

## 2 Public investors - from sustainable solutions and construction costs to user effects

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**Sanja Burnazović**  
sanja.burnazovic@ssrs.si  
**Damjana Varšek**  
damjana.varsek@ssrs.si  
**Gaj Rak**  
gaj.rak@ssrs.si

Housing Fund of the Republic of Slovenia,  
Public Fund  
t: 01 471 05 00

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### 2.1 Introduction

The Housing Fund of the Republic of Slovenia implements the measures and activities of the housing policy at the national level, builds neighbourhoods and multi-apartment buildings, the purpose of which is to solve the housing problem of target vulnerable groups, such as young people, young families, families and the elderly, with a strong emphasis on ensuring high living quality and principles of sustainable construction. The public rental housing fund must reflect a quality built environment for several generations. In its own projects and investments, the Housing Fund of the Republic of Slovenia focuses on the construction of sustainable and energy-efficient buildings, whereby consideration of the life cycle of buildings is particularly important in the case of the construction of a fund of public rental apartments. The design of facilities takes into account all the factors that affect the quality design of a nearly almost zero-energy building (NZEB). The Housing Fund of the Republic of Slovenia, as a public investor in the area of construction of public rental apartments, tries to use target rents to ensure an effective relationship between sustainable and modern solutions, in accordance with legislative requirements and control of construction costs, which in the current state of the construction industry is a demanding and also difficult task.

In order to handle the fund of public rental apartments as carefully and efficiently as possible throughout the life of the buildings, the Housing Fund of the Republic of Slovenia has been introducing BIM standards in all phases of investment development for several years. The final product of the use of BIM processes thus represents a virtual twin of the building - a BIM object model, equipped with all the necessary information about construction, built-in materials and systems, as a basis for the digital and efficient management of multi-apartment buildings and neighborhoods. Smart installation systems are also gradually being introduced into buildings.

### 2.2 Projects and programs of the Housing Fund of the Republic of Slovenia for solving housing problems

The Housing Fund of the Republic of Slovenia implements housing policy measures and activities at the national level and is the main provider of the public housing fund. The Housing Fund of the Republic of Slovenia provides a public rental housing fund for target users (young people, young families, families, the elderly, etc.) in several ways:

- as an investor in own construction of rental apartments,
- in cooperation with municipalities and other applicants or providers from the Program for co-financing the provision of public rental housing units
- and the Program for co-financing the provision of housing units for the elderly,
- with the purchase of apartments and land for the construction of apartments following a public call and directly from known buyers (e.g. BAMT, bankruptcy proceedings, public auctions, exercising the right of pre-emption right according to paragraphs 3 and 4 of Article 154 of HA-1),
- by implementing public rental of apartments.

In the coming years, the Housing Fund of the Republic of Slovenia plans to increase the number of public rental apartments in sustainably acceptable buildings and neighbourhoods in all regions of Slovenia. To achieve this goal, several measures are planned in the field of construction of almost zero-energy buildings, co-financing or co-investment of investments in partnership with local communities, local public housing funds and other entities, as well as the implementation of own investments in the area of the whole of Slovenia. A nearly zero-energy building (NZEB) is a building with very high energy efficiency or a very small amount of energy required for operation, where the required energy is produced to a very large extent from renewable sources,

including renewable energy produced on-site or nearby. In pursuit of the goals of sustainable and highly energy-efficient construction, the Housing Fund of the Republic of Slovenia already in pursuit of the goals of sustainable and highly energy-efficient construction, the Housing Fund of the Republic of Slovenia already in 2017 built a nearly zero-energy building in the Zeleni gaj neighbourhood in Brdo in Ljubljana, namely the Model House in Functional Unit F3.

In 2021, the construction of 607 housing units in Ljubljana was completed with the projects of Novo Brdo and Gerbičeva Youth Community, of which 109 housing units for young people and 25 sheltered apartments for the elderly were provided. There are currently 531 public rental apartments under construction (of which 60 are sheltered apartments for the elderly), namely in Ljubljana, Maribor and Koper. The apartments will be completed in 2022 and 2023. By 2025, it is being planned to build a further of 589 public rental apartments (of which 28 are sheltered apartments for the elderly) in various locations across Slovenia (Novo mesto, Jesenice, Kranj, Lukovica, Nova Gorica, Lendava and Ljubljana). The Housing Fund of the Republic of Slovenia is also preparing long-term investments for 1,171 public rental apartments (of which 90 are sheltered rental apartments) in municipalities throughout Slovenia (Ljubljana, Novo mesto, Maribor, Kranj and Lendava), with construction starting in 2025.

Investments in the coming years depend on available financial resources from own operations, possible material or financial recapitalizations by the founder, receipt of non-refundable funds from the Recovery and Resilience Plan (NOO), obtaining loans from domestic or foreign banks, permissible amount of borrowing, which is currently limited to up to 50% of earmarked assets, earmarked budgetary resources and available personnel resources (Housing Fund of Republic of Slovenia is limited in recruitment by Personnel Plan for the public sector). The value of the currently planned investments in own construction of public rental housing is approximately EUR 500 million.

In the program of co-financing and provision of public rental apartments for the period 2022-2023, funds are provided for the realization of projects for the construction of new public rental apartments and for the reconstruction or purchase of buildings, as this enables a balanced offer of suitable public rental apartments throughout Slovenia. Municipalities, their budget funds, public real estate funds and non-profit housing organizations can apply for a long-term loan or co-investment to obtain funds under the programs in question, provided that the buildings are built or renovated to a modern standard and meet the criteria NZEB and achieve energy class at least B1.

Currently, from previous similar programs, projects in Ljubljana, Celje, Zreče, Koper and Slovenske Konjice are being completed with a total of 340 public rental

apartments  
– non-profit housing.

Due to the aging of the population and the special concern for solving the housing problem of the elderly, a co-financing program for the provision of units for the elderly has been established for the years 2022 and 2023. In this program, financial resources are also available in the form of loans and co-investments intended for the increase of places in homes for the elderly, the acquisition of sheltered apartments and the construction or renovation of day care centers. The following are entitled to financial resources under this measure: municipalities, public real estate funds, public institutes and other legal entities, but only for buildings built or renovated in accordance with modern standards, proven NZEB criteria and proven energy class of at least A2 (in the case of reconstructions at least B1). Through co-financing programs, 72 sheltered apartments are under construction and preparation in Šmarje ob Jelšah, Rogaška Slatina, Trbovlje and Velenje.

The public call for the purchase of apartments and land for the construction of apartments was adopted based on the guidelines of the Resolution on the National Housing Program 2015-2025 (ReNSP15-25) with the aim and goal of acquiring new public rental apartments throughout the Republic of Slovenia. According to the terms of the Public Call for 2022 and 2023, NZEB buildings and energy class of at least A2 are required. According to this Call, 67 apartments (of which 28 are sheltered apartments for the elderly) are under construction and preparation in several facilities in various locations across Slovenia (Ravne na Koroškem, Sv. Ana and Radlje ob Dravi).

## **2.3 Developmental and sustainable effects of the Housing Fund of the Republic of Slovenia**

As an active stakeholder, the Housing Fund of the Republic of Slovenia plays an important role in the field of energy efficiency and sustainable construction. For many years, it has participated in development and research projects at the national and EU level (CoNZEBs, SUPER-i, HAPPEN, INFINITE, etc.) and is also an active member of the association of the connected group SRIP Smart buildings and a wooden chain home (preparation of a model project - multi-apartment wooden building and smart building) and is the owner of its own brand TPSG (Technical conditions in residential construction). It also participates in the Steering Committee of Action C4.4 - Development of indicators of sustainable construction within the European project LIFE IP CARE4CLIMATE. It also cooperates with ministries and partner organizations as well as with international organizations and banks (CEB, EIB, OECD, HOUSING EUROPE, EFBS, NATIONAL CHAMBER OF COMMERCE, ZAVOD CER, FIAB-CI, ACER EMILIA ROMAGNA et al.) and thus expands its knowledge and gains foreign experience.

An important development effect is the implementation of the BIM (Building Information Modelling) standard in various stages of development and implementation of own investments with the goal of effective digital management and maintenance of facilities. Integral planning is based on the interdisciplinary and direct cooperation of all stakeholders, which enables cost- and time-appropriate planning and construction, and in connection with this, sustainable and energy-appropriate optimization of construction and use throughout the building's lifetime.

In the modern design of the living environment, we strive to build residential buildings that are friendly to the environment and provide the end user with a functional, pleasant and healthy living environment. Raising the technical quality of a residential building in an individual area makes sense if it is balanced and provides the user with a higher quality of living at reasonable costs and with as little environmental impact as possible.

For the entire duration of the facility, project solutions must enable economically justifiable and sustainable facility maintenance. As a priority, they must ensure the lowest possible operating costs of buildings (consumption of energy, water, landscaping of buildings, maintenance of playgrounds, etc.), with an emphasis on energy efficiency and ecological acceptability of selected systems and installed materials.

For project documentation in important phases (preliminary design and detailed design), we therefore use the Life Cycle Cost Analysis (LCCA). Since the Housing Fund of the Republic of Slovenia remains the owner of the buildings after construction and exterior design, and given that the apartments are for rent, the arrangements must also take into account the achievement of optimal costs for maintaining the neighbourhood.

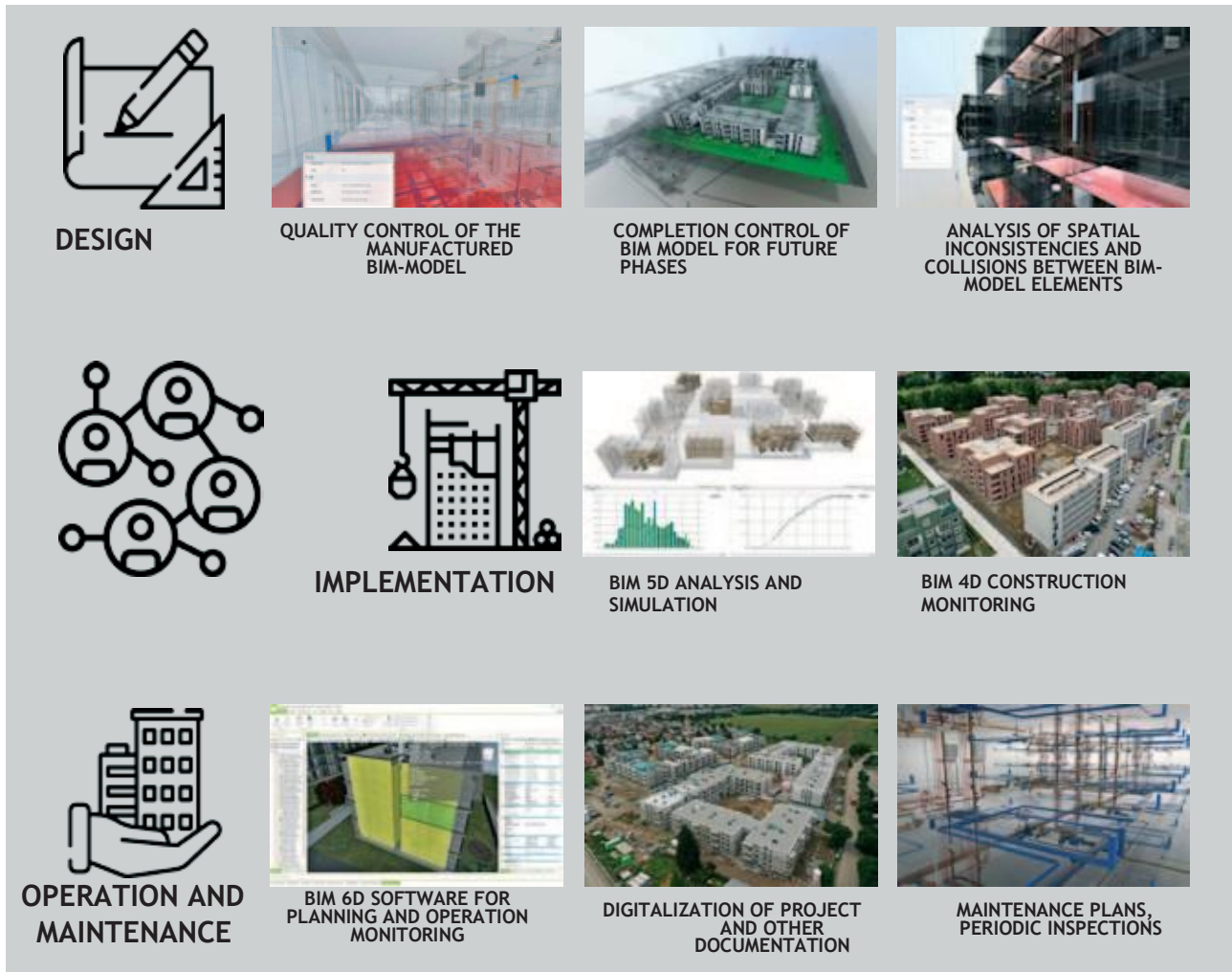


Figure 1: Poster of BIM Application in different phases of investment (internal material of the Housing Fund of the Republic of Slovenia)

In connection with energy efficiency requirements, the Fund's project task highlights in particular:

- high-quality planning of nearly zero-energy buildings,
  - high energy efficiency, a very small amount of energy required for building operation,
  - energy produced from renewable sources, on-site or nearby,
  - adequate energy orientation of the building, from an energy point of view, a favourable ratio between the area of the building's thermal envelope and the conditioned volume,
  - as many elements as possible, which passively contribute to low energy consumption - optimal ratio between glazed and opaque elements of the facade, selection of the most favourable arrangement, orientation, selection of colours, pleasant heating of rooms during transitional periods, etc.,
  - a mechanical ventilation system, which must enable the effective return of heat from the air,
- as a rule, centrally supplied hot water by using renewable energy sources,
  - efficient use of energy for lighting, ensured by natural lighting, if this is not possible, the use of energy-efficient lamps and associated elements and appropriate regulation,
  - in the project design, sustainable and energy-saving solutions must be foreseen and the requirements from the Regulation on Green Public Procurement must be taken into account,
  - it is necessary to achieve at least energy class B1 (15-25 kWh/m<sup>2</sup>a) of the energy indicator based on the annual heat required for heating (preferably at least class A2),
  - take into account the use of available highly efficient alternative energy supply systems, taking into account technical, functional, environmental and economic feasibility,
  - planning solutions for charging vehicles for the needs of users (cars, bicycles, motorbikes), installation of at least one charging point for electric vehicles per ten outdoor parking spaces is ensured.

### 2.3.1 Energy efficiency - own investments of the Housing Fund of the Republic of Slovenia

HFRS investments: completed and in progress - effects and goals:

- 1,241 housing units in 35 buildings,
- energy classes A1 to B1 (up to 25 kWh/m<sup>2</sup>a),
- annual CO<sub>2</sub> emissions in total approx. 470 kg/m<sup>2</sup>a,
- predominantly NZE buildings (nearly zero-energy buildings in accordance with the Act on the Efficient Use of Energy).

Investments in preparation and before implementation - effects and goals:

- NZEB,
- at least A2 class (up to 15 kWh/m<sup>2</sup>a),
- by 2025, the share of renewable energy sources shall be at least 75%,
- wooden windows (green public procurement),
- demo project - a wooden multi-apartment building.

There is no need to apply many systems to meet the energy requirements of NZEB. More important than the number of technologies is the appropriate optimization of technologies and their integration into a comprehensive building system, adapted for each individual building. Here, an integral planning approach is key, as each building is specific, and the requirements of NZEB can be achieved by using different combinations of systems, such as heat pumps, mechanical ventilation (with heat recovery), photovoltaic system and solar energy receivers.

Based on internal analyzes (Housing Fund of the Republic of Slovenia) and related to the achievement of the presented and legislative goals regarding sustainable construction and energy efficiency, we estimate that

construction costs have increased by at least 10-15%, mainly due to mechanical installations (mandatory mechanical ventilation with recuperation, technologies related to the use of renewable energy sources and other necessary measures). While analyzes show that the value of mechanical installations in relation to the total value of construction in the previous period represented a 12% share, now this share has risen to 18-20%, which represents a 60-70% increase in this part of the construction. Also, as a result, maintenance costs can be expected to rise throughout the lifetime of the facilities. There is also a significant increase due to the implementation of measures related to green public procurement, such as mandatory implementation of wooden joinery, which roughly increases construction costs by at least 3%.

For example, we indicate an average project-estimated value of the construction for one apartment, with an average usable living area of 60 m<sup>2</sup>, including a parking space in the building's underground garage, and taking into account all the requirements listed above. It amounts to approx. 125,000.00 euros excluding VAT. The average cost of an identical apartment of similar construction in completion amounts to approx. 110,000.00 euros. If we also include the costs of intelligent management of apartments and facilities (smart buildings) in the facilities under preparation, the value increases by an additional 2,000euros -3,000 euros per apartment.

Recently, due to the impact of the covid-19 epidemic and the war in Ukraine, as well as the general state of the economy, construction costs have been uncertain and unpredictable, which additionally affects the final construction costs and the controllability of the final investment values and consequently rents.

The Fund's own investments 2021-2023 (completed, in progress or with granted building permit)	Number of public rental apartments	Completion of the investment / handover to tenants	Energy class	NZEB building	Releases CO <sub>2</sub> (kg/m <sup>2</sup> a)
Residential neighbourhood Community for young people Gerbičeva, Ljubljana	109	2021	B1	NO	24
Residential neighbourhood Novo Brdo (areas E2 and E3), Ljubljana	498 (25 OS)	2021/2022	B1	NO	12-15
Residential neighbourhood Pod Pekrsko gorco, Phase 1, Maribor	212 (30 OS)	2022	A1	YES	14,5
Residential neighbourhood Pod Pekrsko gorco, Phase 2, Maribor	188 (30 OS)	2022/2023	A1	YES	14,5
Residential neighbourhood Dolgi most, Ljubljana	40	2022/2023	B1	YES ready	6,2
Residential neighbourhood Nova Dolinska, Koper	91	2023	A1	YES	12,7
Residential neighbourhood Podbreznik, Novo mesto	103	2024	A1	YES	14,3
<b>Total apartments</b>	<b>1.241</b>				

Table 1: Investments of the Housing Fund of the Republic of Slovenia: completed and in progress - energy effects

List of co-financing projects: Public call for the purchase of apartments and land for the construction of apartments Public purchase 2019, 2020 and 2021	Number of public rental apartments	Completion of the investment / handover to tenants	Energy Class	NZEB building	Releases CO <sub>2</sub> (kg/m <sup>2</sup> a)
Block of flats Lenart, Lenart	10	2019	B1	YES	15
Holm villas, Slovenj Gradec	20	2020	B1	NO	14,5
Residential building Radenci, Radenci	10	2020	B1	YES	14
Mozirski gaj, Mozirje	24	2020	B1	NO	50
Trate, Gornja Radgona	10	2020	A1	NO	11
Peca, Mežica	19	2020	B1	NO	20
Multi-apartment building, Sv. Ana	2	2020	B1	YES	11
Pod obzidjem, Brežice	6	2020	A1	NO	11
Kočevje residences, Kočevje	76	2021	B1	YES	2
Slovenska Bistrica facility	28	2021	A2	NO	58
Čardak, Črnomelj	30	2021	B1	YES	6
Ozare, Slovenj Gradec	40	2021	B1	NO	15
Harpf, Slovenj Gradec, sheltered apartments	27	2021	A2	NO	10
Kocljeva facility, Murska Sobota	27	2021	A2	NO	12
Dalgona, Podčetrtek	10	2021	B1	YES	12
Total apartments	339				

Table 2: Purchases of the Housing Fund of the Republic of Slovenia, completed construction - energy effects

List of co-financing projects: Public call for the purchase of apartments and land for the construction of apartments in 2022/2023	Number of public rental apartments	Completion of the investment / handover to tenants	Energy Class	NZEB building	Releases CO <sub>2</sub> (kg/m <sup>2</sup> a)
Vrata Javornika, Ravne na Koroškem	35	2023	A2	YES	12,26
Radlje ob Dravi, sheltered apartments	28	2024	A2	YES	8,46
Block 3 at Sv. Ana	4	2023	A2	YES	12,9
Total apartments	67				

Table 3: Purchases by the Housing Fund of the Republic of Slovenia, projects in progress - energy effects

### 2.3.2 Energy efficiency – purchases by the Housing Fund of the Republic of Slovenia

Public calls for the purchase of apartments and land for the construction of apartments in the period 2019-2021:

- 339 housing units in 17 buildings,
- energy classes A1 to B1 (up to 25 kWh/m<sup>2</sup>a),
- annual CO<sub>2</sub> emissions in total approx. 282 kg/m<sup>2</sup>a,
- 40% of buildings are NZE buildings (nearly zero-energy buildings in accordance with the Act on Efficient Use of Energy).

Public calls for the purchase of apartments and land for the construction of apartments from 2022 - 2023:

- 67 housing units in 3 buildings,
- NZEB,
- at least A2 class (up to 15 kWh/m<sup>2</sup>a),
- annual CO<sub>2</sub> emissions in total approx. 33.6 kg/m<sup>2</sup>a,
- by 2025, the share of renewable energy sources shall be at least 75%.
- 

### 2.4 Investments of the Housing Fund of the Republic of Slovenia - green components, energy models, smart buildings

A selection of some of the housing fund's own investments is presented below, with various built-in elements highlighted, or systems (e.g. green components, building energy model, central control system, intelligent management systems). Already in 2017, the Housing Fund of the Republic of Slovenia completed the first NZEB with built-in systems with a 100% share of RES for heating, partly wooden design and mostly passive apartments. It continued with a larger number of investments, to which it gradually added new sustainable and user-friendly elements, while trying to adapt to the current situation in the construction industry and to find suitable solutions for solving the housing problem of vulnerable groups of the population.

#### 2.4.1 Model house F3, Zeleni gaj na Brdu, Ljubljana

The neighbourhood of Zeleni gaj na Brdu developed in the south-eastern part of Ljubljana in the degraded area of the abandoned Viš brickworks on an area of 62 ha. 641 new apartments were built in functional units F2, F3, F4, F5 and F6. The neighbourhood is one of the most modern and pleasant residential areas in Ljubljana. We started designing the neighbourhood in 2007, and it took place in several phases until 2012. Construction of the neighbourhood took place in several phases until 2017. Most of the apartments were for sale, primarily intended for young families and young people.

Within the neighbourhood of Zeleni Gaj na Brdu, there is also an F3 multi-apartment building, called Model house, the first nearly zero-energy multi-apartment building of the Housing Fund of the Republic of Slovenia with 52 residential units.

One of the more important aspects of the Model House project is also the pursuit of the goals of sustainable construction, building energy efficiency, the use of renewable energy sources and the introduction of various modern mechanical installation systems. The building as a whole is low-energy with required heat for heating of 14 kWh/m<sup>2</sup>a, which places it in energy class A2. The building has a 100% share of renewable energy sources for heating. The main source of energy for heating is wood biomass - wood chips with the support of solar energy receivers, which contribute energy in favorable weather conditions. Part of the building (one lamella) primarily uses an air-to-water heat pump for heating and domestic hot water, which switches to a boiler with wood biomass in adverse weather conditions (air temperature below 0°C). Most apartments have built-in individual mechanical ventilation with recuperation, and individual ones have hygrosensitive ventilation. 31 apartments with mechanical ventilation with recuperation are built in a passive standard, including obtained PHPP certificates, the rest of the apartments are low-energy. Passive apartments complied with the conditions of the ECO fund for obtaining a subsidy for the purchase of an apartment.

Construction costs amounted to approx. 7.3 million euros (excluding VAT), which is approx. 130,000 euros per apartment (including parking spaces in the building's underground garage). At the same time, we would like to point out that the building is partly made of wooden construction, with innovative architectural and material solutions, which is consequently reflected in the higher cost of construction compared to the usual construction costs of NZEB buildings.

As part of the project, it is also planned to monitor the building's key sample parameters during the first years of use, the residents' response, which will give us feedback on the success of the project's goals (evaluation). Monitoring is carried out for all elements of the exemplary building: energy efficiency, architectural design, use of materials and sociological aspects. With measurements, we monitor the consumption of all types of energy (biomass, heat pump, SSE, electricity, etc.) and water consumption at the facility level. We want to obtain information about the quality of living in apartments by measuring living comfort and conducting surveys.

Due to the difficulty of implementing monitoring during the covid-19 epidemic (processes were practically interrupted), the Housing Fund of the Republic of Slovenia will obtain the final report on the implementation of monitoring by the end of this year.

With this project, we also gained our first experience related to the management of the NZEB. In order



to better educate the residents, upon handing over the apartments and during the initial year of use of the apartments by the users, we ordered an additional service from the manager to train the residents in handling devices for a quality stay and energy efficiency in the apartment. The additional training of users proved to be effective and was received positively by them.

In 2021, the Housing Fund of the Republic of Slovenia made an energy analysis of the model house F3 and obtained an energy certificate of the bEQ type "in operation", which showed significant deviations in relation to the calculations of the energy parameters, on the basis of which experience was also drawn for new projects. Nevertheless, Model House F3 achieves above-average energy performance according to the published Energy Certificate according to the international ASHRAE bEQ system "in operation".



Figure 2: Model house F3, Zeleni gaj na Brdu, Ljubljana (Kambič, 2017)

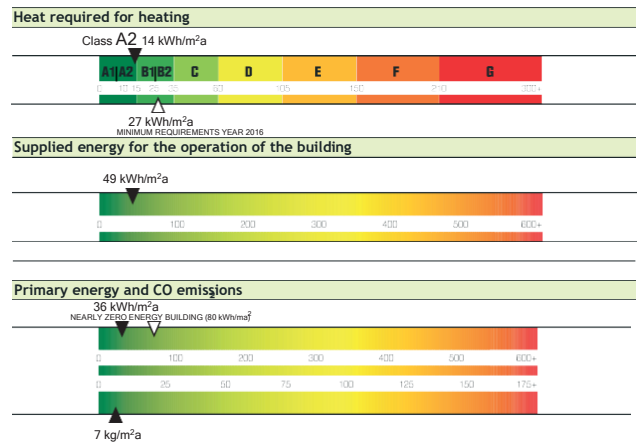


Figure 3a: Energy Certificate, Model house F3, Zeleni gaj na Brdu, Ljubljana (Housing Fund of the Republic of Slovenia)

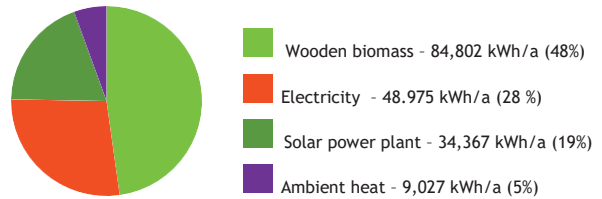


Figure 3b: Structure of total energy use for building operation by energy sources and energy products [kWh/a] (Housing Fund of the Republic of Slovenia)

1. The actual required supplied energy for heating needs is several times higher than predicted by the calculated energy certificate -  $59.6/1.148 = 52.2$  kWh/m<sup>2</sup>a versus 14.0 kWh/m<sup>2</sup>a.

2. The actual supplied energy for domestic hot water is almost double the value from the energy certificate -  $43.9/1.14 = 38.5$  kWh/m<sup>2</sup>a versus 20.0 kWh/m<sup>2</sup>a.

3. Considering the properties of the building envelope, which already includes more than adequate energy properties according to the requirements of modern rules of the profession, as well as the airtightness verified by testing, it does not make sense to implement any improvements in this area.

4. The reason for the difference in the required energy for heating can rightly be found in the heat losses caused by the heating distribution system during the heating period over the whole year. It means that in future projects, more attention should be paid to the thermal insulation of the distribution system of heating and preparation of domestic hot water. Taking the sum of both heats into account, the ratio between the actual consumption of 103.5 kWh/m<sup>2</sup>a and the calculated forecast of 38.0 kWh/m<sup>2</sup>a is 2.72!

5. In addition to the thermal insulation of the distribution network from the previous point, the reduction of the required energy for building heating can only be achieved by providing exclusively mechanical ventilation with the capture of the heat of the discarded air. The current share of such ventilation is now around 70%. In the case of urgent energy utilization, technical solutions with an energy (enthalpy) efficiency of energy exchange between the two air streams of at least 60% must be sought.

6. In order to ensure real comfort in the room, the minimum prescribed requirements from established standards regarding system performance must be increased by 30%. As presented in the previous point, depending on the needs, the periodically increased amount of air will not represent the annual increased required energy for operation.

7. To ensure the mandatory implementation of the NZEB, everything presented in the previous points is a basic prerequisite. In any case, it is clear that according to the valid ANs NES 2020, it is not possible

to achieve the set RER criterion of 50% without ensuring the share of renewable energy in district heating systems and gas pipeline networks by the distributors. As it follows from the analysis of this functional unit, the solution is topologically appropriate, but at this moment it is not consistent with for example the Decree on priority use of energy sources for heating in the area of the Municipality of Ljubljana (OG RS, no. 41/16) or other LEK according to the RS. As a rule, the use of natural gas and district heating systems (at least in cities) cannot be given up.

8. According to the issued Energy Certificate according to the international ASHRAE bEQ system, the building achieves above-average energy properties in relation to the median placed there. In fact, it reaches a value of 60% in terms of the total required energy.

9. The annual maintenance cost of the mechanical and technical systems used (central boiler room with all additional systems and mechanical local ventilation with waste air heat capture) amounts to €2.7/m<sup>2</sup>a. The average consumption of drinking water is 45 m<sup>3</sup>/person per year, which should be taken into account in the future planning of buildings.

10. Based on the experience with the technical systems of functional unit F3, the use of the SSE system for multi-apartment buildings is not suitable. At least not the method used in this building, i.e. by central heating of water, which requires a (too) high preflow temperature (65 °C). It might be suitable only for the preheating of domestic hot water or exclusively for the needs of underfloor heating.

11. The average consumption of total electricity in apartments is 25.9 kWh/m<sup>2</sup>a, in common areas 9.6 kWh/m<sup>2</sup>a. It is calculated that the part intended for lighting amounts to 3.5 kWh/m<sup>2</sup>a, and the part intended for driving mechanical devices, 5.0 kWh/m<sup>2</sup>a." (Lenassi, 2021)

#### 2.4.2 Pod Pekrsko gorco, Maribor

In the southern part of the city of Maribor, near the famous Pekrska gorca, the Housing Fund of the RS is completing the new residential neighbourhood Pod Pekrsko gorco. 400 new rental apartments in the size of 35-80 m<sup>2</sup> will be built. Implementation of the works of the 1st phase, which includes 212 public



Figure 4: Pod Pekrsko gorco neighbourhood, Maribor, view from above, May 2022 (Matevž Lavrinc s.p.)

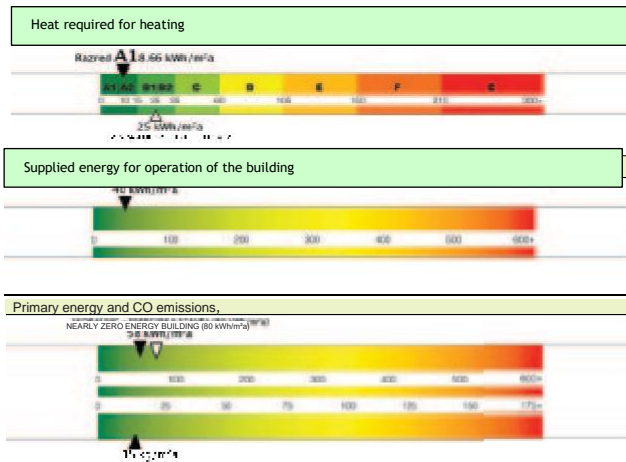


Figure 5a: Pod Pekrsko gorco, energy certificate (Housing Fund of the Republic of Slovenia)

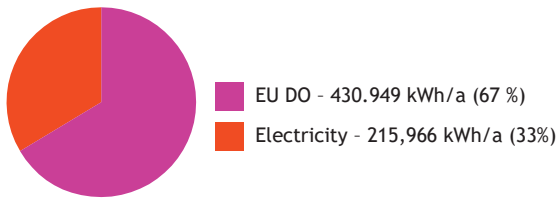


Figure 5b: Structure of total energy use for building operation by energy sources and energy products [kWh/a] (Housing Fund of the Republic of Slovenia)



Figure 6: Pod Pekrsko gorco, Maribor (internal material of the Housing Fund of the Republic of Slovenia)

rental apartments, of which 30 are sheltered apartments for the elderly, is in the final phase, a technical inspection is scheduled for the beginning of July. The construction of the 2nd phase of the neighbourhood will be completed by the end of 2022, providing an additional 188 public rental apartments, of which 30 will be sheltered apartments for the elderly.

To the greatest extent possible, the neighbourhood is planned with the aspect of sustainable construction in mind. The sustainability of the building is manifested in the efficient use of energy and the installation of durable materials, lifelong use and adaptability, low maintenance costs, adaptation to the mobile forms of the future and adaptation to climate change. During the planning phase using BIM technology, project solutions were also checked with the help of life cycle cost analysis (LCCA). The solutions that represent the best choice in terms of the balance between construction costs and the costs of maintenance and use of the facilities were chosen. On the basis of such checks, ventilation systems, smoke and heat extraction systems, prefabricated sanitary cabins and balconies were selected. A project using BIM technology is the foundation for a quality project and rational design. Verification of design solutions from the point of view of implementation and especially the use of facilities ensures control over the expected investment and costs in the lifelong use of the facility.

The neighbourhood is nearly zero-energy (NZE) with an achieved energy class A1.

In the following, we highlight the sustainability and energy effects achieved:

- energy class A1 (8.66 kWh/m<sup>2</sup>a),
- annual CO<sub>2</sub> emissions - 15 kg/m<sup>2</sup>a/building,
- Nearly zero-energy building - Act on efficient use of energy,
- controlled central mechanical ventilation (above-ground and underground part of the building),
- energy-efficient apartments with low operating costs;
- intergenerational bonding,
- many green and outdoor areas,
- readiness for e-mobility,

- pre-installations for a photovoltaic system;
- BIM design in all phases,
- preparation of PID BIM for digital management,
- financial monitoring of the project throughout its life cycle.

Green components of the project:

- significantly lower emissions during operation: effective shading, green areas and planting reduce the need to cool apartments;
- an energy-efficient building reduces the need for heat supply, which in turn contributes to lower emissions;
- pre-preparation for e-mobility for each apartment and bike shed encourages users to use alternative modes of mobility;
- the design of all apartments according to the principle of universal construction contributes to the reduction of greenhouse gas emissions, because there is no need to build special apartments for the disabled people or it is not necessary to move residents in case of need for such an apartment;
- the urban-architectural design with landscaping enables the preservation of existing natural habitats (greenery and meadows) and, with well-thought-out planting, also the expansion of new habitats characteristic of the surroundings;
- all standards and measures for water protection are taken into account (oil catchers when collecting water from roadways, water consumption regulation for toilet flushers, etc.);
- the facilities are supplied exclusively from an energy-efficient district heating system, most of the heat for heating is produced directly or indirectly from renewable energy sources;
- the facility complies with the concept of a circular economy, mainly because it takes into account the recycling of waste both during construction and during the use of the building, especially with the use of prefabricated elements, which significantly reduces the consumption of various materials and waste. The amount of construction waste will be reduced to the minimum possible, waste construction material will be properly removed and recycled.

The rationality of the solutions used and the thoughtful selection of technologies and materials and systems used are also demonstrated

in construction costs, which amount to approx. 110,000 euros per apartment of an average usable residential area of 60 m<sup>2</sup>, including a parking space in the building's underground garage, excluding VAT.

The course of construction was greatly affected by the covid-19 epidemic. Although the construction on the site never stopped, the consequences related to the availability of materials, lack of labour, rising prices of materials, as well as legislative measures to mitigate the consequences shape the fate of construction in the final stages. The good intention of the legislator, who allowed all contractors paid from public funds to extend the execution of works during the duration of the epidemic, turned out to be a big problem. In the case of an extension of the deadline, the client himself bears the costs associated with the loss of income due to the delay, and the contractor thereby avoids contractual penalties. Thus, the contractor can overcome labour shortages and delays in material deliveries. The problem arises if the contractor believes that he can extend the construction for the entire duration of the epidemic, regardless of the demonstrated problems and without providing evidence. In this case, the legal provision becomes a tool for blackmailing the client, with which contractors try to extract additional benefits. The changed working conditions in the construction industry have become a reality and a big problem for construction companies and, consequently, contracting authorities. This means significantly greater risk and burden for contractors in ongoing construction contracts and often results in unreasonable and unfounded requests for increases in contract values. Regardless of the situation, we, public contracting authorities are obliged to consistently observe valid contracts and legal obligations. Agreeing to the unfounded demands of the contractors to increase the contract prices would be reflected in unsustainable price increases for the project and, in the case of the Fund, consequently higher rental prices for apartments intended for vulnerable groups of the population.

### 2.4.3 Youth Community Gerbičeva, Ljubljana

In 2021, the Housing Fund of the Republic of Slovenia completed the construction of a pilot project of the Youth Community Gerbičeva on Gerbičeva Street in Ljubljana (in the area of the existing Student's Dormitory Vič and Ljubljana Student Dormitory), with 109 housing units intended for the residential independence of young people from 18 to 29 years of age.



Figure 7: Youth Community Gerbičeva (Kambič, 2021)

In addition to the emphasis on the concept of youth living, the pilot project with a varied program is also intended for intergenerational cooperation, with which we want to encourage solidarity, trust and mutual assistance between generations and, as a result, establish more effective joint action.

With simple functional solutions, the maximum quality of living is ensured in the new facility. The multifaceted design enables the creation of apartments adapted to the needs of young people, which ensure a high degree of privacy and also enable different levels of connection to the community. It is characterized by pleasant views into the green atrium, and the formation of various larger communities is possible.

For the needs of heating and cooling and the sanitary hot water, a common gas heating station with a multi-boiler system using natural gas is provided on the ground floor of the building in the technical room. Fan convectors are installed as heating and cooling units in the living units, and the heating of the common rooms on the ground floor is provided via underfloor heating and

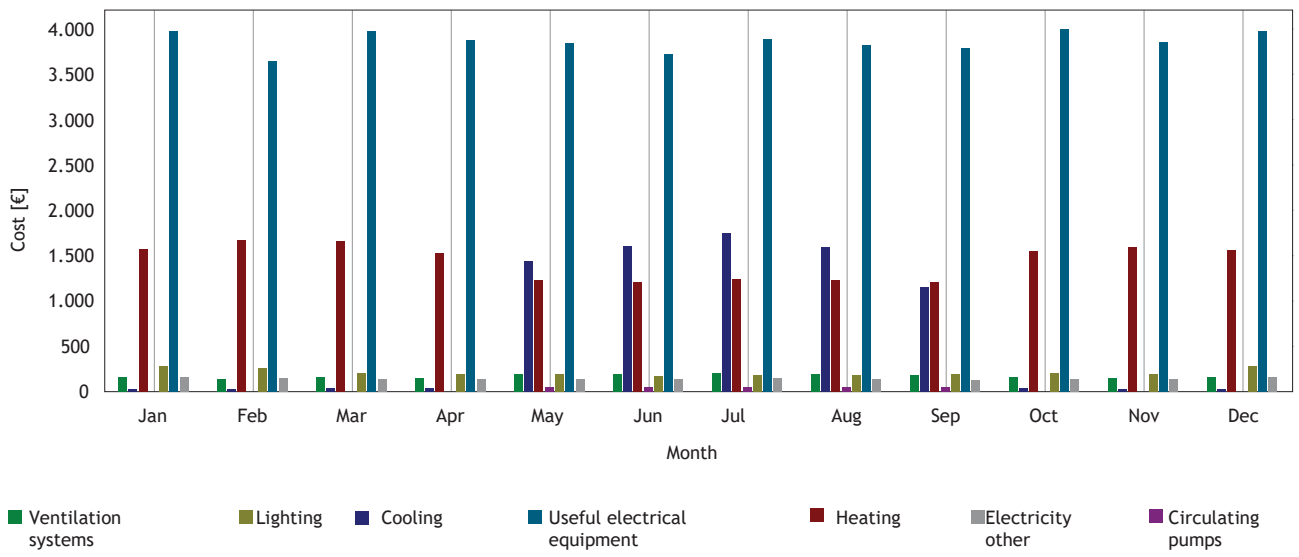


Figure 8: Simulation of monthly costs by individual technical system (Lenassi, 2021)

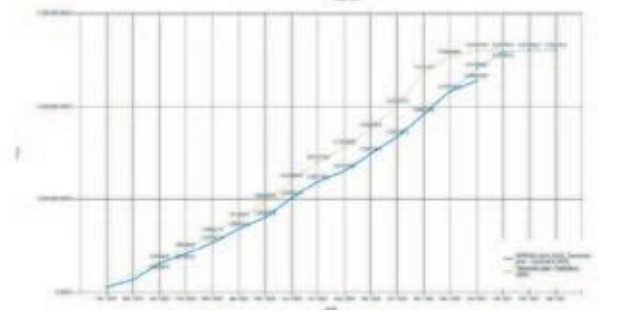
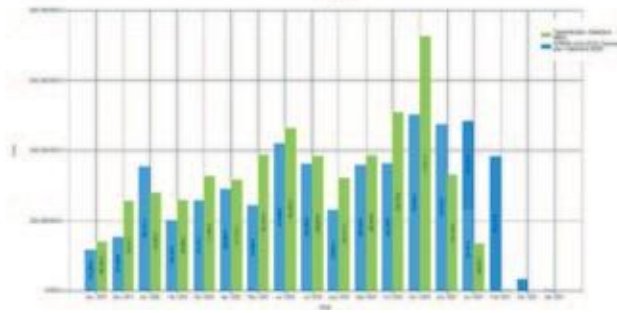
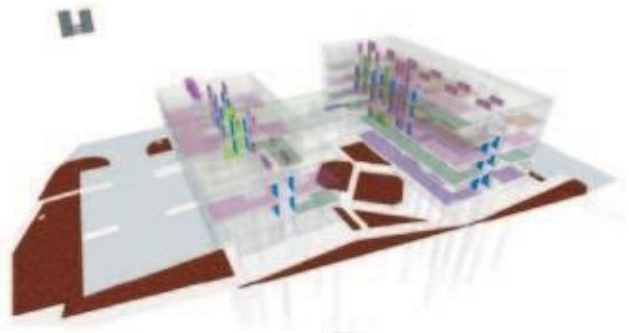


Figure 9: BIM monitoring of construction (internal material of the Housing Fund of the Republic of Slovenia)

optionally with convectors, which are primarily intended for room cooling needs. The living units are ventilated by mechanical ventilation with hygrosensitive regulation. The air supply comes into the living units via the window supply elements built into the upper part of the window frame, while the air extraction from the bathrooms is made possible by exhaust elements.

The design of the building takes into account the principles of sustainable coexistence and mobility, as there are four charging points for electric vehicles intended for car sharing on the parking spaces, and bicycle shelters are installed on the north side of the building.

The roof is a green flat roof with extensive greening and minimal slopes, as well as built-in sensors to monitor the humidity level in the layers of the flat roof. An integrated moisture sensing system provides a specialized approach to the management and maintenance of the green roof throughout the life of the building.

In order to monitor, control and manage individual systems, the building has a built-in central control system that covers the heating, cooling, ventilation and air-conditioning systems, convectors in the residential units and enables analysis and monitoring of parameters via built-in meters. The investment value of the central control system is 110,000.00 euros (excl. VAT), which is 2.15% of the construction value of the building or approx. 50 euros per square meter of living space.

At the level of residential units, there is an advanced management system with the help of built-in sensors and executive elements, mainly in order to optimize energy consumption depending on the occupancy of the residential unit. Advanced management of the equipment in the residential unit thus covers the management of the heating, cooling and switching on/off the consumers whose power supply is not necessary in the absence of the user. Sensors are also built in windows, which, when the window is open switch-off the convector after a certain time.

People live in the building for the first year, we are getting the first experiences and reactions from young users. Leaving in a rather technologically different building brings young tenants an optimized or economical living environment and also new (unfamiliar) handling of technologically more demanding devices or strict adherence to individual rules. The way of living in such a building is adapted to modern principles and requires a change in existing habits, and also poses new challenges and obligations for the mutual cooperation of the manager and tenants in the first pilot facility, intended to solve the housing problem of young people.

The building, with an annual heat requirement of 23 kWh/m<sup>2</sup>, is classified as energy class B1. From an energy point of view, the features of the building on Gerbičeva Street were foreseen to be high occupancy density, central cooling of living units by using fan convectors and

mainly humidity-sensitive negative pressure ventilation. It was these things that led to the creation of an energy model of the building, on the basis of which an own database with the energy characteristics of buildings will be established, with the aim of predicting the required energy for the normal operation of the building and later also for monitoring the achievement of the planned parameters and comparison with other multi-apartment buildings.

"Energy modelling of buildings includes the use of scientific methods and analytical tools to make an estimate of the required energy for a building and for the costs for its operation, built from certain materials, with certain technical systems installed, placed in a certain geographical area and operating according to given schedules. Simply put, a building is built on a computer from its individual assemblies and a simulation is run by managing the building on default schedules over a year

through characteristic weather conditions from hour to hour, a total of exactly 8760 hours" (Lenassi, 2021).

The Housing Fund of the Republic of Slovenia works in the field of BIM technology as a promoter for development in the implementation segment of the BIM standard for the field of residential construction, primarily with the aim of increasing the efficiency and transparency of construction investment management. The Gerbičeva project is also entirely designed in BIM technology, i.e. from planning, execution to use and operation of the building. During construction, BIM technology was used to monitor the schedule and financial (4D and 5D) construction. A comprehensive PID BIM model is provided for the operation and maintenance phase.

#### 2.4.4 Dolgi most, Ljubljana

The Housing Fund of the Republic of Slovenia is building two multi-apartment buildings with a total of 40 public rental apartments at the Dolgi Most location (next to the Za progo Street) in Ljubljana, on a plot of 4,602 m<sup>2</sup>. Each unit will be built from a basic ground-floor building, which is intended for residents' parking. Two two-story multi-apartment slats will be placed on each parking house. On the ground floor of the roof of the parking facility, a green atrium is planned between the residential slats, which will be an internal common outdoor space for the residents. The apartments are on the first and second floors. The floor-plan organization of the apartment enables two-sided orientation of the living spaces. Each apartment also has an outdoor space - a balcony. A building permit has been granted for the construction of buildings. In July 2021, the Housing Fund of the Republic of Slovenia started construction in the "design and build" manner. Facade cladding and other crafts are currently being carried out. Construction is expected to be completed by the end of 2022.

The buildings are designed to achieve energy class B1, NZEB



ready. Considering the fact that the use of the gas pipeline is prescribed by the decree of the MOL as a priority, the legislation obliges the gas distributor to ensure an appropriate share of biogas in its network in the future period, the Housing Fund of the Republic of Slovenia is of the opinion that as an investor it has fulfilled its part of the obligations and therefore, the buildings are currently NZEB ready, they will be completely NZEB when the distributor fulfills its share of renewable energy sources.

For the investment in question, the Housing Fund of the Republic of Slovenia decided to implement a system of intelligent installations, which will be combined into a central control system via a smart application. The system will enable the Fund and the tenants to carefully and economically manage the facilities. Based on remote data, the Housing Fund of the Republic of Slovenia will also be able to determine the suitability of living conditions in individual apartments and will be able to implement measures aimed at effective management and maintenance throughout the entire life of the buildings.

The smart system will be installed in each apartment separately and in the shared electrical distribution box. A weather station will be installed on the roof, which will transmit information to each individual apartment. The system is not only intended to control individual functions, but also to control the condition and comfort of the apartments.



Figure 10: Dolgi most, Ljubljana, neighbourhood, aerial view, May 2022 (Matevž Lavrinc, s.p.)

In addition to control and monitoring, signaling is also connected to the system in the event of failure of the following systems: recuperators, gas boiler room and gas central. The following functions are integrated into the system: lighting of the garage, stairs, corridors and external lighting; apartment blinds; hardware devices of apartments. The CCS system will monitor and manage the following segments: lighting of common areas, sensing humidity, temperature and air quality in all rooms, operation of mechanical devices, control of blinds (preparation), alarming (gas installation, recuperators), recording of various events.

All data and statuses of lighting, blinds, and air conditioners will be displayed on the smart application. Through it, it will be possible to: set the switch-on/off of the described systems, operating modes, inspection of facility operation (ventilation, heating stations), alarms, warnings, etc. Applications will be separate, for each housing unit separately. Also, the authorized administrator of residential buildings will have access to the entire application of all meters and installations of common areas.

Based on the SRI (Smart Readiness Indicator for Buildings) standard, the degree of digitization of an individual building is determined by evaluating the degree of digitization of an individual process in the building (heating, cooling, ventilation, lighting, blinds, control and management from a common place). The degree of digitization of an individual process can range from 0 to 4. The proposed digitization system at the Dolgi Most location provides the maximum rating according to the SRI standard for the processes of heating, ventilation, and control and management from a common location.

The installation is estimated at approx. 2,000 euros per residential unit, excluding VAT.

## 2.5 Problem of price increase in the construction industry

The Housing Fund of the Republic of Slovenia is the main implementer of the national housing policy in the Republic of Slovenia. We are currently completing the construction of 400 apartments Pod Pekrsko Gorco in Maribor in two phases, the construction of 40 apartments is underway at the Dolgi Most location in Ljubljana, and we have started the construction of 91 public rental and non-profit apartments (together with the Public Housing Fund of the Municipality of Koper) at the Nova Dolinska location in Koper, and we are in the process of obtaining a building permit for the construction of three buildings with 103 apartments in Novo mesto, with construction scheduled to begin by the end of the year. At the same time, we are preparing investments with construction scheduled to start in 2023 and 2024 at locations in Jesenice, Lukovica, Ljubljana, Kranj, Nova Gorica and Lendava.

As a construction investor and at the same time a person under public law who is bound to respect public procurement and legislation, we addressed a letter to the Chamber of Commerce of Slovenia in January 2022 and warned them about the problems that we contracting authorities are facing due to the current situation related to the covid-19 epidemic and the measures adopted by the Government of the Republic of Slovenia to mitigate the consequences of the epidemic, and called upon them to act sensibly and resolve the issues amicably.

We have not receive an answer to the request yet, in the meantime, due to the war in Ukraine, the situation in the economy and in the construction industry has drastically

worsened due to the increase in energy prices, construction materials, difficult supplies and transports (e.g. reinforced steel in Slovenia cannot be supplied, the price has been increasing drastically), lack of labor force and others. We receive announcements from almost all project contractors that circumstances for the realization of construction contracts have changed as well as requests regarding price increases and extension of contract deadlines (individual are also unjustified by using the given options for extending deadlines according to ZIUZEOP and ZIUPOPdVE and showing price differences). Considering the trend of high price growth

in the construction industry (e.g. the average index for residential construction of the Slovenian Chamber of Commerce rose by 15.6% in 2021, and by 12.87% in the first five months of 2022 alone), the execution and completion of investments is strongly threatened with unmanageable financial consequences for HFRS. We also encounter similar situations in public programs, where we act as a co-investor in the construction of public rental non-profit apartments together with municipalities, municipal funds and non-profit organizations, and as a buyer of apartments following a public call for the purchase of apartments and land for the construction of public rental apartments.

## INVESTMENTS IN PUBLIC RENTAL HOUSING

National Housing Program Resolution 2015-2025 was adopted with the aim and goal of regulating the situation in the housing sector. The role of the main contractor of the national housing policy was entrusted to the Housing Fund of the Republic of Slovenia, (hereinafter: Fund). The basic goal of the Fund is to ensure a balanced offer of suitable rental apartments for vulnerable groups of the population, preferably young people, young families, families and the elderly population. We want to provide the users of apartments with the maximum quality of living at reasonable costs and with as little environmental impact as possible.

Fund provides public rental housing by:

- investing and building own rental apartments
- co-financing the projects in cooperation with municipalities in the framework of Program for Co-financing Public Rental Apartments and Program for Co-financing the housing units for the elderly
- buying on the basis of the Public Call for the purchase of apartments and land for the construction of apartments

The fund follows important priorities in the field of buildings, such as energy efficiency, use of renewable energy sources, assessment of environmental impacts during the life cycle of buildings, consideration of all costs of buildings throughout their life cycle, improvements in the use of resources and energy during the life cycle... When designing buildings, we take into account all factors that influence the quality planning of a nearly zero-energy building (NZEB).

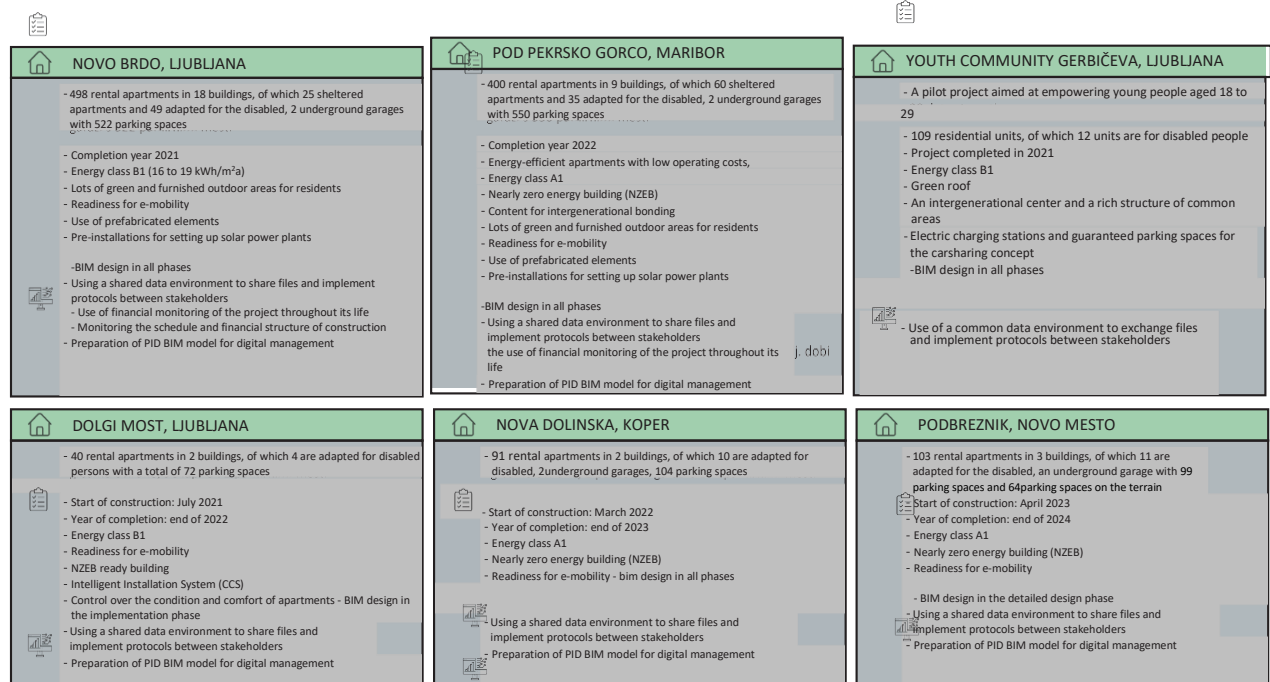


Figure 11: Poster Investments in public rental housing (internal material of the Housing Fund of the Republic of Slovenia)

## 2.6 Conclusion

Based on the experience of the Housing Fund of the Republic of Slovenia to date, we can summarize that living in a sustainable NZEB brings residents a better living environment, constantly ventilated, fresh, bright spaces with lower costs for energy sources, more responsible behaviour in relation to the environment and greater independence from changes in energy prices. For owners, tenants and managers, it also brings other challenges of mutual cooperation, obligations and innovations, especially more uncertainty regarding the handling of devices in the apartment and building due to more technologically demanding equipment and lack of familiarity with it. The same applies to smart installations. Additional training of residents is needed for the needs of changes in the way they live and for handling equipment and devices in apartments, as well as for managers who manage common devices in buildings. It is also necessary to understand that staying in such facilities means additional maintenance costs, as more work is required with its management and maintenance due to more installed equipment.

The Housing Fund of the Republic of Slovenia, as an implementer of housing policy measures and activities at the national level and an active stakeholder in the market, builds neighbourhoods and multi-apartment buildings, the purpose of which is to solve the housing problems of vulnerable target groups, such as young people, young families, families and the elderly, with a strong emphasis on ensuring high quality of living and principles of sustainable construction and has an important development role in the field of energy efficiency (NZEB), sustainable construction, the introduction of BIM technologies and the implementation of smart buildings. The goal of the Housing Fund of the Republic of Slovenia is the construction of NZEB with at least B1 energy class, in newer projects A2, taking into account green components, regardless of the method of providing public rental housing.

Finally, we point out that due to the complex situation in the construction industry, it will be difficult for us to achieve the expected goals and continuously ensure the desired number of public rental apartments on an annual basis. We see the solution in the form of systemic solutions and measures of the state with the aim of a fair regulation of relations in these challenging times, which, due to the use of European funds (Resilience and Recovery Plan), are also a time of development and realization of many public construction investments, if the approach will be based on establishing an environment of fair business.

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