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2022

ON THE SYSTEMIC ORGANIZATION OF MODERNIZATION OF THE MULTI-DWELLING HOUSING STOCK IN KAZAKHSTAN FOR THE PURPOSE OF DECARBONIZATION

The article touches upon the problem of organizing a comprehensive thermal modernization of residential apartment buildings in Kazakhstan. The importance of solving this problem in terms of Kazakhstan's commitments to decarbonization and achieving carbon neutrality is substantiated, the main barriers and solutions are described. For the first time, the issue of thermal modernization of residential buildings is raised as a systemic process that affects not only buildings built 30–50 years ago, but also buildings currently being built, the stage of modernization of which will begin in the near future. Key recommendations are given for Kazakhstan on the organization of large-scale energy modernization, taking into account the accumulated international experience. *The article was written within the framework of the project funded by the European Union "PROMHOUSE – Promoting professional housing management in Kazakhstan and Uzbekistan".*

1. The structure of multi-dwelling housing stock in Kazakhstan

According to the Bureau of National Statistics [16], for 2020, the number of multi-dwelling units in the republic is 308,240, of which 128,589 or 41.7% are in urban settlements, and 179,651 or 58.3% are in rural settlements. The largest number of multi-dwelling units (MDU) is concentrated in Almaty, Karaganda, Almaty, and in East Kazakhstan regions.

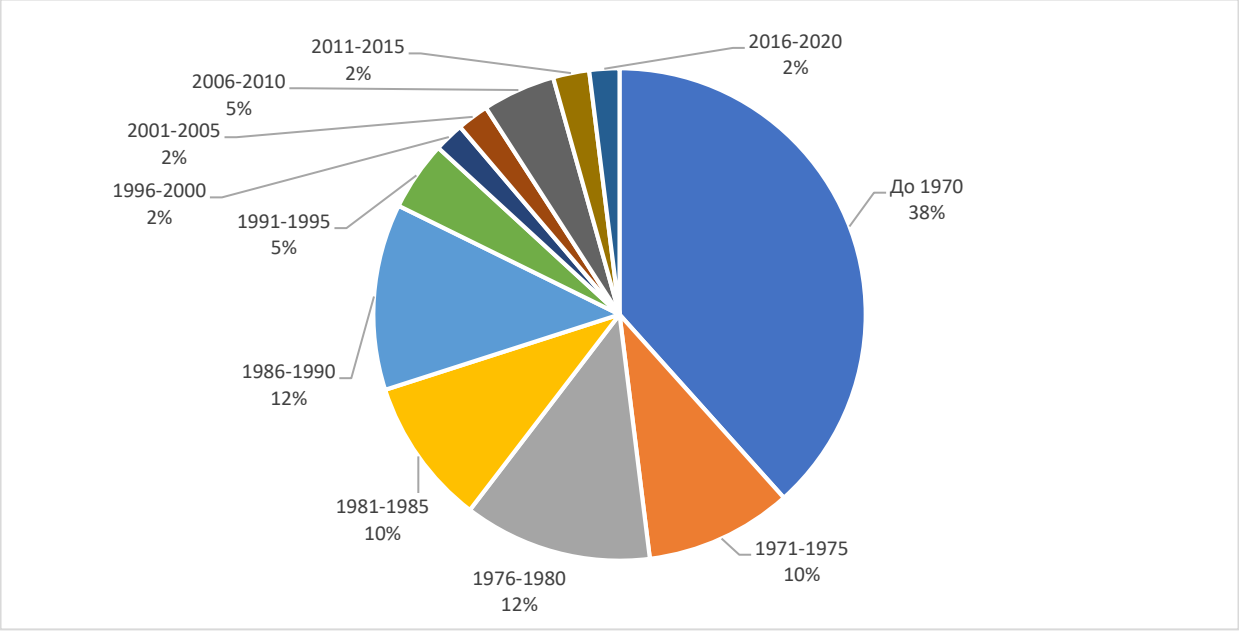

Fig. 1. Share (%) of multi-dwelling units by year of commissioning

As is known, the buildings built in 1950-1990 in Kazakhstan were erected without regard to energy saving. Over the past 20 – 30 years, the energy modernization of this housing stock has not been carried out [15]. The share of residential buildings built before 1990 in Kazakhstan is significant and reaches 82% (see Fig. 1).

The year 2004 is considered a turning point in the energy efficiency of buildings, when Kazakhstan introduced a document SN RK 2.04-21-2004* "Energy Consumption and Thermal Protection of Civilian Buildings" [16].

Thus, it can be assumed that residential buildings built before 2005 require increased attention in terms of energy consumption, and such houses are in the vast majority – 91% (see Fig. 1).

2. Situation with energy efficiency in MDUs

A significant part of the housing stock in the cities of Kazakhstan consists of multi-dwelling units with centralized heat and power supply built using brick, large-panel, large-block material in external walls, as well as monolithic reinforced concrete [16]. This housing stock is becoming obsolete from year to year and requires renovation with elements of thermal modernization, which will significantly increase the energy efficiency of buildings and, as a result, will lead to a reduction in greenhouse gas emissions from this sector. According to local executive bodies, 72% of the housing stock of the Republic of Kazakhstan is in a satisfactory condition, 23% are subject to major repairs, 2% are in disrepair, and 3% are repaired houses.

Despite these seemingly good indicators, experts note that the vast majority of existing residential multi-dwelling units require improvement in thermal performance.

In Kazakhstan, the consumption of thermal energy in buildings is about 240 kWh/m2 per year (for comparison, this figure in Sweden is 82 kWh/m2 per year, in Germany - 120, in France - 126, in England - 130). Buildings, primarily in the residential sector, consume approximately 13.6% of electricity and 40% of heat energy [3]. Of course, this is partly due to the rather harsh climate in winter in a large part of the country, as well as long hot and dry summers in the south, center and west of the country. All this necessitates the consumption of a significant amount of thermal energy for the needs of heating buildings in winter, as well as electrical energy for cooling purposes in summer.

In 2010-2013, in Kazakhstan, a massive energy audit of residential buildings was carried out, which showed a large consumption of thermal energy in multi-dwelling units: for example, the average thermal energy consumption in Almaty is 136 kWh/m2 per year, in Atyrau – 181 kWh/m2 per year, in Kokshetau – 257 kWh/m2 per year (according to AO "Kazakhstan Center for Modernization and Development of Housing and Communal Services").

In 2011-2017, with the support of UNDP-GEF projects and the Government of the Republic of Kazakhstan, an energy audit/energy inspection of a number of residential multi-dwelling units located in different cities of Kazakhstan was carried out. Information on the energy consumption of the surveyed residential buildings is given by us in Table 1.

Table 1

Heat energy consumption (kWh per 1 sq.m) in multi-dwelling units located in different cities of Kazakhstan in comparison with the requirements of SNiP RK (building regulations of the Republic of Kazakhstan)

No.	Number of storeys	Wall material	Year of construction	City	Actual heat energy consumption (kWh/m2 per year)	Requirements of SNiP RK[1] for class "C-" (highest allowable number kWh/m2 per year)	Deviation from the norm (%)	Energy efficiency class
1	9	reinforced concrete panel	1988	Karaganda	230	142	38	E
2	4	reinforced concrete panel	1969	Almaty	264	97	63	E
3	5	brick		Astana (Nur-Sultan)	266	168	37	E
4	3	brick	1959	Karaganda	290	166	43	E
5	5	reinforced concrete panel	1971	Astana (Nur-Sultan)	212	168	21	D
6	5	reinforced concrete panel	1971	Astana (Nur-Sultan)	184	168	9	D
7	5	reinforced concrete panel	1971	Astana (Nur-Sultan)	211	168	20	D
8	5	reinforced concrete panel	1971	Astana (Nur-Sultan)	209	168	20	D
9	5	reinforced concrete panel	1971	Astana (Nur-Sultan)	198	168	15	D
10	5	reinforced concrete panel	1987	Temirtau	235	160	32	E

The data in the table are given on the basis of information in [6-8].

According to the current regulation, residential buildings cannot currently be built below the "C-" - "Normal" class, and those already in operation should be thermally modernized in order to increase their energy efficiency class.

A few years ago, UNDP conducted a small study under the UNDP-GEF project "Energy-Efficient Design and Construction of Residential Buildings" to test the energy efficiency class of newly erected buildings in the capital of Kazakhstan. The results showed that 25–30% (depending on the number of storeys) of buildings did not meet the minimum allowable energy efficiency class requirements (class "C" – "normal") [9]. As a rule, this was due to savings on thermal protection of buildings, the absence of modern heat consumption control systems and / or the lack of subsequent proper maintenance of these

[1] *Specific consumption of thermal energy by residential buildings for the minimum allowable energy efficiency "C-" class in accordance with the SN RK 2.04.04-2011 regulation on "Thermal protection of buildings".*

systems. As this small UNDP study shows, the situation requires urgent action to improve energy efficiency in new buildings.

Unfortunately, performing a more detailed energy consumption analysis both for the sector of existing (operating) buildings and for newly constructed buildings is complicated in Kazakhstan because of the lack of up-to-date data on the housing stock - energy consumption statistics are not kept.

However, such information would make it possible to systematize houses by region and building series and to describe their main shortcomings. Based on these data, it would be possible to implement targeted pilot projects to test the technical and organizational decisions made. And then it would be possible to make decisions on strategic planning for the systemic thermal modernization of residential buildings.

We would like to draw attention to one more fact - in a few decades, modern buildings erected according to today's energy efficiency standards will need energy modernization. Considering the low quality of energy efficiency in today's construction, this will not be a long time, and we will once again face the problem of modernization.

In this regard, it is also necessary to approach the thermal modernization of buildings that are currently built in a systematic way and plan this work for the future already now. There is no way we can get around this problem!

3. Organizational and financial aspects regarding thermal modernization of the housing stock

At the same time, the very thermal modernization of housing stock in Kazakhstan, based on the experience of implementing UNDP pilot projects, as well as the projects financed by other donors, faces a number of serious organizational and financial problems hindering its implementation.

More than 98% of the housing stock in Kazakhstan has been privatized; condominium management bodies have been created, which, as a rule, do not have sufficient experience in organizing repairs, attracting investments and working with owners in this direction, not to mention such a complex project as the energy modernization of the house.

Residents of multi-dwelling units themselves do not yet have sufficient experience in the collective management of common ownership and in solving problems of common property, which include the problems of heat supply to buildings, the condition of enclosing structures (facade, roof, basement, etc.). Unfortunately, many issues of delineation of responsibility, decision-making, their execution and control have not yet been fully resolved by law. The management bodies of the condominium themselves are not able to carry out such complex projects for the thermal modernization of buildings, since they do not have the appropriate knowledge and experience. These problems are sufficiently described in detail in [17].

To ensure high-quality and effective interaction of stakeholders in the process of implementing a thermal modernization project, a lot of preparatory work in the field of information, education and training of specialists will be required.

A very important issue is the financing of thermal modernization measures. As shown in [18], the largest costs are for the roof, facade and engineering networks of a residential building. According to the

experience of already implemented pilot projects in Nur-Sultan, the owner of each apartment must invest more than 2 thousand US dollars in home repairs[2]. For many owners living in such residential buildings, this amount is unbearable and requires long-term savings or borrowing.

Until 2020, financing of such projects in residential buildings was carried out within a number of programs of the Government of the Republic of Kazakhstan, in particular the Program for the Modernization and Development of Housing and Communal Services (2011-2014), and then the Program for the Development of Regions, within the framework of which work was carried out on the overhaul of multi-dwelling units in the country using a return mechanism. Owners were given the opportunity to renovate their homes, including thermo-modernization works, in installments over 5–7 years. Funding for the work was actually provided on an interest-free basis. Very good funding conditions, unfortunately, did not lead to further dissemination of the experience of this program and did not give significant results.

In total, more than 3.3 thousand apartment buildings in the Republic were repaired in this way (with low implementation of energy-saving measures). However, it is impossible to assess the effectiveness of such repairs in terms of reduction of energy consumption in the repaired buildings, as there is no such statistics.

The problem was the insufficient organizational component of the projects – the lack of professional management of houses; lack of energy modernization specialists/managers who could help houses organize the decision-making process and select an energy auditor, designer, construction companies on a competitive basis, conclude contracts with them and monitor quality; lack of a system for monitoring and verifying the achievement of energy saving goals in buildings after modernization, etc.

It is obvious that there is a need to create a financial instrument for the thermal modernization of MDUs in Kazakhstan, taking into account the experience of countries that have already implemented such a mechanism (for example, the Baltic countries, Eastern Europe). The mechanism should be market-based, providing access to commercial capital (banks) under appropriate guarantee conditions with mandatory support from the state. As shown in [18], the thermal modernization of residential buildings in Kazakhstan should be considered through the focus of sustainable infrastructure, climate care, reducing the risks associated with ensuring housing safety and reducing the possible consequences of mass discontent among residents. These factors should explain the participation of the state in this important process. It is in order to give a mass character to such works, the state subsidy can be considered as a measure of motivation for apartment owners to participate in the implementation of projects for the thermal modernization of residential buildings. Calculations made on the basis of previously completed pilot projects in Kazakhstan (with the support of UNDP-GEF) showed the most likely structure for financing repairs, which could look like this: 38% is a subsidy from the state; 38% is savings of residents; and 24% is loan financing (through commercial banks) [18].

However, we note that this is a fairly large figure for the owners to save, because usually low-income categories of citizens live in the old housing stock, and in order to accumulate such an amount (and according to our calculations, this is from 750 to 1000 US dollars per apartment), it takes a very long time[3]. It should also be noted that such savings are usually hindered by large needs for current repairs (houses, as a rule, are old and constantly require minor repairs), as well as by a relatively high level of inflation in the country. On this basis, we believe it is optimal to assume that the savings of owners for

[2]For reference: the average salary in Nur-Sultan, as of Q4 2021, is $893 per month.

[3]According to the current Law of the Republic of Kazakhstan "On Housing Relations", the owners of apartments and non-residential premises in the MDUs are obliged to accumulate money for the overhaul of common property in the amount of at least 0.005 times the monthly calculation index per square meter of an apartment. Based on this indicator, in order to accumulate the necessary amount for repairs, the owner will need an average of 30–35 years.

repairs will be no more than 10% of total costs. Another 10% could be a possible bank loan financing, and 80% should be a subsidy from the state.

Summing up the description of the organizational and financial problems of the thermal modernization of muti-dwelling units in Kazakhstan, we note the following factors:

- a high proportion of privatized apartments, which makes it difficult to make decisions on the modernization of common property;
- unresolved problems of managing the common property in multi-dwelling units, which cannot yet be called professional;
- the lack of experience in cooperatives of apartment owners (KSK) / associations of property owners (OSI) in carrying out difficult projects for complex energy modernization of houses; as well as small management companies, with the exception of large management companies, which manage mainly new housing stock;
- the problem of financing the overhaul of buildings, including works on their thermal modernization: there is no financing tool through bank loans; state funding programs often do not provide the proper quality of repairs and cannot cover the entire housing stock; owners' savings are offset by high inflation and a significant rise in prices for building materials and services.

4. Experience of thermal modernization of residential buildings in Kazakhstan

As we noted earlier, in 2004 Kazakhstan introduced the document SN RK 2.04-21-2004* "Energy Consumption and Thermal Protection of Civilian Buildings". In comparison with previous regulatory documents, these norms introduced new indicators of energy efficiency in buildings, such as the specific consumption of thermal energy for heating during the heating period, taking into account air exchange, heat gains and orientation of buildings.

In 2011, building codes for the thermal protection of buildings were updated and the document SN RK 2.04-03-2011 was introduced. According to this document, the energy efficiency classes of buildings were designated in Latin (from A to E); besides this, additional subclasses were introduced: A++, B+, C+, C-. In addition, the basic rate of specific energy consumption has been tightened by an average of 6%.

In general, Kazakhstan has the necessary standards to ensure proper energy efficiency of buildings - both newly constructed and those already in operation.

Although, as we can see, many countries go further in this direction - they adopt target indicators for the energy efficiency of buildings for a certain period at the legislative level. Regular tightening of conditions for thermal protection of buildings in Germany was as follows: Thermal Protection Regulation for Buildings (WSVO) 1977, 1984, 1995; Energy Saving Ordinance (EnEV) 2002; EnEV 2007 + 40% energy savings in comparison with EnEV 2002; EnEV 2009 + 30% energy savings in comparison with EnEV 2007 etc. Since 2020, the Act on Energy in Buildings (GEG) has come into force, implementing the European requirements for the energy efficiency in buildings for the construction of buildings with low energy consumption. From 2021, only buildings with low energy consumption (70kWh/m2 per year) can be built in Germany, and for public buildings this requirement exists from 2019.

In Kazakhstan, as far as we know, there are no such goals yet. They will probably be adopted after the approval of the Concept of Carbon Neutrality, the format and main provisions of which are currently being discussed in Kazakhstan. In any case, it is necessary to develop (tighten) the conditions for thermal protection of buildings.

In our opinion, now it is necessary to focus on the implementation of already adopted energy efficiency standards. Unfortunately, as shown in [19], a study of the process of implementing the investment cycle for the construction of new buildings in Kazakhstan from the point of view of energy efficiency showed that the priority of the issue of energy efficiency is still low and there are not enough mechanisms for the mandatory inclusion of energy efficiency in the market value of objects under construction.

The very process chain of design, construction and subsequent operation of buildings, as well as the management of these processes is not active enough.

During the implementation of capital repairs projects for existing buildings within the framework of the Government Programs (the Program for the Modernization and Development of Housing and Communal Services and the Program for the Development of Regions), we witnessed cases when even an energy passport was not developed as part of the project documentation; therefore, no one paid due attention to the energy consumption characteristics of the modernized building.

Many apartment owners simply do not know their rights and obligations (lack of interest, lack of information). The main problems in carrying out such projects were the lack of organizational component – the lack of professional management of houses; lack of energy modernization specialists/managers who could help houses organize the decision-making process and select an energy auditor, designer, construction companies on a competitive basis, conclude contracts with them, and monitor the quality of construction; lack of a system for monitoring and verifying the achievement of energy saving goals in buildings after modernization, etc.

More attention was paid to the energy performance of residential buildings in the framework of the implementation of pilot projects for the modernization of buildings, supported by various donors (GEF, UNDP, USAID, etc.), when the energy passport was actually developed and the result of energy consumption in the modernized buildings was monitored. The results of such projects are presented in a series of publications [6-8,13,18, etc.].

In the UNDP-GEF project “Sustainable Cities for Low-Carbon Development”, when conducting a pilot project for the energy modernization of a residential area in Nur-Sultan (5 panel 80-apartment typical multi-storey residential buildings), the necessary package of thermal modernization works was developed, which included at least the following steps: installation of an Automated Heat Point (ATP) with the modernization of the heating system in the basement (replacement of distribution pipelines for heating systems, hot and cold water supply); replacement of windows in common areas (entrances); replacement of lighting in common areas; measures for the facade of the building; insulation of the basement floor; waterproofing and insulation of a soft roof; replacement of external doors, etc. In general, we note that the set of energy-saving measures is individual for each building, depending on its initial condition.

The result of the thermal modernization of residential buildings in the residential area was a reduction in the consumption of thermal energy for heating and hot water supply by an average of 30%. The experience of previously completed pilot projects in Kazakhstan shows that the maximum effect of energy-saving measures in this type of residential buildings occurs after 3 years of proper operation of energy-saving equipment. Taking into account averaging over a number of years (to offset the level of severity of winters observed), when implementing such a package of energy-saving measures, 40–50% savings in heat consumption were obtained (Temirtau, Karaganda, etc.). The implementation of the above measures in this type of residential buildings leads to an increase in the energy efficiency class of the building to class "C" - "normal" according to the building codes existing today in Kazakhstan. At the same time, other effects of energy efficiency measures were achieved, in particular, comfortable conditions in heated rooms were ensured, "under-heating" was eliminated, and the level of "over-heating" was reduced.

The mass practice of performing such complex work in order to reduce energy consumption, and as a result, reduce greenhouse gas emissions, is hampered by the need for significant investments. According to pilot projects carried out in Kazakhstan, about 160-180 thousand dollars are required for one modernized building (the calculation was made for an average 5-storey 4-entry residential panel house). The amount of investment for 1 apartment of 50 square meters is about 2.5 thousand US dollars. At the

same time, the benefits from reducing heat consumption due to the thermal modernization of a residential building are very small and average only $40–50 per year for the same apartment.

The reason for this marginal benefit is primarily due to low heat tariffs in Kazakhstan. As an example, we note that the cost of 1 Gcal of thermal energy in Nur-Sultan is currently 2.4 thousand tenge (about 6 US dollars), which is almost 10 times less than, for example, in European countries. The low tariffs are largely due to the existence of fossil fuel subsidies in Kazakhstan. The International Energy Agency (IEA) has been systematically evaluating country-specific fossil fuel subsidies for over a decade. Subsidies for fossil fuels that are consumed directly by end users or are consumed as inputs for electricity generation are subject to this assessment. This analysis uses the price difference method, the most commonly used methodology for quantifying consumer subsidies (Kosmo (1987), Larsen and Shah (1992), and Coady et al. (2010)). It compares average end-user prices paid by consumers to benchmark prices that correspond to the full cost of supply. The price gap indicates the presence of subsidies.

At the end of 2020, Kazakhstan is among the top 20 countries in terms of the size of such subsidies, which, according to the IEA, amount to 2.7% of GDP. At the same time, subsidies for coal (the main fuel for the production of electricity and heat in the country) reached $1.4 billion in 2020, and subsidies for gas reached $0.2 billion [10].

As noted in [11], retail prices for natural gas in Kazakhstan are subsidized by export deliveries of the national company QazaqGaz. Cheap energy for the population is the result of cross-subsidization (businesses pay more than households) and active exploitation of coal capacities, the modernization of which in the last three or four years has been limited by the same tariff; and now it is difficult to attract investments in this sector due to the decarbonization trend.

The presence of fairly significant subsidies (2.7% of GDP), as well as the practice of cross-subsidizing, create disincentives for mass thermal modernization of buildings, especially residential ones.

It turns out to be much more profitable to waste thermal energy irrationally than to reduce its consumption in buildings, thereby reducing the volume of fuel combustion at sources. But such a situation, in our opinion, will not always exist, and here we agree with the author of the article in [11].

A likely reason, in our opinion, may be that the Government will not be able to provide subsidies to the energy sector indefinitely, as new challenges emerge that require investment. And one such challenge is the aging energy infrastructure, founded on the use of fossil coal. The adopted course towards decarbonization will make it necessary to actively modernize these power capacities, while introducing as many as possible non-coal stations based mainly on green technologies. As noted in the Low-Carbon Development Framework (KNUR), failure to replace the existing capacities with carbon-free and low-carbon equipment is fraught with either not meeting emission reduction targets, or the need for additional investment in the modernization of high-carbon equipment, or its early write-off and turning into bad assets. In any case, all this will require attention to the energy consumption sector, including the sector of buildings and, in particular, the residential houses.

Reducing the specific heat consumption of buildings through thermal modernization is a necessary condition for the decarbonization of the national economy. One solution to the problem could be to redirect part of the current energy subsidies to support the thermal modernization of residential buildings.

According to this Subsidies to Investments principle, the Energy Efficiency Fund was created in Ukraine, from which, starting from 2019, associations of apartment building owners (OSMD) can receive support for the energy modernization of the MDUs in the form of a loan and additional grants. In parallel, there are programs of financial support at the local level.

Successful examples of such support already exist in Kazakhstan. Thus, a number of UNDP pilot projects tested the scheme of energy service contracts (ESCO-contracts) in the performance of certain types of capital repairs of residential buildings. As we know, this scheme assumes the involvement for

repairs of a specialized energy service company (ESCO), working in the field of modernization of buildings to save energy (electricity, heat, gas, water). Savings must be achieved compared to the state before the modernization ("baseline") for the owners or tenants of the facility. Payment for the services of the energy service company is carried out from the savings achieved, which is formed as a result of the technical measures taken to modernize the building.

A preliminary analysis showed that the most rapid and tangible effect for obtaining savings is provided by measures to modernize the heating and hot water supply system (installation of an automated heat point). Table 2 below shows our analysis of the payback periods for such activities for different cities of Kazakhstan.

Table 2

Simple payback period (year) of measures to modernize the heating system and hot water supply (installation of an automated heat point) for a typical average statistical MDU in various cities of Kazakhstan

City	Simple payback period, year	City	Simple payback period, year
Aktau	10-13	Taraz	10-12
Almaty	6-7	Temirtau	11-13
Karaganda	8-10	Uralsk	6-8
Kostanay	6-7	Ekibastuz	20
Astana	16-18	Lisakovsk	6-7
Pavlodar	thirty	Petropavlovsk	8-10

As can be seen from the data in the table, even for these simple and relatively low-cost activities (investments in the range of 3.5–4.5 million tenge per house), the payback periods go beyond the 3-year period. Under these conditions, UNDP has tested subsidy measures that provide ESCO companies with a 10% subsidy on a commercial loan rate. This mechanism is fully described in [12].

Thus, the already implemented experience of thermal modernization of residential buildings in Kazakhstan shows possibilities for obtaining good performance (up to 50% reduction in energy consumption). At the same time, problems of an organizational and financial nature that have not yet been resolved do not allow this practice to be applied on a large scale.

5. Government targets for energy efficiency and decarbonisation

Kazakhstan has taken a course to reduce the energy intensity of the country by 25% by 2030 and by 50% by 2050 from the level of 2008 [1]. Increasing energy efficiency will have a positive impact on the environment, as reducing fuel consumption will reduce emissions. The policy of energy and resource conservation will contribute to the transition to "green" development, reduce production costs and increase the competitiveness of the national economy.

An important incentive to address the problem of energy consumption in the buildings sector are the commitments made by Kazakhstan under the Paris Agreement. Kazakhstan, having ratified the Paris Agreement (2016), assumed a voluntary contribution to reduce greenhouse gas emissions by 15% by 2030 from the 1990 level. In December 2020, at the Climate Ambition Summit, Kazakhstan announced carbon neutrality by 2060. As of the beginning of 2022, Kazakhstan has developed a Low-Carbon Development Concept (KNUR) - “Kazakhstan: The Path to Carbon Neutrality by 2060”, which is currently under discussion. It involves significant transformations in key sectors of the economy, including energy,

industry, buildings, transport and agriculture. Under the carbon neutrality scenario of this Concept, it is predicted that residential buildings will become carbon-free by 2060, and non-residential buildings will become carbon-free by 2050. At the same time, the building sector will achieve carbon neutrality through improved energy efficiency and the use of district heating, electricity for heating and renewable energy.

The buildings sector, and in particular the sector of residential buildings, is a significant consumer of energy in Kazakhstan and ranks second (after industry) among economic sectors in final energy demand. In this regard, increasing the energy efficiency of buildings (thermal modernization) is a necessary condition for achieving the goal of energy efficiency and, in general, decarbonization of the country's economy.

In order to improve living conditions, make them safe, comfortable, and meeting modern standards, as well as maintain and increase the value of residential real estate for many citizens, it is necessary to start developing a systematic approach to the topic of housing modernization. It is necessary to create effective sustainable models/schemes of how apartment owners can modernize their houses. Note that this is important not only for the old housing stock of the 1960-90s, but this is also important for the future, since there has always been and will be a need for extensive repairs and modernization of housing. Houses built in the 2000s in a dozen years must also undergo modernization, including in order to improve their thermal performance, as well as to introduce more modern engineering systems - heating, ventilation, water supply, etc.

Obviously, the energy efficiency and decarbonization goals noted above are most likely to be achieved if the energy quality of new buildings is radically improved, and the existing building stock and housing stock, which make up a significant portion of it, are energetically modernized.

6. Organization of large-scale energy modernization in Kazakhstan, taking into account the accumulated international experience

Taking into account the barriers and prerequisites (which are marked in the text in the box above), which are typical for most post-Soviet countries, it is necessary to study the best international practices for the energy modernization of the housing stock. Based on this experience, which the authors of this article have practically studied in their international projects, the following approach to the deployment of large-scale energy modernization of the housing stock can be proposed for discussion in Kazakhstan.

Long-term strategy

The listed prerequisites and challenges described in paragraphs 1-3 of this article (the most important provisions are marked in the text in boxes) clearly show the complexity of the widespread implementation of measures for the comprehensive energy modernization of residential buildings in Kazakhstan.

As we see from the experience of European and post-Soviet countries, first of all it is necessary to have *a Long-term strategy for the energy modernization of the housing stock. Strategy development is a complex process that should be carried out by all participants in the process of energy modernization of buildings.* It is recommended to consolidate all stakeholders and create an Alliance of government agencies, civil society, business (energy auditors, designers, builders), financial institutions, owners' associations, management companies, which will stimulate the development and implementation of a climate-neutral strategy for the energy modernization of the housing stock in Kazakhstan.

Pilot projects

Along with the development of a strategy for the energy modernization of the housing stock and financial support programs, it is necessary to organize a pilot stage.

Theoretical part of the pilot stage consists of conducting an analysis of the framework conditions in Kazakhstan in order to identify the potential and barriers for energy modernization of the housing stock; and conducting an analysis of the energy modernization of housing stocks in other countries (e. g. Germany, Ukraine, Lithuania). It is recommended to conduct a detailed study of the housing stock: which

segment of the building stock should be refurbished first? For example, multi-dwelling units (MDUs), erected in the 1960s-90s (serial industrial development): it is necessary to study the main damage to the main building series, classify the damage, draw conclusions about what non-energy and energy measures should be implemented in the course of modernization; how many buildings are we talking about; what materials and equipment (heating, ventilation, etc.) are needed for modernization; how deep should the modernization be; what activities should be implemented, etc.

Instead of promoting the implementation of separate energy-saving measures, an assessment of the modernization cost should be carried out, taking into account the implementation of a set of energy-saving measures (the entire building envelope and the heating system), in order to determine financing needs on its basis and orient the creation of long-term financing programs with the necessary support measures.

Practical part of the pilot stage is to implement practical projects to visualize the attractiveness of the energy modernization of residential buildings. With their help, a positive perception, efficiency and attractiveness of modernization will be achieved. Pilot projects are needed to test/find out in practice at least the following items:

- real costs of preparation and implementation of energy modernization of houses – data collection, home research, energy audit, design, as well as the construction phase;
- what part of the cost of energy modernization of the house can actually be borne by homeowners, and what part should be assumed by the state (state programs, programs at the local level);
- order and organization of decision-making in MDUs. How can work with cooperatives of apartment owners (KSK) / associations of property owners (OSI) be improved;
- readiness of local companies (energy auditors, designers, builders) to prepare and implement energy modernization projects;
- what percentage of socially weak owners are not even able to use support programs for the modernization of residential buildings due to their financial situation. It is necessary to develop a discussion in order to resolve the question - how this category of owners should be supported;
- how to control the quality of construction and achieve the planned energy saving goals, organize and monitor the projects.

For pilot projects, it is necessary to select houses that are typical representatives of the most common building series. In the pilot stage, it is recommended to carry out energy modernization of houses representing one series and located in different regions and different cities (big city, city of regional and district significance) in order to compare construction costs and availability of local specialists.

An information campaign is needed to disseminate information both about the progress of the projects and about the particularly successful experience of pilot projects among the population.

The information from the pilot stage should be carefully analyzed and used to improve the strategy and financial mechanisms.

Support programs

Low energy tariffs in Kazakhstan and the high cost of energy refurbishment of residential buildings determine a long payback period (see paragraph 4 of this article). For homeowners, the implementation of these measures becomes ineffective. Therefore, it is possible to recommend a gradual introduction of mechanisms to bring the existing difference in energy tariffs in line with the development of support programs. Tariffs should be raised and gradually less and less subsidized by the state, and the released subsidies should be invested in energy modernization.

Effective programs for financing the energy modernization of the MDUs in Kazakhstan should be based on bank loans with the participation of the state, as well as on the creation of special revolving funds. The management of such programs or funds must be organized.

According to the UNDP proposals (conclusions from the implemented pilot projects on energy efficiency and the introduction of renewable energy sources in Kazakhstan), in order to ensure financing for the thermal modernization of residential buildings in Kazakhstan, it is also important to organize / streamline the process of gradual accumulation of owners' funds for capital repairs of residential buildings (according to current legislation, owners are required to set aside funds for these goals). This is especially

true for homes that are planning a major refurbishment/thermal modernization in 5-10 or even 15 years. Clear procedures should be adopted for the process of accumulating the funds of owners, ensuring their safety through existing banking mechanisms (for example, through a paid guarantee of the relevant guarantee funds), as well as the possibility of voluntary participation of such accumulations in solidarity repair funds, the experience of organizing which needs to be studied in different countries and tested in practice in Kazakhstan. This will make it possible to effectively manage the savings of owners, ensuring the circulation of funds and preventing their depreciation.

Another possibility is to combine a loan with a non-repayable grant. Grants have proven to be effective in financing energy modernization in buildings both in the EU (Poland and Romania) and in post-Soviet countries (e. g. Ukraine). However, in order to make the scheme for financing energy modernization of buildings more attractive, the share of the grant component should be increased to 50% or more.

In Kazakhstan, the revolving fund mechanism can be applied. A revolving fund is a fund whose capital is constantly replenished by incoming repayments or installments to repay a loan within the framework of projects financed by these funds. The returned means can be used again to finance further projects (for example, the Energy Efficiency Fund in Ukraine).

Subsidies should be provided to low-income households. If the monthly load resulting from the refurbishment exceeds 30% of the household's monthly income, then the state should bear up to 100% of the cost of modernizing the MDUs, as the example from Lithuania shows us.

Profitability can be achieved through the implementation of comprehensive programs for the energy modernization of residential buildings in Kazakhstan due to energy savings, as well as as a result of increased tax revenues due to a significant expansion of the labor market. When carrying out a large-scale modernization of the housing stock, the market for building materials will grow, there will be an additional need for energy auditors, designers, engineers, builders and other specialists associated with the process of repairing, operating, and improving the energy efficiency of buildings.

Comprehensive refurbishment / Individual plan

From the experience of countries where the modernization of the housing stock is already taking place, it is recommended to carry out a comprehensive modernization. Financial programs should cover the costs of the entire range of both non-energy-saving necessary measures (for example, roof repairs before insulation) and energy-saving measures. Comprehensive refurbishment is ultimately cheaper than disparate implementation of individual measures over a number of years. Its implementation can help save up to 70-90% of energy (the saved funds can be used to repay the loan for energy modernization). The housing stock of the MDUs in Kazakhstan is very worn out, especially houses built in the 1960s-90s. Therefore, along with the implementation of energy-saving measures, these houses need a major overhaul so that houses and apartments become comfortable and meet modern standards.

If a comprehensive refurbishment is difficult due to the financial possibilities of the homeowners, it is very important that the individual measures are optimally coordinated with each other. It is recommended to use the Individual Refurbishment Roadmap (iSFP), developed in detail in Germany by the German Energy Agency (dena). The roadmap defines specific measures, and most importantly their sequence (coordinated steps aimed at a comprehensive energy refurbishment and optimization of the process).

Support for cooperatives of apartment owners (KSK) or associations of property owners (OSI) / Professional implementation of energy modernization projects

When organizing the prerequisites for the deployment of a large-scale refurbishment of the housing stock, it is also necessary:

- to provide expert support and professional refurbishment management; to train Residential Houses Modernization Managers (RHMM) to assist homeowners in energy modernization of residential buildings. RHMM accompanies the entire process of energy modernization of an apartment building – preparation of all financial and technical solutions, selection of specialists (energy auditors, designers, builders), support and acceptance of work, quality control. The RHMM cooperates with stakeholders involved in the modernization process for the benefit of the KSK /OSI. The experience of refurbishment of residential buildings in Germany and in various post-Soviet countries shows that the

process of comprehensive energy modernization of buildings does not proceed properly even with basic prerequisites, such as financial support programs for homeowners; high energy prices that are not subsidized for end consumers; availability of a legal framework, etc. KSK/OSI lack the technical, economic and legal knowledge to carry out complex projects such as integrated energy modernization of buildings;

- to include professional management organizations existing on the market in the refurbishment process; to improve the qualifications of housing managers on the following topics: energy efficiency improvement in buildings, implementation of energy measures, communication, selection of specialists (energy auditors, designers, builders) on a competitive basis, etc., so that the housing manager provides professional support to the KSK/OSI during the modernization of residential buildings;
- to standardize the refurbishment process (single documents, procurement process, databases of specialists);
- to organize accompanying information campaigns; to create competence centers in Kazakhstan for refurbishment at the local or regional level on a one-stop-shop basis;
- to include municipal structures in the housing stock renovation program, including the selection of renovation projects based on local renovation concepts and the results of pilot projects.

Conclusion

In the context of the recovery from the COVID-19 pandemic and the decarbonization of the Kazakh economy, a large-scale refurbishment of the housing stock would serve to:

- providing input to international climate protection efforts;
- a significant increase in jobs in the labor market due to the development of the construction field, the field of building materials, as well as small and medium-sized businesses associated with the modernization of buildings;
- an increase in tax revenues to local budgets due to the revival of the economy; the intensive growth of enterprises, firms and organizations associated with the modernization of buildings;
- achieving social impact. Complex modernization of housing, as shown by the experience of modernization of housing stock in Germany, the Baltic countries and Ukraine averages 30% of the cost of new construction, and at the same time energy savings of up to 50% are achieved. Thus, by creating conditions for energy refurbishment of the housing stock, it is possible to improve the living conditions of a large part of the population living in the old housing stock, i.e., improve access to high-quality, safe, reliable, and energy-efficient housing.

Possible perspectives for the transfer of experience for the modernization of residential buildings from Germany and other Eastern European countries to Central Asian countries:

- practice of legal regulation – development of a legislative framework for energy saving in buildings
- financing instruments and related social issues – financial support for socially weak strata
- conducting pilot projects – the development of targeted programs should be based on the experience of pilot projects
- planning and implementation of energy saving measures, organization of the refurbishment process
- training to improve the competence of modernization participants

It is expedient to organize a series of international projects in all these areas, which would unite all institutions and all specialists involved in the energy modernization of the housing stock.

It should be noted that the problem of modernization of the housing stock cannot be postponed in time; it will still require a solution sooner or later, which, as can be seen from the whole complex of problems described in the article, takes a lot of time. Therefore, it is necessary to start this long-term process now. The advantage for Kazakhstan is that the country already has a fairly well-established experience on the examples of completed pilot projects, as well as good experience in other countries. All this can be successfully used and implemented in reality.

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The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms.
The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders. The European Commission is the EU's executive body.

EU Regional programme CENTRAL ASIA INVEST (started in 2007) supports private sector development in the five countries of Central Asia, with a particular emphasis on the growth of Small and Medium-sized Enterprises (SMEs). A healthy private sector requires a reliable network of Business Intermediary Organisations (BIOs), which can support its members and act as a reliable source of the diverse private sector.
The Central Asia Invest Programme has the following objectives: 1) to support private sector development in the region through reinforcement of the role and capacity of BIOs, whilst increasing their number; 2) to improve the business environment for SMEs by promoting and supporting policies that strengthen competitiveness, facilitate investments and access to finance, open new markets and reduce red tape.