Indeed, the challenges associated with the process can become an opportunity to engage in reflective and deliberate communication between stakeholders and partners. This includes thinking strategically about time-efficient communication and preparing in advance of meetings and contact points to ensure that multiple parallel processes are coordinated and yet self-sustaining. The current situation also requires that up-to-date and clear information is constantly made available to all stakeholders and community members.

Social-ecological orientation

The ambitious goals of the project can become a strong motivation and encourage the commitment of potential residents and community members. A social-ecological orientation of the actors combined with the idea that social, economic and energy dynamics need to be considered holistically and addressed in one way support the development of a project that is not only concerned with energy efficiency but takes up the challenge to grow as a community. A successful project must therefore ask its members: What do we really need to live well?

A picture of the future of the Nová Cvernovkas community is emerging: (socio-ecological) synergies can be created, the building conversion can take place while maintaining the community, and new groups of residents such as teachers and students could be addressed in the future while maintaining affordability and diversity. Through the surveys conducted, it became apparent that there is a great willingness in the community to share spaces such as bathrooms and kitchens in order to save resources.

Affordability, technology and spaces

The attention given to a plus-energy concept as opposed to affordability is great. The opportunity to focus more on spaces, functions and collaboration with future residents than just technology-based sustainability already offers significant opportunities in the short term. This includes a wide range of improvements to facilities and spaces. In addition, the citizens:inside budget and participatory budgeting offer the opportunity to fund self-help improvements and adaptations proposed and implemented by current and future residents.

People will lose their interest and motivation if they are not effectively involved. This finding is consistent with a user:inside oriented approach that aims to prioritise building features that future occupants can afford, want and actually need. This user:inside orientation is based on the assumption that there is no "standard person" or "average user:in" and that effective person-centred housing concepts are created by asking people about their needs and desires. It is crucial to develop a strategy to document the concrete needs and preferences of future residents. For this, as well as for the design of the organisation in the Nová Cvernovkas community, further tools and (creative) methodologies of participatory planning could be used in the future (see e.g. Baupiloten, "Organise yourselves", Soziokratie 3.0).

CoHousing is a cultural practice

Nová Cvernovka can learn from other projects, but it also develops its own housing cultures. CoHousing is as much about processes as it is about achieving goals. The "social architecture" is as important as the "built architecture", i.e. the structures for decision-making and management need to be developed together with the building structures. This should come out of a well-planned series of meetings, discussions and workshops, as well as surveys. Roadmaps and scenarios are necessary to explain the steps, milestones and important decisions to all stakeholders.

For something like a critical perspective - such as social ecology, gender mainstreaming or inclusion and autonomy of people with disabilities - to be included, implemented and taken seriously, this would need to be integrated into the planning process from the beginning, involving all stakeholders,and then referred to at every stage of the planning process. The involvement of socially engaged businesses can improve quality of life, including through the creation of employment opportunities, which can range from care facilities to projects such as Housing First, food growing, education and job placement.

7.2 Recommendations and transferability of results

The following recommendations for the further development of the CMI.BA project in Nová Cvernovka can therefore also be seen as recommendations for other projects pursuing similar goals.

Courage and perseverance to realise visions

We encourage the Nová Cvernovka project to continue with an ambitious and larger vision as the CMI.BA project comes to an end and in the following months and years of project development. Experience from other social-ecological projects teaches that these realisation processes - especially when many actors are involved and the available financial resources set a tight framework - often take a longer period of time than desired. We propose to aim for an optimal combination of social and ecological as well as cultural and economic objectives. While in the CMI.BA project, due to time constraints, a social-ecological concept could only be sketched and thought of, we assume that the Nová Cvernovka project will have the time to learn further, to develop innovations and to implement them.

Realisation of a strong CoHousing model

We recommend striving for a "strong CoHousing" model, as this involves a higher degree of community participation, cooperation and decision-making rights and responsibilities of the residents. It also has the potential to increase residents' identification with their place of residence and the project. How a "strong CoHousing" model could look in practice was discussed in the scenario workshop. For example, the size and characteristics of common spaces as well as the preferred organisational and management structures should be further discussed and developed. This information and discussion will also be useful in developing future roadmaps and scenarios for Nová Cvernovka. In particular, milestones for critical decisions as well as 5-, 10- and perhaps even 20-year plans should be defined and reviewed at regular intervals in order to be able to make adjustments if necessary when the framework conditions change. In order not to overburden those involved, appropriate planning and realisation phases should be taken into account.

Energy use, monitoring and readjustment in the use phase, user manual

For Nová Cvernovka, energy recovery should be pursued and reviewed in terms of size. The plus-energy concept can be implemented and may need a creative investment and operating model for realisation, for example through energy contracting or the establishment of an energy cooperative. The possibilities for an energy partnership with the neighbours should also be examined (energy concepts at the neighbourhood level). In many cases, the building's operation in the use phase is not as optimal as expected according to (energy) technical simulations. This can be related to suboptimal basic settings of the building technology or the individual behaviour of the users. We therefore strongly recommend monitoring during the utilisation phase to ensure successful operation of the technical systems, to identify the strengths and weaknesses of concepts and components and to readjust them if necessary. This involves a certain (financial) effort, but it is the only way to realise the desired ecological and financial benefits to the desired extent in the long term. For the "correct" handling of the building, we also recommend creating a clear "user manual" to make important information available to both existing and new residents. In addition to disseminating practical know-how, this can also contribute to savings in operating and maintenance costs (e.g. man hours for the community in maintaining the grey water and hydroponic systems).

7.3 Further research

(1) Technical and process knowledge is brought into practice primarily through pilot projects. There is a great need especially for information on innovative, regenerative and transformative planning and design options in a short time. Although there is great interest in proposed and discussed synergies, these remain elusive and setting comprehensive priorities is difficult.

(2) It was not possible to record and calculate the grey energy of the planned structural measures within the given project framework. With regard to utilisation cycles and (energy) amortisation periods, this would be another level of consideration for a holistic project evaluation.

(3) The concept of the homepage is designed for growth. An addition of further project documentation, the systematic linking to other homepages with project databases as well as an expansion of socio-ecological design patterns and theoretical texts would be beneficial to the homepage as a "hub" for socio-ecological projects. In particular, the project of a model language of energy-efficient and sustainable building would be an exciting (research) endeavour. It would also be important to evaluate the design patterns presented to see whether they really have the intended effect in practice. A workshop with experts and practitioners on this topic could not be held within the framework of the research project.

Bibliography

Ala-Juusela, Mia et al. (2021): Positive Energy Building Definition with the Framework, Elements and Challenges of the Concept. Mia Ala-Juusela, Hassam ur Rehman, Mari Hukkalainen and Francesco Reda. Energies 2021, 14(19), 6260; https://doi.org/10.3390/en14196260

Alexander et al. (1977): A Pattern Language. Autor:innen: Christopher Alexander, Sara Ishikawa, Murray Silverstein mit Max Jacobson, Ingrid Fiksfahl-King, Shlomo Angel. Oxford University Press, New York. Deutsche Ausgabe: Alexander et al. (1995): Eine Muster-Sprache. Städte, Gebäude, Konstruktion. Löcker, Wien, https://www.einemustersprache.de/

Alexander, Christopher (1996): Keynote Speech to the 1996 OOPSLA Convention. https://www.patternlanguage.com/archive/ieee.html und https://www.youtube.com/watch?v=98LdFA-_zfA

Baccini, Peter; Brunner, Paul H. (1991): Metabolism of the Anthroposphere. Berlin, Heidelberg: Springer

Baccini, Peter (2008): Zukünfte urbanen Lebens mit Altlasten. In: Gleich, Arnim von / Stefan Gößling-Reisemann (Hrsg.) (2008): Industrial Ecology – Erfolgreiche Wege zu nachhaltigen industriellen Systemen. S. 218 – 237

BBSR - Bundesinstitut für Bau-, Stadt-und Raumforschung (Hrsg.) (2014). Neues Wohnen – Gemeinschaftliche Wohnformen bei Genossenschaften. Bonn.

BBSR (Hg.) (2017): Die Weisheit der Vielen. Bürgerbeteiligung im digitalen Zeitalter. Herausgegeben vom Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR), Bonn. Abgerufen am 26.04.2021 von https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/sonderveroeffentlichungen/2017/smart-cities-buergerbeteiligung-dl.pdf?__blob=publicationFile&v=2

BBSR (Hrsg.) (2018): Effizienzhaus Plus. Planungsempfehlungen. Forschung für die Praxis, Band 15 https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/zukunft-bauen-fp/2019/band-15.html

BBSR (Hrsg.) (2019): Wege zum Effizienzhaus Plus. Grundlagen und Beispiele für energieerzeugende Gebäude https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/ministerien/bmi/verschiedene-themen/2018/effizienzhaus-plus.html

BBSR (Hg.) (2020): Digitale Tools für die kollaborative Entwicklung von Smart City Strategien. Herausgegeben vom Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR), BBSR-Online-Publikation Nr. 10/2020, Bonn. Abgerufen am 26.04.2021 von https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/bbsr-online/2020/bbsr-online-10-2020-dl.pdf?__blob=publicationFile&v=2

Becker, Carlo W.; Neuhaus, Anna (2016): Stadtentwicklungsplan Klima - KONKRET - Klimaanpassung in der wachsenden Stadt. Berlin: Senatsverwaltung für Stadtentwicklung und Umwelt. Herausgeber: Senatsverwaltung für Stadtentwicklung und Umwelt, Inhalte und Bearbeitung bgmr Landschaftsarchitekten GmbH. https://www.stadtentwicklung.berlin.de/planen/stadtentwicklungsplanung/download/klima/step_klima_konkret.pdf

Becker, Egon; Jahn, Thomas (Hrsg.) (2006): Soziale Ökologie. Grundzüge einer Wissenschaft von den gesellschaftlichen Naturverhältnissen. Frankfurt a. M. / New York: Campus Verlag.

Becker, Egon (2016): Keine Gesellschaft ohne Natur. Beiträge zur Entwicklung einer Sozialen Ökologie. Frankfurt a. M.: Campus Verlag.

BDA; Bahner, Olaf; Böttger, Matthias (Hrsg.) (2016): Neue Standards. Zehn Thesen zum Wohnen“, Bund Deutscher Architekten. Katalog zur gleichnamigen Ausstellung Architekturzentrum. Berlin: Jovis-Verlag

Bielefeld, Bert (2017): Basics Gebäudetechnik. Berlin: Birkhäuser Verlag

BMI (2014): Gemeinschaftsgärten im Quartier. Handlungsleitfaden für Kommunen. http://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/bauen/wohnen/soziale-stadt-gemeinschaftsgaerten.pdf?__blob=publicationFile&v=4

Heinrich-Böll-Stiftung (2017): Geteilte Räume. Strategien für mehr sozialen und räumlichen Zusammenhalt. BAND 21. Bericht der Fachkommission «Räumliche Ungleichheit» der Heinrich-Böll-Stiftung.

Bossi, Silvia; Gollner, Christoph; Theierling, Sarah (2020): Towards 100 Positive Energy Districts in Europe: Preliminary Data Analysis of 61 European Cases. Energies 2020, 13, 6083
https://jpi-urbaneurope.eu/wp-content/uploads/2020/12/PED-Article-2020-energies-13-06083.pdf

Brand, Karl-Werner; Jochum, Georg (2000): Der deutsche Diskurs zu nachhaltiger Entwicklung. Abschlussbericht eines DFG-Projekts zum Thema „Sustainable Development / Nachhaltige Entwicklung – Zur sozialen Konstruktion globaler Handlungskonzepte im Umweltdiskurs", Münchner Projektgruppe für Sozialforschung e.V., MPS-Texte 1/2000. München
http://www.sozialforschung.org/wordpress/wp-content/uploads/2009/09/kw_brand_deutscher_nachh_diskurs.pdf

Buchholz, Martin (2002): Energiegewinnung, Wasseraufbereitung und Verwertung von Biomasse in Gewächshaus - Gebäude - Modulen, Dissertation an der TU Berlin. https://depositonce.tu-berlin.de/handle/11303/768

Daly, Herman E. (2002): Ökologische Ökonomie: Konzepte. Analysen, Politik. Aus dem Amerikanischen übersetzt von Udo E. Simonis, Discussion Paper FS-II 02-410. Berlin: Wissenschaftszentrum

Difu (Hrsg.) (2017): Wasserinfrastrukturen für die zukunftsfähige Stadt. Beiträge aus der INIS-Forschung. Deutsches Institut für Urbanistik, Berlin. https://repository.difu.de/jspui/handle/difu/240075

Disch, Rolf (2010: Häuser als Kraftwerke. Neue Siedlungen von Rolf Disch SolarArchitektur. Das Prinzip Plusenergie. Abgerufen am 10.05.2022 von http://www.rolfdisch.de/wp-content/uploads/BROSCHUERE_HA%CC%88USER_ALS_KRAFTWERKEEINZELSEITENSEITEN-1.pdf

Dürr, Susanne; Kuhn, Gerd (2017). Wohnvielfalt. Gemeinschaftlich wohnen – im Quartier vernetzt und sozial orientiert. Hrsg. von Wüstenrot Stiftung. Ludwigsburg

EU (2010): Richtlinie 2010/31/EU des europäischen Parlaments und des Rates vom 19. Mai 2010 über die Gesamtenergieeffizienz von Gebäuden (Neufassung Amtsblatt der Europäischen Union L 153/13 vom 18.6.2010)
https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:DE:PDF

Feist, Wolfgang (1998): Das Niedrigenergiehaus. C.F. Müller Verlag, Heidelberg

Fischer-Kowalski, Marina et al. (1997): Gesellschaftlicher Stoffwechsel. Ein Versuch in sozialer Ökologie. Beiträge von Fischer-Kowalski, Marina; Haberl, Helmut; Hüttler, Walter; Payer, Harald; Schandl, Heinz; Winiwarter, Verena; Zangerl-Weisz, Helga. Amsterdam: Gordon & Breach Fakultas

futurice o.J.: The Lean Futures Creation Handbook. VERSION 2.0. A collaborative method toolkit for futures thinking and creation

Gantner, Kathrin (2002): Nachhaltigkeit urbaner Regenwasserbewirtschaftungsmethoden. Berichte zur Siedlungswasserwirtschaft Bd. 20, Dissertation an der TU Berlin : Techn. Univ., FG Siedlungswasserwirtschaft,
http://webdoc.sub.gwdg.de/ebook/diss/2003/tu-berlin/diss/2002/gantner_kathrin.pdf

Gottschlich, D. (2017): *Soziale Ökologie. Charakteristika, Besonderheiten, kritisch-emanzipatorische Erweiterungspotenziale.* In Nr. 29. S. 4-13. fiph - Forschungsinstitut für Philosophie Hannover. Schwerpunktthema Kulturökologie

Hagbert, Pernilla; Bradley, Karin (2017): Transitions on the home front: A story of sustainable living beyond ecoefficiency. In: Energy Research & Social Science (2017), http://dx.doi.org/10.1016/j.erss.2017.05.002

Hahn, Ekhart (1992): Ökologischer Stadtumbau: Konzeptionelle Grundlegung. Beiträge zur kommunalen und regionalen Planung 13. Frankfurt/ Main, Bern, New York, Paris: Peter Lang

Hamann et al. (2018): Mustersprache Stadtgestalten. Baugemeinschaften als Impulsgeber für eine nachhaltige Stadtentwicklung. Endbericht. Institut für Partizipatives Gestalten (IPG), Oldenburg, Autor:innen: Mio Sibylle Hamann, Sonja Hörster und Jascha Rohr
http://stadtgestalten.net/wp-content/uploads/2019/07/Baugemeinschaften_Impulsgeber_Stadtentwicklung.pdf

Hegger, Manfred et al. (2007 a): Energie Atlas: Nachhaltige Architektur (Detail Atlas). Autoren: Manfred Hegger, Matthias Fuchs, Thomas Stark, Martin Zeumer. Birkhäuser Verlag AG: Basel

Hegger, Manfred et al. (2007 b): Bewertung der Nachhaltigkeit von Gebäuden anhand von 20 Beispielprojekten als konkrete Handlungslinie und Arbeitshilfe für Planer. Abschlussbericht des Forschungsvorhabens gefördert unter AZ 24084-25 durch die Deutsche Bundesstiftung Umwelt (DBU). Autoren: Manfred Hegger, Matthias Fuchs, Thomas Stark, Martin Zeumer. Abgerufen am 12.05.2022 von https://www.dbu.de/OPAC/ab/DBU-Abschlussbericht-AZ-24084.pdf

Hellmann, Kai-Uwe (2016) : Auf dem Weg in die "Prosumentengesellschaft"? Über die Stabilisierbarkeit produktiver Konsumentennetzwerke, Vierteljahrshefte zur Wirtschaftsforschung, ISSN 1861-1559, Duncker & Humblot, Berlin, Vol. 85, Iss. 2, pp. 49-63, http://dx.doi.org/10.3790/vjh.85.2.49

Herbst, Heinrich Bernhard (2008): Bewertung zentraler und dezentraler Abwasserinfrastruktursysteme. http://darwin.bth.rwth-aachen.de/opus3/volltexte/2008/2453/pdf/Herbst_Heinrich.pdf

Hiessl, Harald (Hrsg.) (2005): AKWA 2100. Alternativen der kommunalen Wasserversorgung und Abwasserentsorgung. Harald Hiessl, Dominik Toussaint, Michael Becker, Amely Dyrbusch, Silke Geisler, Heinrich Herbst, Jens U. Prager. Fraunhofer Institut für System- und Innovationsforschung. Stuttgart: Fraunhofer IRB Verlag

Hillebrandt, Annette; Riegler-Floors, Petra; Rosen, Anja; Seggewies, Johanna-Katharina (2021): Atlas Recycling. Gebäude als Materialressource. Edition Detail

Hönger, Christian et al. (2009): Das Klima als Entwurfsfaktor / Climate as a design factor. 1. Band der Reihe Laboratorium, Hochschule Luzern, Autoren: Christian Hönger, Roman Brunner, Urs-Peter Menti, Christoph Wieser. Quart Verlag, Luzern

Hofmann, Susanne (2014): Partizipation macht Architektur: die Baupiloten - Methode und Projekte. Berlin: Jovis Verlag.

Hummel, Diana, Thomas Jahn, Florian Keil, Stefan Liehr, and Immanuel Stieß (2017): *Social Ecology as Critical, Transdisciplinary Science—Conceptualizing, Analyzing and Shaping Societal Relations to Nature*. In *Sustainability* 9, no. 7: 1050. https://doi.org/10.3390/su9071050

Keßling, Britt (2010): Die Schweizer 2000-Watt-Gesellschaft – ein Konzept auch für Deutschland? db Deutsche Bauzeitung 11/2010. https://www.db-bauzeitung.de/db-themen/energie/2000-watt-fuer-deutschland/

Klein, Naomi (2019): Warum nur ein Green New Deal unseren Planeten retten kann. Hamburg: Hoffmann und Campe

Krapmeier, Helmut; Drössler, Eckart (2001): Cepheus - Wohnkomfort ohne Heizung. Schlussdokument des Projektes Cepheus Austria 1998-2001 – Wien: Springer

Leibundgut, Hansjürg (2007): viaGialla. Wegbeschreibung für Gebäude in eine nachhaltige Energie-Zukunft. Version 2.1

Krebs, Sarah Marie (2019): Vertikale Landwirtschaft im urbanen Raum. Chancen und Grenzen. Welche Projekte können hier als Vorbild dienen? Masterarbeit im Studiengang Urbane Zukunft, Fachhochschule Potsdam

Krusche, Per und Maria; Althaus, Dirk; Gabriel, Ingo (1982): Ökologisches Bauen. Herausgegeben vom Umweltbundesamt. Wiesbaden und Berlin: Bauverlag, 360 S.

LaFond, M. et al. (2017). COHousing Inclusive - Selbstorganisiertes, gemeinschaftliches Wohnen für Alle. 1. Aufl. Autoren: Michael LaFond, id22: Institut für kreative Nachhaltigkeit, Larisa Tsvetkova (Hg.). Berlin: Jovis Verlag.

Lenel, Severin (2012): 2000-Watt-Gesellschaft in der Schweiz – vom globalen Modell zum einzelnen Gebäude. In: M. Drilling, O. Schnur (Hrsg.), Nachhaltige Quartiersentwicklung, DOI 10.1007/978-3-531-94150-9_11, Wiesbaden: Springer VS Verlag für Sozialwissenschaften

Leitner, Helmut (2015): Mit Mustern arbeiten. in: Silke Helfrich & Heinrich-Böll-Stiftung (Hrsg.) (2015): Die Welt der Commons – Muster des gemeinsamen Handelns. Band 2. Berlin: transcript-Verlag https://www.band2.dieweltdercommons.de/essays/mit_mustern_arbeiten.html

Leitner, Helmut (2016): Mustertheorie. Einführung und Perspektiven auf den Spuren von Christopher Alexander. Eigenverlag, Erstveröffentlichung 2007 bei Nausner & Nausner Verlag, Graz

Liehr, S., Becker, E. & Keil, F. (2006): *Systemdynamiken*. In: Becker, E. & Jahn, T. (Hrsg.): *Soziale Ökologie. Grundzüge einer Wissenschaft von den gesellschaftlichen Naturverhältnissen*, Frankfurt a. M./ New York, S. 267-283.

Lindholm, Oscar.; Rehman, Hassam ur; Reda, Franceso (2021): Positioning Positive Energy Districts in European Cities. Buildings 2021, 11, 19. https://www.mdpi.com/2075-5309/11/1/19

Löber, Torsten (2001): Beitrag zu einer städtebaulich neuorientierten Regenwasserbehandlung in Wohnsiedlungen. Dissertation an der Universität der Künste, Berlin: Lehmanns.
http://webdoc.sub.gwdg.de/ebook/q/2002/tu_berlin/loeber_torsten.pdf

Löhnert, G. (2002). Der Integrale Planungsprozess. Eine Serie in vier Teilen: Grundlagen, Wirkungszusammenhänge, Empfehlungen, Der NAVIGATOR.

Ludwig, Ferdinand; Well, Friederike; Moseler, Eva-Maria; Eisenberg, Bernd (Hrsg) (2021): Integrierte Planung blau-grüner Infrastrukturen. Ein Leitfaden. Autorinnen und Autoren: Ludwig, Ferdinand; Well, Friederike; Moseler, Eva-Maria; Eisenberg, Bernd; Deffner, Jutta; Drautz, Silke; Elnagdy, Mohamed Tarek; Friedrich, Renate; Jaworski, Till; Meyer, Sebastian; Minke, Ralf; Morandi, Carlo; Müller, Hans; Narvaéz Vallejo, Alejandra ; Richter, Philipp; Schwarz-von Raumer, Hans-Georg; Steger, Lotta; Steinmetz, Heidrun; Wasielewski, Stephan; Winker, Martina. München.
https://mediatum.ub.tum.de/doc/1638459/1638459.pdf

Luther, Joachim; Wittwer, Volker; Voss, Karsten (2001): Energie für Gebäude - solare Technologien und Konzepte. Wie könnte ein Haus von morgen aussehen. Physikalische Blätter 57 (2001) Nr. 11, 39-44

McDonough, William; Braungart, Michael (2002): Cradle to cradle: remaking the way we make things.

Mahlke, Friedemann (2007): Schwerelos erdverbunden – Vom Leichtbau zum Lehmbau. Das Werk des Architketen Gernot Minke. Staufen bei Freiburg: ökobuch Verlag

Mauser, Jana Marie (2016): Gemeinschafts(t)räume. Diplomarbeit WS 2015/2016 Stuttgart: Universität Stuttgart. Institut für Wohnen und Entwerfen Fachgebiet Architektur- und Wohnsoziologie.
https://www.iwe.uni-stuttgart.de/dokumente/wohnsoziologie/material/mauserjana-2016-diplom_gemeinschaftstrc3a4ume.pdf

Million, Angela; Bürgow, Grit; Steglich, Anja (Hrsg.) (2018): Roof Water-Farm. Urbanes Wasser für urbane Landschaft. Sonderpublikation des Instituts für Stadt- und Regionalplanung der Technischen Universität Berlin, Universitätsverlag der TU Berlin, https://depositonce.tu-berlin.de//handle/11303/7413

Musall, Eike (2015): Klimaneutrale Gebäude – Internationale Konzepte, Umsetzungsstrategien und Bewertungsverfahren für Null- und Plusenergiegebäude. Vollständiger Abdruck der von der Fakultät für Architektur und Bauingenieurwesen der Bergischen Universität Wuppertal genehmigten Dissertation.
http://elpub.bib.uni-wuppertal.de/edocs/dokumente/fbd/architektur/diss2015/musall/dd1507.pdf

Nagler, Florian et al. (2018): Einfach Bauen. Ganzheitliche Strategien für energieeffizientes, einfaches Bauen – Untersuchung der Wechselwirkung von Raum, Technik, Material und Konstruktion. Schlussbericht
https://www.einfach-bauen.net/wp-content/uploads/2019/04/einfach-bauen-schlussbericht.pdf

Nagler, Florian et al. (2021): Einfach Bauen 2. Planen, Bauen, Messen. Schlussbericht.
https://www.einfach-bauen.net/wp-content/uploads/2021/07/210726_EINFACH-BAUEN-2__Endbericht_f%C3%BCr-TUM_gr.pdf

Nanz, Patrizia; Fritsche, Miriam (2012): Handbuch Bürgerbeteiligung. Verfahren und Akteure, Chancen und Grenzen. Schriftenreihe der Bundeszentrale für politische Bildung Bonn Bd. 1200 – Bonn. Abgerufen am 15.05.2022 von https://www.bpb.de/system/files/dokument_pdf/Handbuch_Buergerbeteiligung.pdf

Neo, H.; Chua, C. Y. (2017): Beyond inclusion and exclusion: Community gardens as spaces of responsibility. Annals of the American Association of Geographers, 107(3), 666-681.

Nolde, Erwin (2013): Dezentrale Abwasserwärmerückgewinnung in Kombination mit einer Grauwasserrecyclinganlage. Abschlussbericht eines Forschungsprojekts gefördert durch die Deutsche Bundesstiftung Umwelt, Osnabrück. DBU Projekt AZ 28201. https://www.dbu.de/OPAC/ab/DBU-Abschlussbericht-AZ-28201.pdf

Overmeyer, Klaus et al. (2014): Nospolis. Räume gemeinsamer Zukünfte. Dokumentation eines Symposiums an der Universität Wuppertal am 7. Februar 2014. Konzept und Redaktion: Klaus Overmeyer, Isabel Finkenberger, Christoph Schlaich

Pauli, M. & Schauermann, R. (2017): Messbare Vorteile von Fassadenbegrünungen. In DETAIL green, Ausgabe 1/2017, 56-60, Institut für internationale Architektur-Dokumentation GmbH & Co. KG, München.

Pfeifer, Günter (2002): Das kybernetische Prinzip. in: Der Architekt 11/2002, 37-44

Pfoser, Nicole (2016): Fassade und Pflanze – Potenziale einer neuen Fassadengestaltung. TU Darmstadt: Darmstadt. https://tuprints.ulb.tu-darmstadt.de/5587/

Ponweiser, D. (2021). Einsatz von Nutzpflanzen bei Fassaden- und Dachbegrünung. Diploma Thesis an der Technischen Universität Wien. https://doi.org/10.34726/hss.2021.7400

Prytula, Michael (2011): Ein integrales Energie- und Stoffstrommodell als Grundlage zur Bewertung einer nachhaltigen Entwicklung urbaner Systeme. Dissertation an der TU Berlin, Universitätsverlag der TU Berlin. Abgerufen am 10.05.2022 von https://depositonce.tu-berlin.de/handle/11303/3425

Prytula, Michael; Rexroth, Susanne; Lutz, Manuel, May, Friedrich (2019): Der Beitrag von Cluster-Wohnungen für eine nachhaltige Stadtentwicklung. In: STATTBAU Gemeinschaftliches Wohnen im Cluster: Ein praktischer Leitfaden zum Planen, Bauen und Wohnen. S. 10-15. https://www.netzwerk-generationen.de/fileadmin/user_upload/PDF/Downloads_brosch%c3%bcren-dokumentationen/2019-12-13_Broschuere_Cluster_web.pdf

Prytula, Michael; Hanko, Jeannette (2019): Neubau Wohnhaus für Studierende in Berlin-Grunewald. Endbericht des Forschungsprojekts Vario-Wohnungen, gefördert mit Mitteln der Forschungsinititative Zukunft Bau des Bundesinstituts für Bau-, Stadt- und Raumforschung (BBSR)

Prytula, Michael; Rexroth, Susanne; Lutz, Manuel, May, Friedrich (2020a). Cluster-Wohnungen für baulich und sozial anpassungsfähige Wohnkonzepte einer resilienten Stadtentwicklung. Abschlussbericht. Stuttgart Fraunhofer IRB Verlag. http://www.irbnet.de/daten/rswb/20039026082.pdf

Prytula, M., Rexroth S., Lutz, M., May, F. (2020b): Clusterwohnungen. Eine neue Wohnungstypologie für eine anpassungsfähige Stadtentwicklung. Herausgegeben vom BBSR, Bonn.
https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/zukunft-bauen-fp/2020/band-22.html

Ritzer, G., & Jurgenson, N. (2010). Produktion, Konsumtion, Prosumtion: Die Natur des Kapitalismus im Zeitalter des digitalen "Prosumenten". Journal of Consumer Culture, 10(1), 13-36.
https://journals.sagepub.com/doi/10.1177/1469540509354673

Rüther, Christian (2018): Soziokratie, S3, Holakratie, Frederic Laloux' „Reinventing Organizations" und „New Work". Ein Überblick über die gängigsten Ansätze zur Selbstorganisation und Partizipation. Zweite, überarbeitete und stark ergänzte Auflage. Norderstedt: BoD, 2018. Kostenlose PDF-Version
https://www.soziokratie.org/wp-content/uploads/2018/07/buch-soziokratie-holakratie-laloux-2018-zweite-auflage.pdf

Schneidewind, Uwe; Singer-Brodowski, Mandy (2014): Transformative Wissenschaft. Klimawandel im deutschen Wissenschafts- und Hochschulsystem. Marburg: Metropolis Verlag

Senatsverwaltung für Stadtentwicklung (2003): Innovative Wasserkonzepte, Betriebswassernutzung in Gebäuden. http://www.stadtentwicklung.berlin.de/bauen/oekologisches_bauen/download/modellvorhaben/betriebswasser_deutsch2007.pdf

SenStadtUm (2012): Handbuch zur Partizipation. Herausgegeben von der Senatsverwaltung für Stadtentwicklung und Umwelt Berlin. Projektbegleitgruppe „Handbuch Partizipation": Dr. Jochen Hucke, Sibylle Krönert, Carsten Lilie, Ursula Renker, Sieglinde Krabs, Kurt Nelius, Dr. Peter Fleischmann, unter Mitarbeit von Zine Eddine Hathat, Claudia Ladewig und Sandra Rosenow. 2. Auflage Februar 2012.
https://www.stadtentwicklung.berlin.de/soziale_stadt/partizipation/download/Handbuch_Partizipation.pdf

Spreng, Daniel (1994): Graue Energie, Hochschulverlag Zürich / B.G. Teubner Stuttgart/Leipzig

Spreng, Daniel; Semadeni, Marco (2001): Energie, Umwelt und die 2000 Watt Gesellschaft. Grundlage zu einem Beitrag an den Schlussbericht Schwerpunktsprogramm Umwelt (SPPU) des Schweizerischen National Fonds (SNF). CEPE Working Paper Nr. 11

Stadt Luzern (2020): *Partizipative Planungsprozesse – Leitfaden*. Luzern: Stadt Luzern.

Stadt Wien (2017): Stadt der Zukunft – über partizipatives Bauen. Dokumentation einer Gesprächsreihe. Herausgegeben von der Stadt Wien, MA 18 - Stadtentwicklung und Stadtplanung, Gesamtkoordination: Wolfgang Dvorak.
https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008510.pdf

Tepasse, Heinrich (2001): Stadttechnik im Städtebau Berlins, 19. Jahrhundert. – Berlin: Gebr. Mann Verlag, 217 S., Bd.2: Stadttechnik im Städtebau Berlins, 1945 - 1999. Mitarbeit Torsten Löber – Berlin: Gebr. Mann Verlag

Tersluisen, Angèle (2009): Effizienz als Prinzip. Planungstools für klimagerechtes Bauen. in: Der Architekt 03/2009: Ästhetik der Ökologie, Aufbruch in die klimatische Moderne, wiederveröffentlicht 04.04.2019. Abgerufen am 10.05.2022 von http://derarchitektbda.de/effizienz-als-prinzip/

Theobald, Jil Ann (2022): Zirkuläres Bauen: Relevanz und Umsetzung. Masterarbeit FH Potsdam

Thiesen, Claudia (2014): Wohnungscluster und Terrasse Commune. Die Gemeinschaft in der Genossenschaftssiedlung Kraftwerk1 Heizenholz. In: Arch Plus (2014): Wohnerfahrungen. Ausgabe 218, S. 74-79. Abgerufen am 22.02.2021 von: https://www.kraftwerk1.ch/assets/downloads/publikationen/siedlungen/Heizenholz/1411_Arch_218_Kraftwerk1%20Heizenholz.pdf

Thoma, Klaus (Hrsg.) (2014): > Resilien-Tech. „Resilience-by-Design": Strategie für die technologischen Zukunftsthemen. https://www.acatech.de/publikation/resilien-tech-resilience-by-design-strategie-fuer-die-technologischen-zukunftsthemen-2/

Trapp, Jan Hendrik; Winker, Martina (Hrsg.) (2020): Blau-grün-graue Infrastrukturen vernetzt planen und umsetzen. Ein Beitrag zur Klimaanpassung in Kommunen. Autorinnen und Autoren: Jeremy Anterola, Herbert Brüning, Dr. Fanny Frick-Trzebitzky, Michel Gunkel, Dr. Jens Libbe, Dr. Stefan Liehr, Dr. Andreas Matzinger, Diana Nenz, Brigitte Reichmann, Dr.-Ing. Pascale Rouault, Dr. Engelbert Schramm, Dr. Immanuel Stieß, Jan Hendrik Trapp, Dr. Martina Winker, www.networks-group.de, Berlin: Deutsches Institut für Urbanistik gGmbH https://repository.difu.de/jspui/bitstream/difu/281578/1/20200507_Sonderveroeffentlichung%20netWORKS4.pdf

Tuerk, Andreas et al. (2021): Integrating Plus Energy Buildings and Districts with the EU Energy Community Framework: Regulatory Opportunities, Barriers and Technological Solutions. Andreas Tuerk, Dorian Frieden, Camilla Neumann, Konstantinos Latanis, Anastasios, Tsitsanis, Spyridon Kousouris, Javier Llorente, Ismo Heimonen, Francesco Reda, Mia Ala-Juusela, Koen Allaert, Chris Caerts, Thomas Schwarzl, Martin Ulbrich, Annette Stosch, Thomas Ramscha. Buildings 2021, 11(10), 468; https://doi.org/10.3390/buildings11100468

TUM & ZSK (Hrsg.) (2020): Leitfaden für klimaorientierte Kommunen in Bayern Handlungsempfehlungen aus dem Projekt Klimaschutz und grüne Infrastruktur in der Stadt am Zentrum Stadtnatur und Klimaanpassung. Herausgegeben von der Technischen Universität München, Zentrum Stadtnatur und Klimaanpassung, Prof. Dr.-Ing. Stephan Pauleit, Lehrstuhl für Strategie und Management der Landschaftsentwicklung und Prof. Dr.-Ing. Werner Lang, Lehrstuhl für energieeffizientes und nachhaltiges Planen und Bauen.
https://www.zsk.tum.de/fileadmin/w00bqp/www/PDFs/Leitfaeden/ZSK-TP1_Leitfaden_deutsch_komprimiert.pdf

Voss, Karsten (Hrsg.) (1997): Konzeption und Bau eines energieautarken Solarhauses Schlussbericht. – Stuttgart: Fraunhofer IRB Verlag

Voss, Karsten (Hrsg) (2005): Bürogebäude mit Zukunft. Konzepte, Analysen, Erfahrungen. Autoren: Karsten Voss, Günther Löhnert, Sebastian Herkel, Andreas Wagner, Matthias Wambsganß (Hrsg.). Berlin: Solarpraxis GmbH.

Voss, Karsten, Musall, Eike (2011): Nullenergiegebäude. Klimaneutrales Wohnen und Arbeiten im internationalen Vergleich. München: Detail green books, 192 S.

Weeber+Partner (2021): Urban Gardening (mit Waldgärten). Machbarkeitsstudie. Endbericht. Gefördert vom BBSR. https://www.weeberpartner.de/files/WP_UrbanGardening_Endbericht_2021.pdf

Zimmermann, Ulrich (2005): Integrierte siedlungswasserwirtschaftliche Planung. Eine einzugsgebietsweite Betrachtung der Regenwasserbewirtschaftung in Siedlungsgebieten im Hinblick auf eine nachhaltige und optimierte Sanierungsstrategie. http://edok01.tib.uni-hannover.de/edoks/e01dh05/487470664.pdf

All URL addresses were checked for up-to-dateness at the time the report was submitted.

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Potsdam University of Applied Sciences: *Project Management, Integral Planning and Ecological Construction Methods*

The University of Applied Sciences Potsdam (FHP) and was founded in 1991 and currently has around 3,700 students. In 2014, the Institute for Applied Research Urban Future (IaF) was established as a central, interdisciplinary research institution with various research focuses. Under the focus *"Design - Build - Maintain"*, various questions on the physical, spatial and social dimensions of sustainable development of the built environment are investigated.

Within the CMI.BA project, the FH Potsdam team managed and coordinated the work of all project partners and developed an overall ecological concept. An important building block for this was integral planning, through which all important actors are involved in the planning process at an early stage. The FHP was also mainly responsible for collecting "best practice" examples and creating the socio-ecological design patterns.

Nadácia Cvernovka: *Education and* Communication

The Nadácia Cvernovka Foundation was established with the aim of renovating the former industrial area of Cvernovka in Bratislava and filling it with life by offering social, cultural and financial support to artists and the public. In this way, the foundation wants to contribute to the improvement of living conditions and perspectives in the city and in society. The revitalisation of the Cvernovka area will gradually create a cultural and meeting centre in Bratislava.

The fields of action of the *"Nadácia Cvernovka"* Foundation in the CMI.BA project included communication with stakeholders and public administrations, public relations work and coordination of the preparation of the planning documentation for the conversion to a plus-energy building.

ECOboaRD: *Advice on the development of ecological concepts*

ECOboaRD is a technology and energy think tank platform that conducts analyses and develops technological studies and concepts for energy-optimised smart buildings, taking into account environmental aspects. The company offers consulting services, analyses and the development of complex technological studies, and is also active in the research and development of innovative solutions and prototypes in the energy sector.

PLURAL Architects: Design planning for building conversion and energy modernisation

PLURAL produces architecture, exhibition design and speculation about the city. The office is located in Nová Cvernovka. The partners of the architectural office Martin Jančok and Michal Janák were commissioned with the design and planning tasks and prepared the planning documentation.

Institute for Creative Sustainability (id22): *CoHousing and social innovation*

id22 is an interdisciplinary, non-profit organisation in Berlin that researches and supports community-oriented forms of housing in the context of sustainable, cooperative urban development. Inclusion and self-organisation are at the forefront. For many years, id22 has been doing research, education and networking work and has published numerous papers on participatory and community-oriented housing cultures (CoHousing Cultures). The development of housing concepts and the accompaniment of the participation process represented the central fields of action of the *"Institute for Creative Sustainability"* in the CMI.BA project.

Passive House Institute Slovakia (iEPD): *PlusEnergyBuildings*

The Passive House Institute (iEPD) is a non-political, voluntary, non-governmental organisation. As an association, iEPD promotes the development of sustainable architecture and open spaces in Slovakia and, in particular, the provision of information and knowledge in the construction of passive houses. iEPD has been and continues to be involved in the implementation of many national and international research projects. In the CMI.BA project, iEPD investigated the energetic condition of the building and developed an energetic concept for the conversion into a plus-energy building.

Appendix

A1 - Project documentation of the architects (PLURAL and N.C)

- Documents for planning permission, 127 p.

A2 - Design Brief for Architects (N.C. / FHP / id22 / iEPD)

- Summary report by id22, 26 p.

A3 - Social*Ecological Co*Housing (id22)

- Summary report by id22, 23 p.
- Questionnaire, 5 p.
- Evaluation of the CoHousing surveys (id22 / N.C.), 10 pp.

A4 - Energy Concept Calculations (iEPD)

- Calculations in PHPP for existing buildings, 13 p.
- Calculations in PHPP for Passive House Standard, 10 p.
- Lecture slides on the calculation and optimisation of the photovoltaic system, 18 p.

A5 - Documentation of the homepage (FHP)

- About, Theory and Imprint
- Descriptions of the projects
- Descriptions of the design patterns in
  total 90 p.