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High-performance energy efficiency standards in buildings in UNECE Region.

Topic 4. Retrofits of existing building stock and application of high performance energy efficiency standards

Dodonov Andrey, Engineer / Certified Energy Manager AEE

Retrofit of existing building stock

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The term «retrofit» can be referred to the repair and modernization of existing residential and public buildings.

The main factors for retrofitting of existing building stock are:

1. The share of the main existing buildings refer to the construction period of 1960-1980s.
2. At this point of time there is significant deterioration of buildings. Many buildings need capital repairs, including not only modernization of internal engineering infrastructure, but also construction elements.
3. Typical design and construction of buildings were carried out without taking into account the requirements of energy efficiency because of the lack of energy efficiency legislation at the period of construction.
4. Constantly increasing tariffs for energy resources, which affected the energy bills for end users
5. Thermal characteristics of existing building envelope, as well as HVAC systems of outdated existing buildings are inefficient

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The categories of existing building stock

Public buildings (schools, hospitals, children gardens etc)

Multi family buildings

Private residential buildings

Non-residential buildings (commercial buildings)

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All of these categories of existing building stock have:

1) Different legal entity of building owner (legal form for municipal building, HOAs, individuals etc.) and method of property management.

2) Different obligations as per energy efficiency legislation (mandatory obligation of EE legislation for existing municipal buildings in frame of implementation of City Energy Action Plan (CEAP), different obligation for establishing of class of energy efficiency etc.).

3) Different sources for financing the building retrofit (city administration program, federal program for capital repair, own accumulated investments by home owners association, private investments etc.).

4) Different interest and motivation for building retrofit.

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Multi family building

MFB is an association of owners of apartments – an organization representing their interests and managing the common property of the house as decided by the owners

There are various forms of these organizations in different countries with different names and degrees of legal responsibility

Their purpose is to manage, use and dispose of common property of the building in accordance with current legislation

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Public building

Public (Municipal) building represents a legal entity providing services to the population (paid or free)

This organization provides complete management of the building.

Funds for current activities for all sources of costs are provided from the budget of the municipality, including repairs, renewal of fixed assets, payment of energy resources

PB has not separation between common and private property as MFB

The decision for repair is taken inside the organization in coordination with the municipality

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Generally the common household property of MFB includes:

Roof
External walls of house
External walls of MFB, which serve one or more living or non living premises
Engineering equipment and systems, which serve one or more living or non living rooms: mechanical, HVAC, electrical, plumbing, cold water supply and domestic hot water systems, lifts
Plot of land on which the apartment house is located
Any other facilities which serve one or more living or non living premises (basement, technical floor)

Repair of the common property is carried out on the basis of the decision of owners of apartments based on the results of the general vote. An exception is private property. Please provide examples of private property.

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Type of repair (approximate classification)

Current repair

- Prevention of early deterioration of building and engineering infrastructure
- Maintaining the operational factors

Prevention and cosmetic activities

Capital repair

- Elimination of physical deterioration
- Improving and maintaining operational properties without changing of building functionality as well as keeping TEI*

Increasing of efficiency of engineering infrastructure and thermal characteristics of construction elements

Reconstruction

- Changing of TEI* and structural and space planning solutions of building

Improvement of structural and space-planning solutions of building

*TEI - technical economic index

Energy efficiency, EE modernization

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The requirements for the implementation of any type of building repair are usually determined on the basis of the current legislation:

- General provisions on repair, main KPIs, which must be achieved, responsibilities, as well as a general list of recommended works for repair determined on the state level
- More narrow requirements to the order, volume of work performed, and the set deadlines are determined on the basis of regional, which takes into account the peculiarities of the region
- All technological parameters: necessary specific energy consumption, requirements for building envelope and engineering systems, including energy efficiency requirements for existing buildings, are determined on the basis of construction and regulatory documents and other documents

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The needs for capital repair or reconstruction usually determined by the extent of the real physical deterioration of the building

Approximate separation of the group	Common current characteristics of technical condition of the building	Status of capital repair or reconstruction
Up to 10%	Defects of the main construction elements and the main engineering equipment are absent. There are minor damages of individual elements.	Current technical maintenance and cosmetic repair
Up to 20%	The presence of minor defects of engineering equipment, roof, facades	Current repair of individual elements of engineering equipment and other systems
Up to 30%	Defects with foundations, walls, ceilings, partitions are missing or insignificant. Windows, doors and floor coverings have significant damage. Defects of roofs, engineering equipment, external communications are insignificant. The operation of the building is possible with restrictions	To ensure normal operation, the capital repair of the building is necessary with the restoration or replacement of defects of elements
Till 40%	Foundations, walls, ceilings, partitions have significant trouble with restricted distribution. Window and door filling, roof, engineering equipment have significant trouble with their mass dissemination throughout the building. Operation is possible with significant restrictions.	The capital repair is required with the restoration or partial replacement of foundations, walls and complete replacement of the roof, ceilings, partitions, engineering equipment
From 40% to 70%	Foundations, walls, ceilings, partitions have significant trouble with their mass distribution throughout the building. The operation must be stopped immediately.	An immediate reconstruction of the entire building is required, with the restoration of foundations, walls and complete replacement of the roof, floors, partitions, floors.
Above 70%	The main construction elements are not able to carry out own function due to the high deterioration The operation of building must be stopped The security supporting activities are carrying out	Capital repair does not make sense. Building must be demolished

Retrofits of existing building stock

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Energy efficient modernization is a complex of technical measures implemented into the building with aim to reduce energy consumption as well as improve the indoor climate condition. Energy-efficient modernization is part of ongoing work in the framework of building capital repair.

Could you please specify the example of implementation of EE measures within the capital repair?

Conducting all works of energy-efficient modernization will be most effective for the buildings with low physical deterioration (The optimal conditions for conducting EE measures are buildings where the percentage of wear is 30-40%, since it does not require significant resources for renovation of the building within the framework of capital repair)

However, there is a significant number of buildings which need capital repair because of their high deterioration

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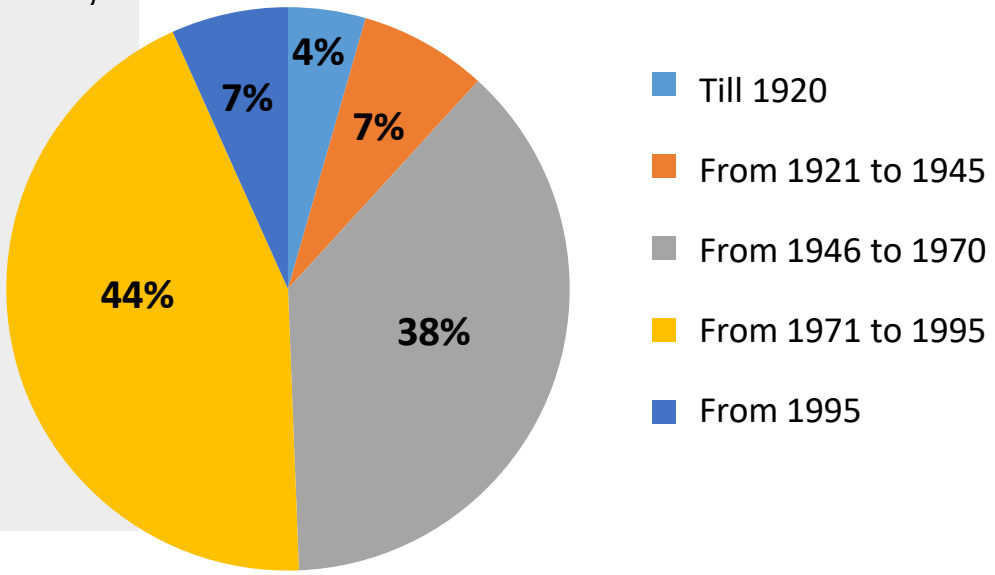
As an example of the existing housing stock of the Russian Federation

According to the Federal State Statistics Service, the total housing stock is over 3,600 million square meters, with more than 70% of residential buildings in the city

Significant volume of old residential houses has been constructed in the middle of 20th century. About 80% of the buildings of the housing stock need capital repair

Approximate share of residential buildings depends on the year commissioning



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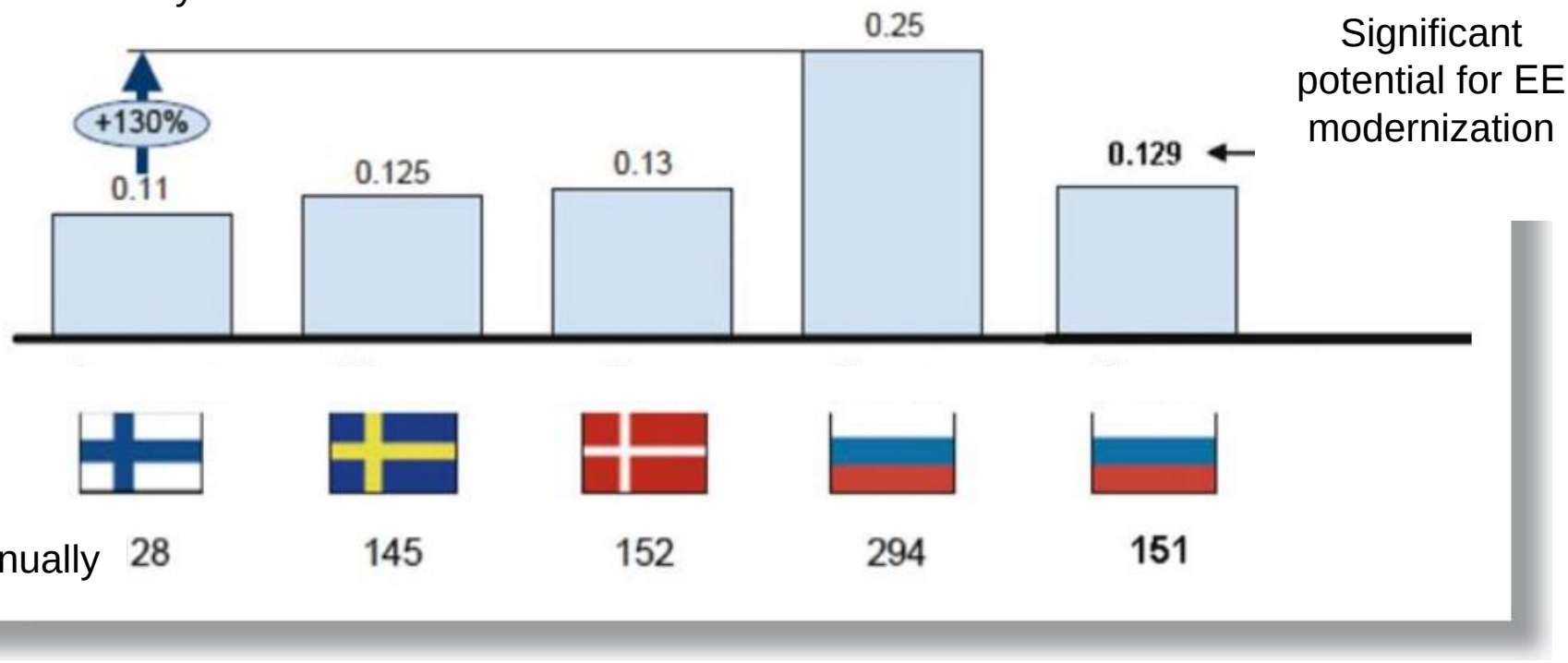
More than 50%

Gcal/m^2 annually



Source: «Financing of capital repair and increase of energy efficiency of multi-apartment houses in Russia», IFC, 2012.

Example of the existing building stock of one typical city in central part of Russia (Volga region, population above 1,2 mln)

Conditionally the existing building stock might be divided onto 3 main types:

Type 1:

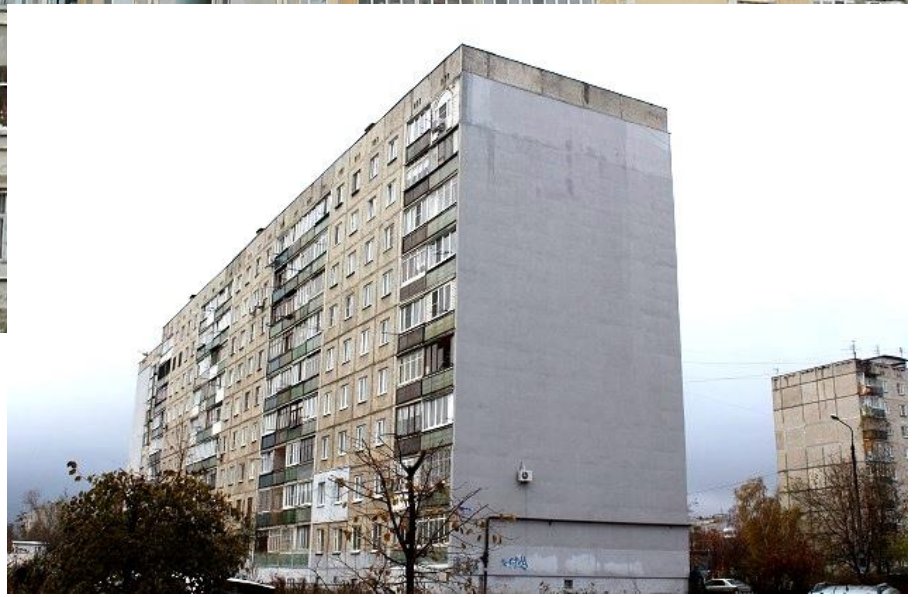
5-8 floors building made of brick,

Year of construction: 70-90s

4-8 porches,
80-256 flats - (average area of a flat - 48 m^2)

Approximate number of such buildings - 3 775, or 38,4% share in total existing building stock.

Example of the existing building stock of one typical city in central part of Russia (Volga region, population above 1,2 mln)



Type 2: 9-12-floors

Year of construction: 70-90s,

1-4 porches (or more)

72-192 flats, average area of a flat - 50 m^2
Approximate number of buildings – 4 119, or 41,9% from total amount

Example of the existing building stock of one typical city in central part of Russia (Volga region, population above 1,2 mln)

Type 3: 13-17 floors, constructed since 1990

Number of porches: 1-3
Number of flats 104-204
Average area of a flat - 57 m^2.

Total number of buildings: 1 120, or 11,4% from total amount.

Example of the existing building stock of one typical city in central part of Russia (Volga region, population above 1,2 mln)

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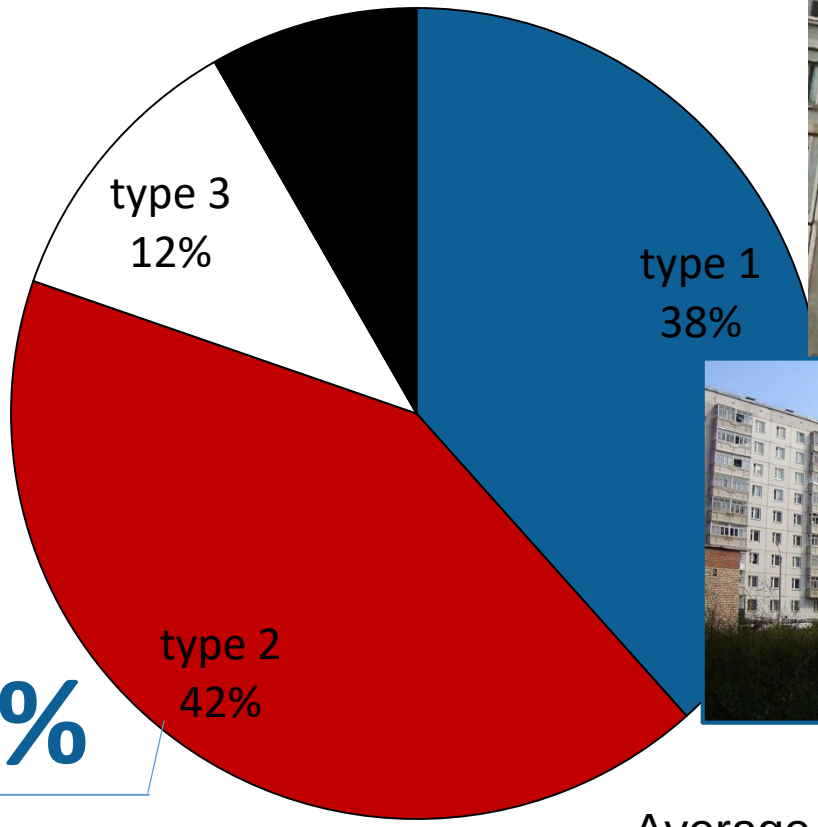
Mix of building type

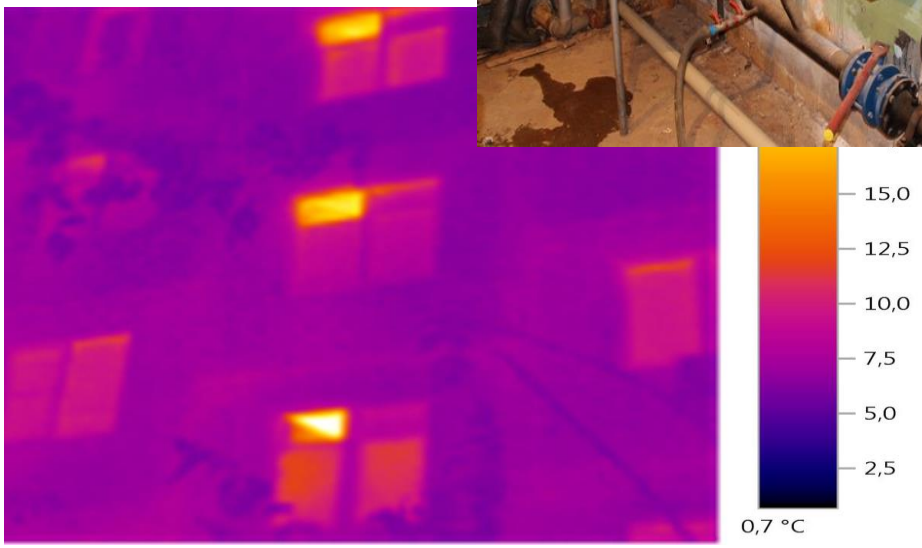


42%

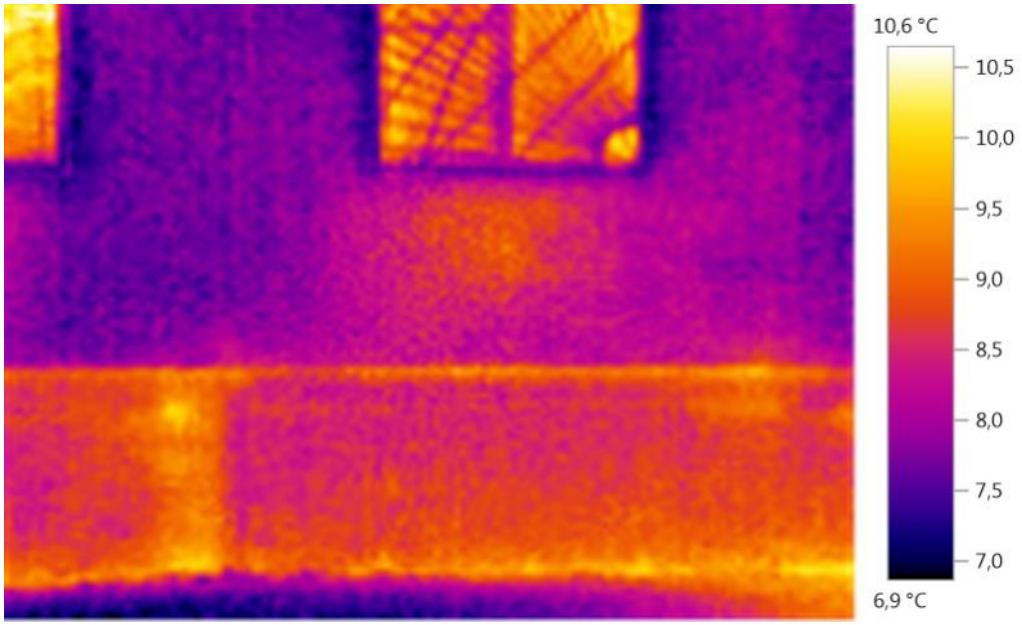
Type 2

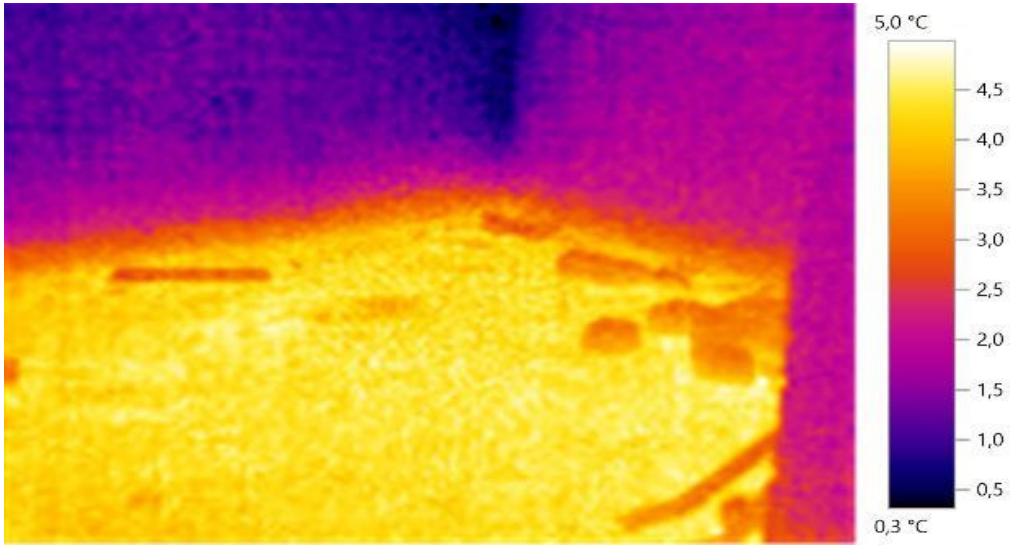
Average specific heat consumption - 180-250 kW*hour/m2 annually

Some technical practical aspects
Buildings of all types have significant reserve for optimization

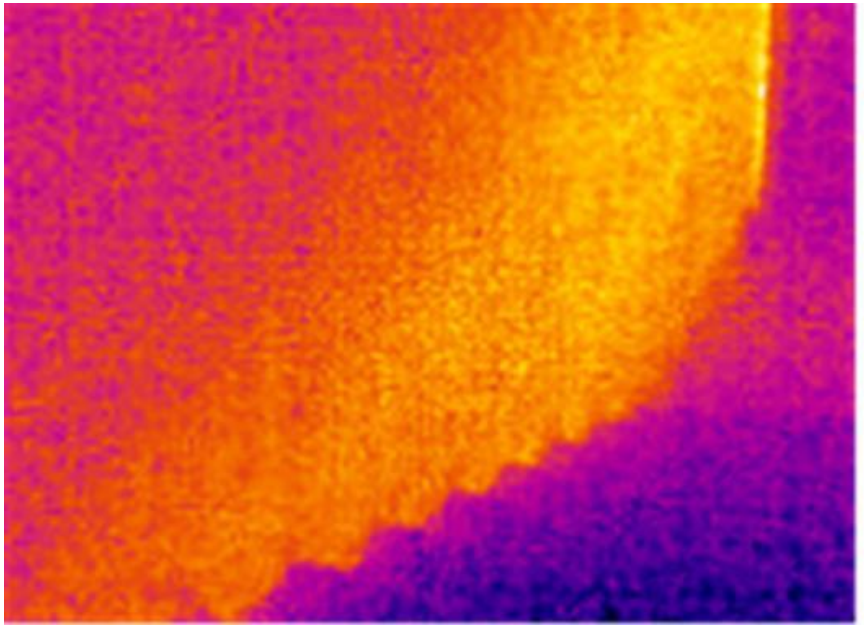


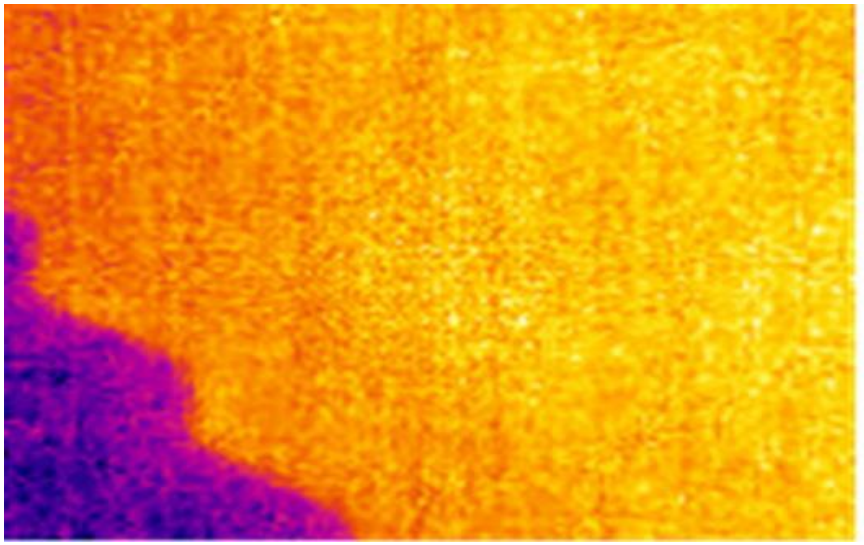
Some technical practical aspects



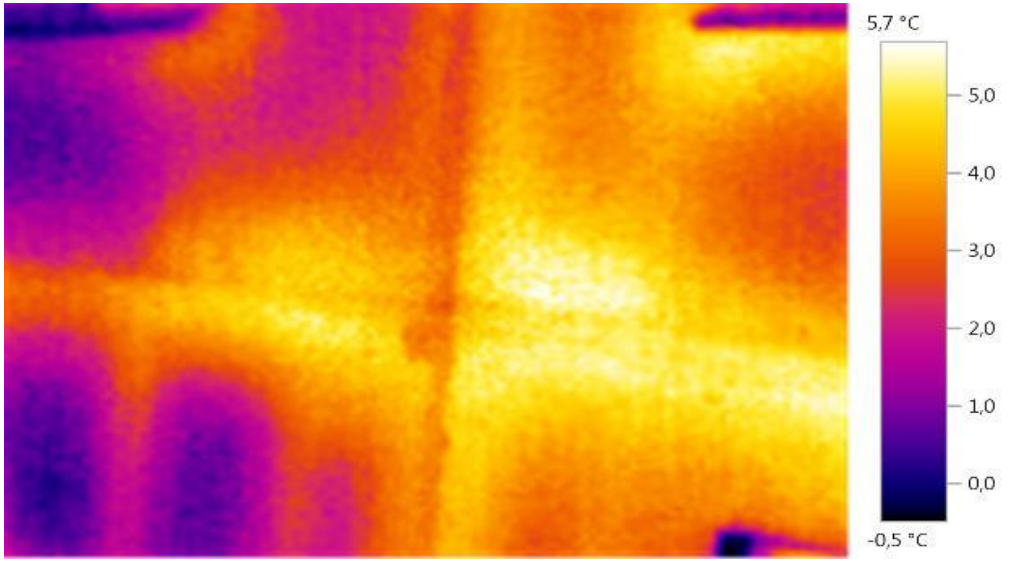


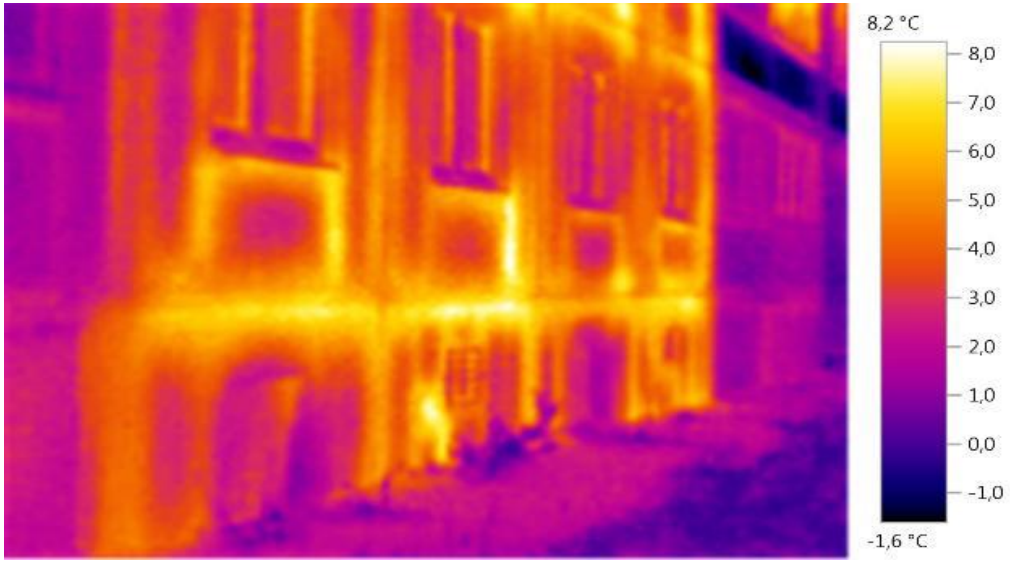
Some technical practical aspects



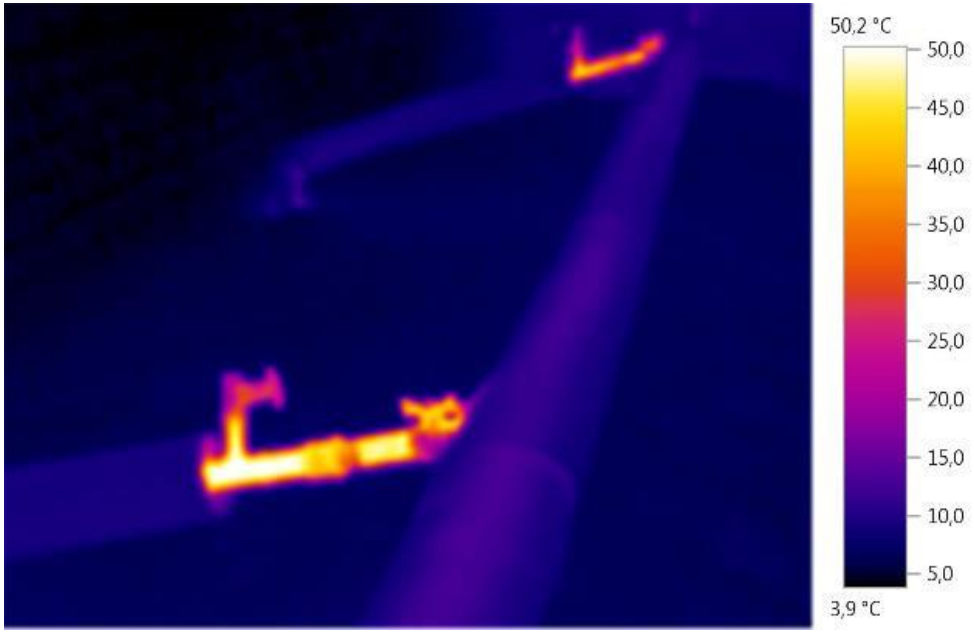


Some technical practical aspects





Some technical practical aspects



An example of the complex implementation of the legislation in the field of capital repairs for multi-family apartment buildings at the federal level

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The following documents were developed:

"Housing Code of the Russian Federation" of December 29, 2004 N 188-FZ (as amended on 02.07.2013) - amendments were made in the framework of Federal Law 217 of December 25, 2012

Methodical manual on maintenance and repair of housing stock
MDK 2-04.2004, approved by the Decree of the State Construction Committee of Russia

Rules for the maintenance of the common property of the apartment building, approved by the Government of the Russian Federation of August 13, 2006, No. 491.

Rules and standards of technical exploitation of housing stock, approved by the Resolution of the State Construction Committee of Russia of September 27, 2003 No. 170

Instruction on the composition, procedure for the development, submission and approval of design estimates for capital repairs of residential buildings approved by Gosstroy Decree of Russia of December 17, 1999 No. 79

Regional Major Repair Programs

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"Housing Code of the Russian Federation„ dated December 29, 2004 N 188-FZ (as amended on 02.07.2013) defines the list of services and works for capital repair of common property in an apartment building.
The provision and implementation financed from the capital repair fund, formed on the basis of the minimum amount of the contribution for capital repairs. The amendments of the Federal Law regulates the mechanism for the payment of capital repairs by apartment owners

1	Repair of HVAC or MEP systems
2	Repair or replacement of lifts and relate facilities
3	Repair of roof
4	Repair of basement (part of common property)
5	Insulation and repair of facades of the building
6	Installation of meters
7	Repair of foundation of the building

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In addition,

Regional capital repair programs identify additional services and works, also financed from the capital repair fund, formed on the basis of a minimum contribution amount.

These include activities such as:

- Development of design documentation
- Approval design documentation from designated state authority
- Construction control
- Conduction of energy audit of an apartment building conducted in accordance with Federal Law No. 261
- Technical inventory and certification of building
- Repair of porches of building
- Improvement of the house territory

The sequence of capital repair

The sequence of capital repair is based on the regional capital repair program in accordance with aggregated criteria

1. Technical criteria

Year of commissioning

Degree of deterioration of building

Complexity of capital repair in accordance with the types of work established by law

Qualitative improvement of the technical characteristics of the apartment building as a result of the planned capital repair

2. Organizational criteria

The level of support by the owners of the decision to carry out capital repair and its share financing

Degree of readiness for the capital repair

Work in a unified regional system of object accounting

Organization of collection of funds from the population for provided housing and communal services

Presence of homeowners association

3. Financial criteria

Financial discipline of owners of MFAB

Appropriate works for the buildings type 2

Category of capital repair measures as per legislation	Disadvantages of the building	Recommended measures (might be added or excluded from the capital repair)
Repair of MEP, HVAC systems	Outdated electrical wiring and distribution devices. Application of incandescent lamps	Replacement of electrical wiring, new modern lighting with LED sensors
	Inefficient main equipment of DHW, heating system	Replacement of outdated equipment by
	Outdated elements of heating systems as well as DHW	Hydro pneumatic flushing of systems, replacement of outdated elements
	Insufficient insulation of distribution pipes of heating system and DHW.	Insulation, repair of insulation
	Inefficient regulation and distribution of heat supply	Modernization of existing

Appropriate works for the buildings type 2

Category of capital repair measures as per legislation	Disadvantages of the building	Recommended measures (might be added or excluded from the capital repair)
Repair of roof, including convert from non ventilated to ventilated roof, arrangement of exits to the roof	Flat or gabled roof with low thermal characteristics	Insulation of technical floor
Repair of the basement	Non heated basement, low thermal characteristics of slab of the first floor	Insulation of basement

Appropriate works for the buildings type 2

Insulation and repair of facade of the building	External walls made of prefabricated concrete panel or brick. Low thermal characteristics. Low tightness of sealing joint between panels	Insulation of external walls, repair of sealing joints
	Outdated windows with thermal low characteristics	Installation of new modern windows with high thermal characteristics
	Entrance door without automatic closer assistance	Installation of automatic closer, arrangement of air tightness
Installation of meters	Absence of meters	Installation of meters

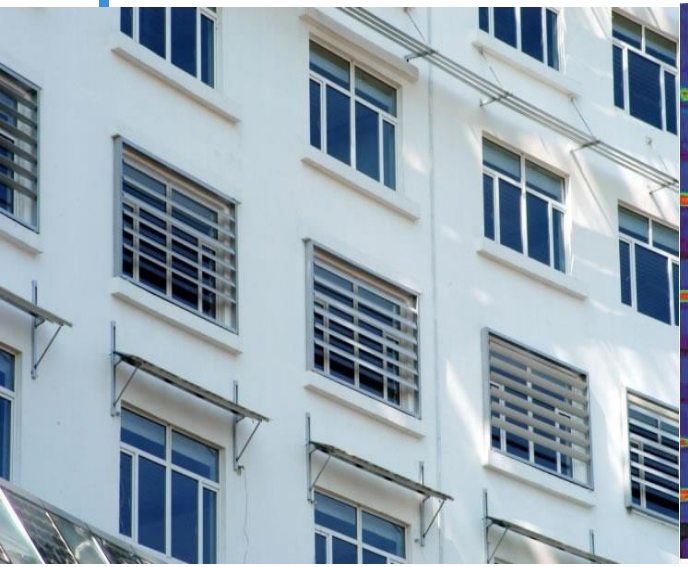
Retrofits of existing building stock

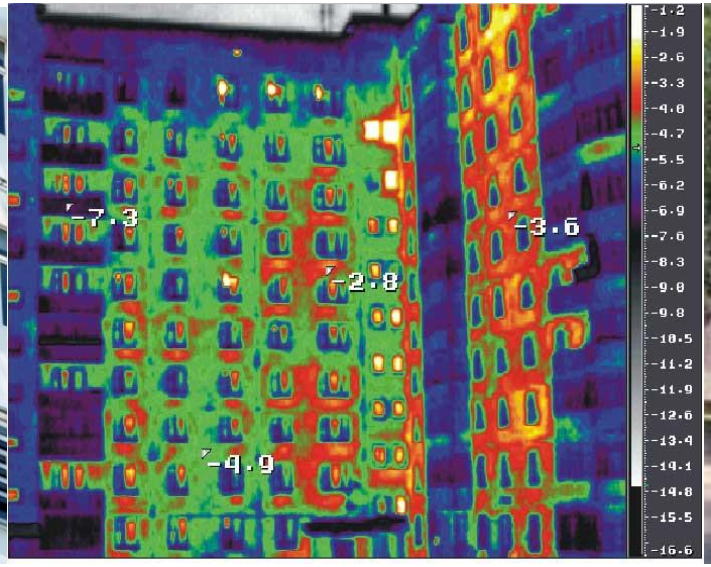
Implementation of capital repair program for municipal buildings

Discussion among participants

ENERGY MANAGEMENT IS ONE OF THE KEY POTENTIAL INSTRUMENTS TO FORM THE CEAP or ACTIVITIES RELATED TO CAPITAL REPAIR

Retrofits of existing building stock





Technical aspects of EE modernization

Retrofits of existing building stock

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Energy efficient modernization is a part of ongoing work in capital repairs or renovation of a multi-family residential building or public building.

Energy-efficient modernization aimed at optimal consumption of energy resources by the building in accordance with the established building codes and standards for existing buildings.

The requirements of construction and regulatory documentation are applicable both for new construction projects and for existing buildings and structures.

Retrofits of existing building stock

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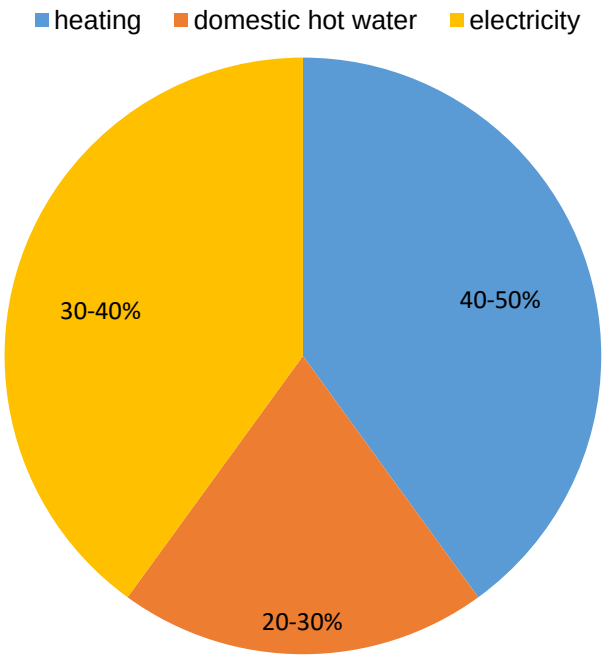
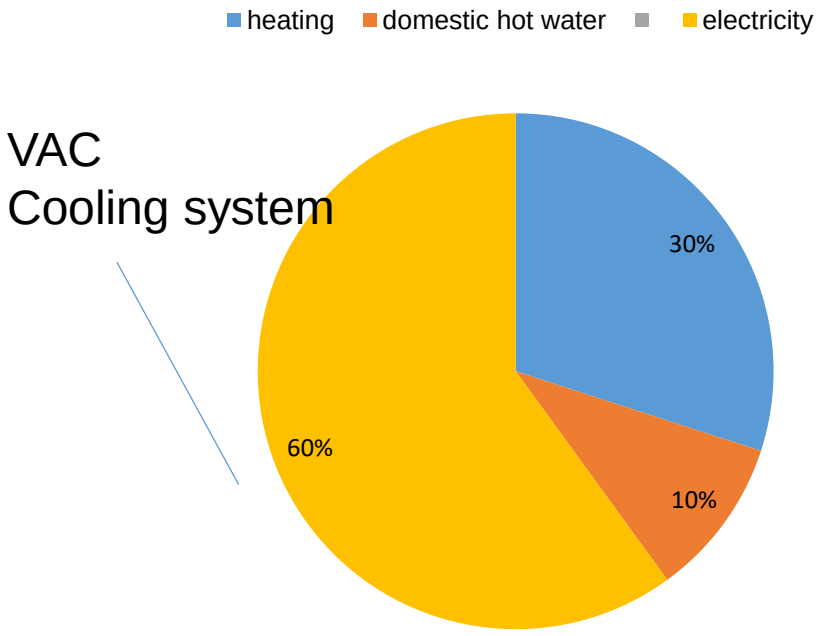
The structure of energy consumption of buildings is heterogeneous

Multi family buildings



Municipal buildings



The structure of energy consumption for municipal buildings is different depending on the type of building (school, hospital or other)

Retrofits of existing building stock

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Distinctive features

Residential building | Municipal building

- Ratio of energy consumption
- Additional technical engineering systems
- Different working hours of the building
- Different requirements to the specific heat and electricity consumption

Retrofits of existing building stock

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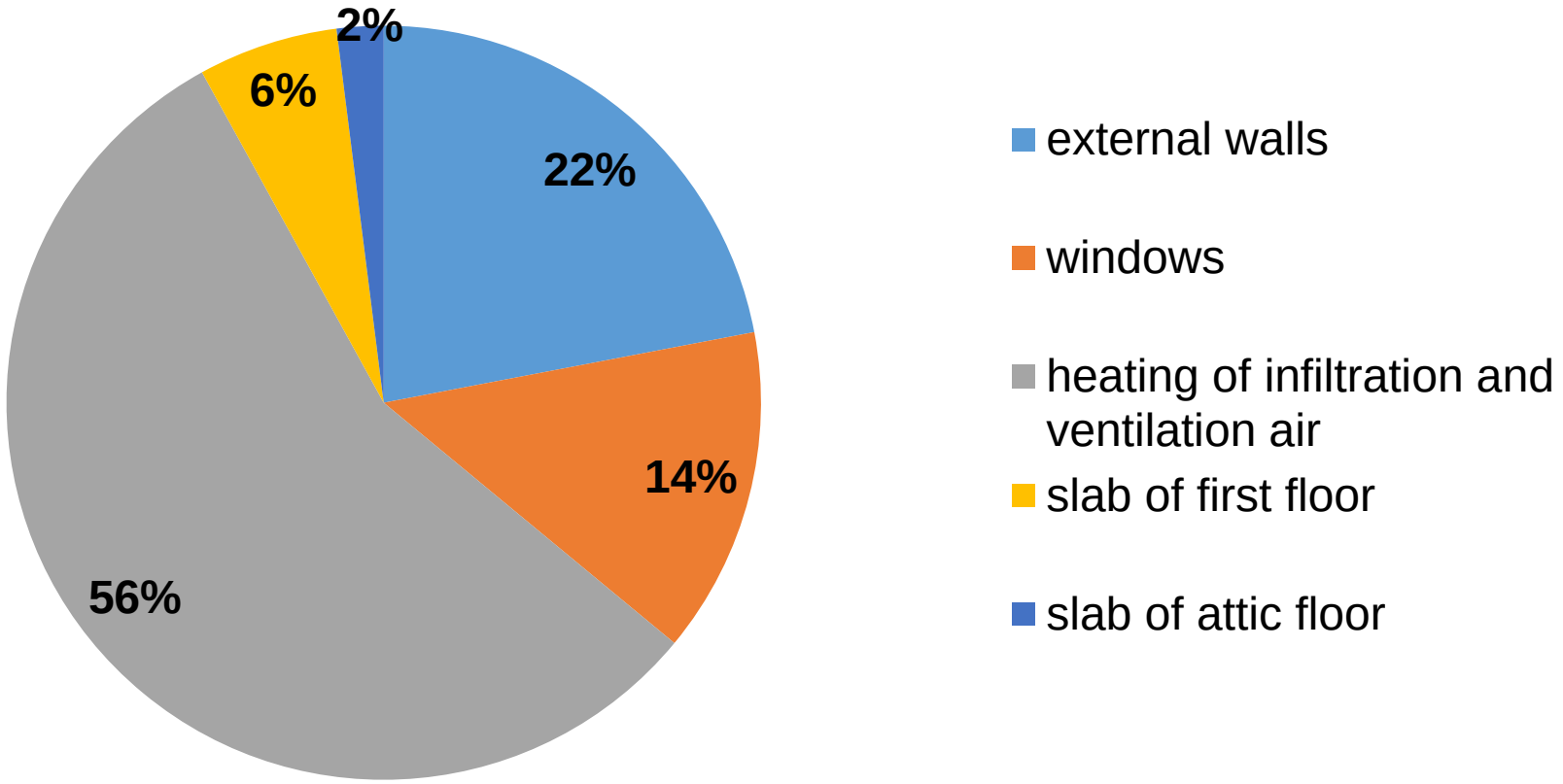
The distribution of heat losses occur approximately equally



Retrofits of existing building stock

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The energy efficient criteria for the building might be defined as

$$E = \frac{N + aQ}{F} \longrightarrow$$ **The ratio of the energy to the unit of space**

The way to decrease the energy consumption:

1) Minimize heat losses through:
   a) construction elements with the help of architecture solutions
   b) construction elements by insulation of external walls, slabs of attic and technical floors
   c) windows replacing them with the new efficient windows
   d) the arrangement of inlet and outlet mechanical ventilation with recuperation of the air
2) Arrange an efficient modern heating system to optimize existing consumption and regulation of heat
3) Instal new modern equipment for engineering system with high efficient factor
4) Replace or install the new modern lighting system
5) Apply solar PV/DNW systems, heating pumps
6) Apply waste water system for recuperation purposes

Retrofits of existing building stock

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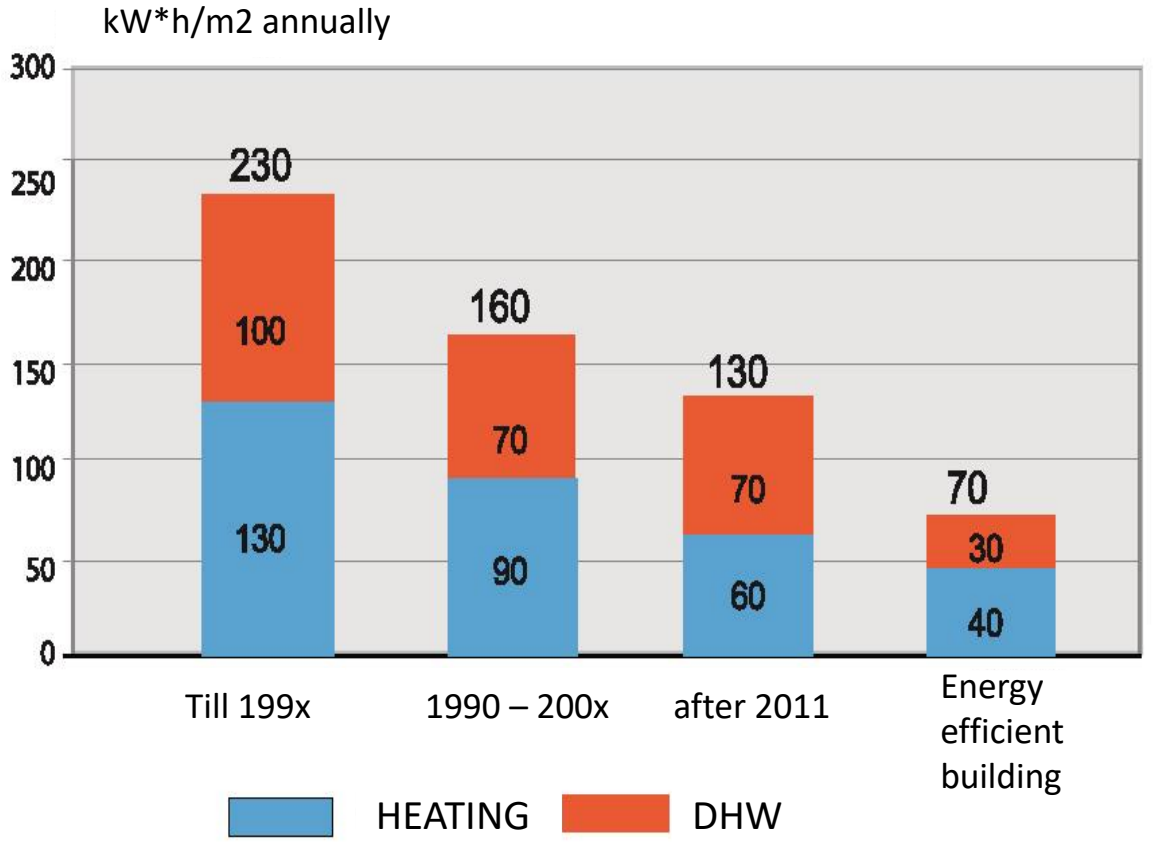
The actual level of specific energy consumption actually reflects situation with the construction approach



THE CLASS of EE for renovation – is one of the Key Performance Energy Indicators (KPEI) as it defines the degree of energy consumed reduction as per as current legislation

year

Retrofits of existing building stock

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Current construction norms and standards
define the main requirements to the thermal characteristics of the construction element

Region with different climatic zones
from 2000 to 12000 heating degrees days

		Heating degrees days D_d, $^0C \cdot$ days	Attic slab	External wall	Window	Slab above basement
			R_c, м$^2C^0$/W	R_w, м$^2C^0$/W	R_F, м$^2C^0$/W	R_f, м$^2C^0$/Вт
	I	2000	2,8	2,1	0,3	1,8
	II	4000	3,7	2,8	0,45	2,0
	III	6000	4,6	3,5	0,6	2,0
	IV	8000	5,5	4,2	0,7	2,0
	special	10000-12000	6,4-7,3	4,9-5,6	0,75-0,8	2,0

The thermal characteristics of the construction elements as per standards and codes determine the optimal technical and economic conditions

Name of parameter	Units of measure	Insulation of wall thickness 5 cm	Insulation of wall thickness 10 cm	Insulation of wall thickness 15 cm	Insulation of wall thickness 20 cm
Type of insulation material`		Mineral wool Izover OL E (IZOVER)			
Area of insulation	m^2	2480			
Heat transfer factor U value with insulation	W/м^{2*} ^{o}C	0,45	0,27	0,19	0,15
Heat transfer factor U value without insulation	W/м^{2*} ^{o}C	1,31			
Total investment cost	Euro	14180	28262	42441	56523
Specific investment cost Euro / per m^2 of insulated area	Euro / m^2	6	11	17	23
Total savings	kW*h	137850	166315	178609	185464
Specific savings per square meter of insulated area	kW*h / m^2	56	67	72	75
Total savings of consumed natural gas	M ^{3}	17231	20789	22326	23183
Total saviings	Euro	3446	4158	4465	4637

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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Case study of municipal buildings.

Multi profile Medical Centers (Uzbekistan)

This case demonstrates the examples of common conditions of existing hospitals (different cities - different climatic zones: Bukhara, Termez, Navoi, Andijon, Samarkand, Nukus) which do not comply with modern standards and codes

and some steps for establishing of EE legislation for existing building stock

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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Today, about 49% of total energy consumption, equivalent to 17 million tonnes of oil, per year falls on the buildings in Uzbekistan [1]. Most buildings constructed during the Soviet era do not meet modern standards.

In the health sector, 1336 out of 6943 buildings operating as medical facilities are in need of major renovation, and 565 facilities are located in temporary premises and are in need of new buildings. In addition, 66% of them are in need of reconstruction of heating systems and hot water supply [2].

[1] Statistical data of the International Energy Agency at www.iea.org
[2] According to data of the State Committee for Architecture and Construction of the Republic of Uzbekistan

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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- The results of analysis (including energy audits, visual inspection) have shown a typical situation for all Multi Profile Medical Centers (MMPCs):

  - The structure and thermal performance of building envelopes are the same for all medical centers
  - The current state of the heating system and the structure is similar for all medical centers (exception - Navoi MMPC)
  - In MMPCs, there is a shift from centralized heating system in the direction of decentralized ones due to the installation of gas-fired boilers, followed by modernization of internal heating pipes (Nukus, Bukhara)
  - Constructive solutions for heating, ventilation, air conditioning in some buildings of medical centers are non-compliant with requirements of the construction regulation

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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- The requirements of the current legislation obliges to carry out energy-efficient modernisation at reconstruction, major repairs or new construction of medical centers

1. КМК 2.01.04-97* Building Heat Engineering
2. КМК 2.01.18-2000* Standards of energy consumption by HVAC system of buildings and facilities
3. КМК 2.01.01–94 Climatic and physical and geological data for designing
4. КМК 2.08.04–04 Administrative buildings
5. КМК 2.04.05-97 Heating, ventilation and air conditioning
6. КМК 2.01.05-98 Natural and artificial lighting
7. ШНК 2.08.02-09 Public buildings and facilities
8. КМК 2.03.10-95 Roofs and roofing
9. КМК 2.08.05-97 Buildings and constructions, adjustable to hospitals

- Requirements to ensure technological and medical processes in health care facilities:
  - Sanitary standards and rules for design, construction and operation of medical institutions and hospitals. SanPin №0292-11

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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Key constructive solutions

- External wall made of bricks (1.5 bricks masonry) with total thickness of 420 mm, without insulation
- External wall made of prefabricated wall panels, with total thickness of 300 mm, without insulation
- Plates of attic - reinforced concrete slab with ceramsite insulation, a total thickness of 300 to 420 mm
- Windows with a PVC profile and double-glazing
- Vestibule with PVC profile glazing with single doors
- Technical unheated floor with flat soft or gable roof

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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According to the results of the surveys in all MMPCs, building envelopes in existing and new buildings do not meet the requirements of current regulations.

КМК 2.01.04-97 * «Building Heat Engineering» recommends three levels of thermal protection:

It recommended 3 levels of heat protection of the building:

I level – correspond with hygienic requirements and excluding dew point on the surface

II level - Increase of heat protection in 1,9- 2,3 times (average)

III level - - Increase of heat protection in 2,5 - 3 times (average)

Extraction from standards:

По КМК 2.01.04-97* «Строительная теплотехника»

✓ **определены степени теплоизоляции зданий, и рекомендованы три уровня теплозащиты:**

✓ **Первый уровень** отвечает санитарно-гигиеническим требованиям, невыпадению на внутренних поверхностях ограждений росы и является минимально обязательным.

✓ **Второй уровень** теплозащиты приведёт по сравнению с существовавшими нормами к увеличению теплозащиты зданий: стен в 1,9 ÷ 2,3 раза, покрытий и перекрытий в 1,7 ÷ 2,0 раза, перекрытий над холодными подпольями, подвалами, проездами в 1,05 ÷ 1,15 раз.

✓ **Третий уровень** теплозащиты превышает от первого уровеня в среднем в 2,5 ÷ 3 раза.

Case study of municipal buildings. Multi profile Medical Centers (Uzbekistan)

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ВТОРОЙ УРОВЕНЬ ТЕПЛОЗАЩИТЫ

Здания и сооружения	Heating Degrees Days	Recommended thermal resistance				
		наружных стен	бесчердачных покрытий и чердачных перекрытий	перекрытий над проездами и холодными подпольями и подвалами	окон и балконных дверей	фонарей
Жилые, лечебно-	До 2000	1,4	2,1n	1,8n	0,39	0,31
MMPCs, schools, colleges	2000-3000	1,8	2,6n	2,3n	0,39	0,31
интернаты	свыше 3000	2,2	3,2n	2,8n	0,42	0,34
Общественные, кроме указанных выше, административные и бытовые	До 2000	1,2	1,6n	1,4n	0,39	0,31
	2000-3000	1,5	2,0n	1.8n	0,39	0,31
	свыше 3000	1,8	2,4n	2,0n	0,42	0,31
Производственные	До 2000	0,9	1,4n	1,2n	0,15	0,15
	2000-3000	1,1	1,6n	1,6n	0,31	0,15
	свыше 3000	1,4	2,0n	1,9n	0,34	0,15

Regulatory minimum thermal performance is shown for medical facilities.
Indicators vary depending on the geographical location (GSOP)

Current constructive solutions of outdoor enclosures of all medical centers; external walls, floor slabs, window structures of medical centers do not meet the minimum regulatory requirements (example of one MMPC)

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The duration of the heating season	**146 days**	
The average temperature of the heating season, o C	2,4	
Degree-days of heating period	3 504 hours	
The required thermal resistance of the external wall m²*°C / W	The actual thermal resistance of the external wall, м2*°C / W	
2,2	External wall made of bricks (1.5 bricks masonry) with total thickness of 420 mm, without insulation for surgical and operating rooms buildings	**0,74**
	External wall made of prefabricated wall panels, with total thickness of 300 mm, without insulation for polyclinic and therapeutic unit buildings	**0,35**
The required thermal resistance of floor slabs м²* °C / W	The actual thermal resistance of the external wall, м 2*°C / W	
2,88	**1,78**	
The required thermal resistance of the window structure м²* °C / W	The actual thermal resistance of the window structure, м2*°C / W	
0,42	**0,3 -0,39** (depending on the thickness of the air gap in the double glass)	

РЕЗУЛЬТАТЫ

расчета удельных расходов тепловой энергии за отопительный период (кВт·час/м^2 год) по регионам Узбекистана на основе показателей нормативных удельных расходов теплоты (Вт/м^2) на отопление зданий согласно обновленного СНиПа 2.01.18-2000 "Нормативы расхода энергии на отопление, вентиляцию и кондиционирование зданий и сооружений "

№	Наименование областей	Температура воздуха наиболее холодной пятидневки, ^{0}C	Продолжительность отопительного периода (сутки)	Средняя температура отопительного периода, ^{0}C	Удельный расход тепловой энергии за отопительный период кВт·час/м^2 год при расчете по:							
					КМК 2.01.18-2000 (старая редакция):				КМК 2.01.18-2000 * (новая редакция):			
					Школы 1-этажные (при 200 Вт/м^2)	Школы 2-этажные (при 120 Вт/м^2)	СВП - 1-этажные (при 125 Вт/м^2)	Клиники-2-этажные (при 115 Вт/м^2)	Школы 1-этажные (при 100 Вт/м^2)	Школы 2-этажные (при 74 Вт/м^2)	СВП 1-этажные (при 94 Вт/м^2)	Клиники-2-этажные (при 79 Вт/м^2)
1.	г. Ташкент	-14	147,5	3,35	347	208	217	199	173	128	163	137
2.	Андижанская	-13	146	2,4	[illegible]	224	234	215	187	138	176	148
3.	Бухарская	-12	144	3,9	348	209	217	200	174	129	163	137
4.	Джизакская	-16	143,5	3,45	317	190	198	182	158	117	149	125
5.	Каракалпакстан	-19	180,5	-0,45	454	273	284	261	227	168	214	179
6.	Кашкадарьинская	-14	133,5	4,45	293	176	183	169	147	108	138	116
7.	Навоийская	-13	141,5	4,2	325	195	203	187	163	120	153	128
8.	Наманганская	-14	143,5	2,3	359	215	224	206	179	133	169	142
9.	Самаркандская	-12	152,5	4,05	365	219	228	210	182	135	171	144
10.	Сурхандарьинская	-10	112,5	5,4	263	158	164	151	131	97	124	104
11.	Сырдарьинская	-19	150	2,7	319	192	200	184	160	118	150	126
12.	Ферганская	-14	148	2,65	363	218	227	208	181	134	170	14[illegible]
13.	Хорезмская	-18	162	1,2	385	231	240	221	1[illegible]2	142	181	[illegible]52

SPECIFIC ENERGY CONSUMPTION

The heat loss through construction elements, including windows and vestibules

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The heat loss through construction elements, including windows and vestibules

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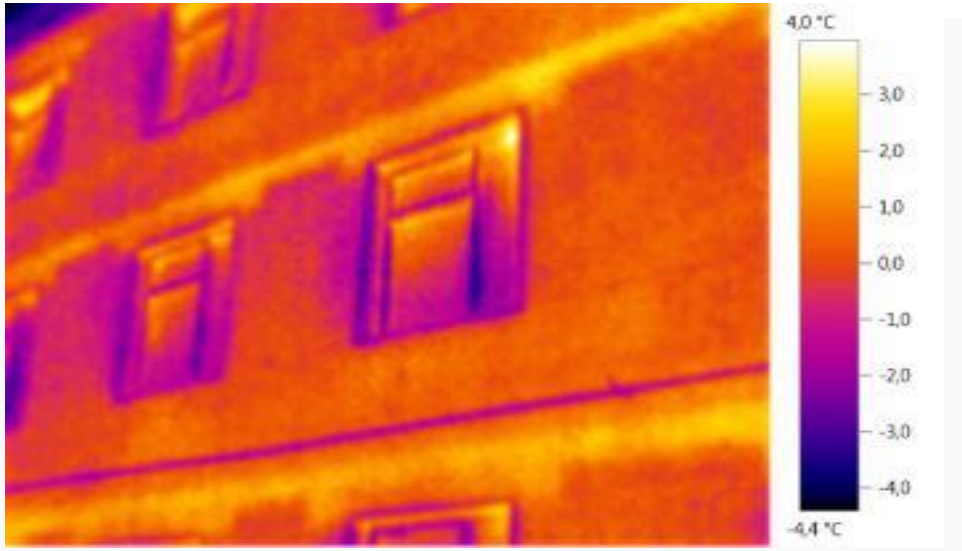
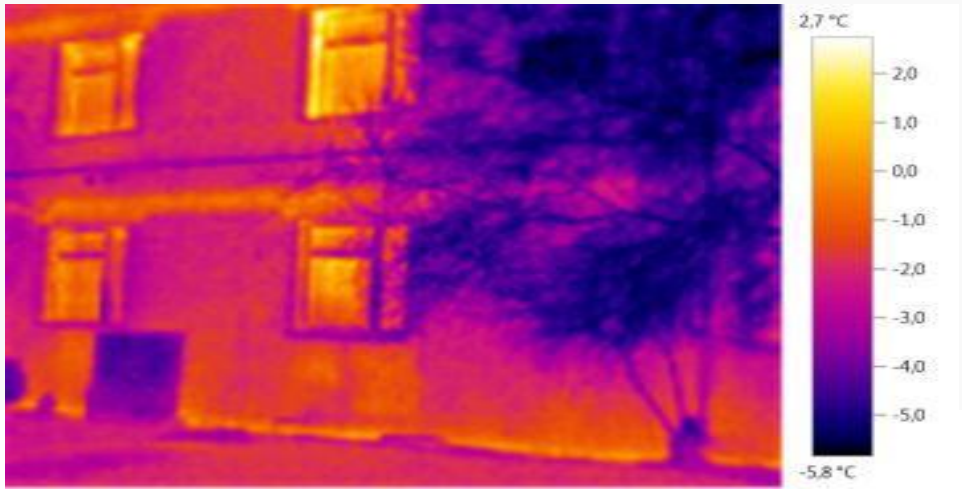
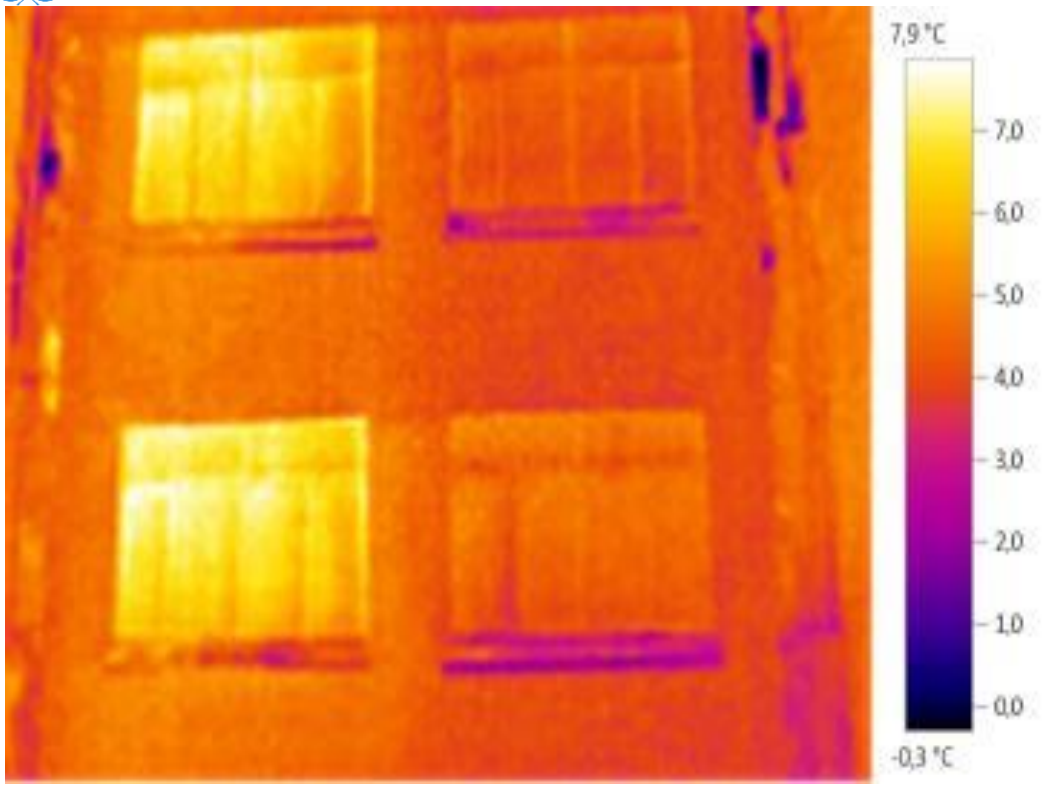




The heat loss through construction elements, including windows and vestibules

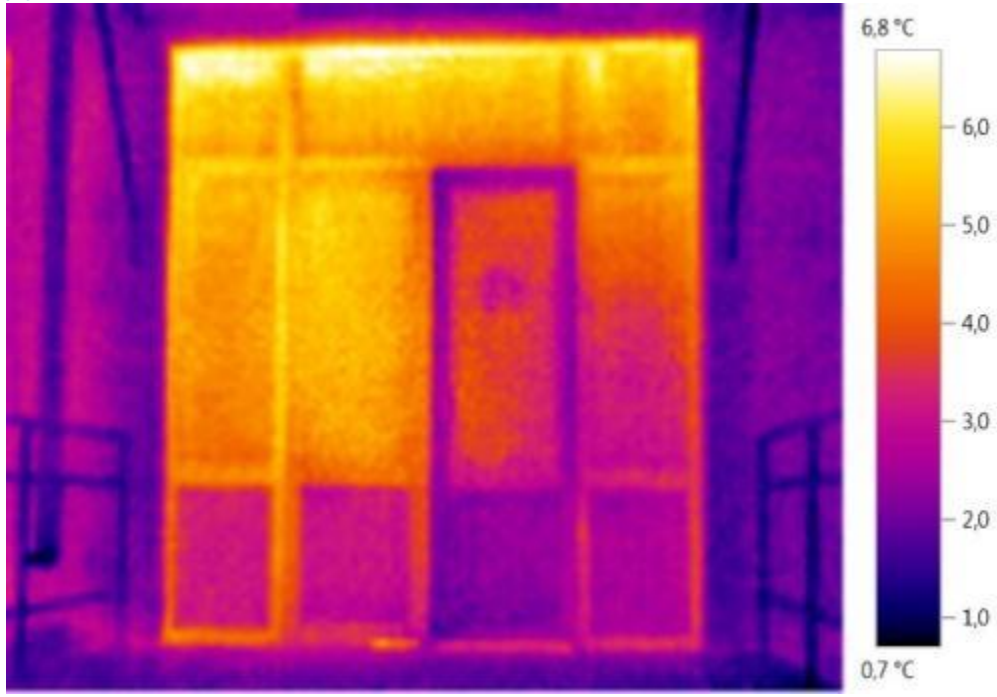


Thermal picture of a fragment of the facade with windows. Intense orange colour reflects the large heat losses through the windows in the stairwell (single glazing) and even those windows that have double glazing (right side)

The temperature of the stairwell was 14°C.

Fragment of the facade with windows for which thermographing was carried out.

The heat loss through construction elements, including windows and vestibules



Thermal picture of polyclinic entrance. The entrance is not equipped with double doors. Intense orange colour depicts heat losses

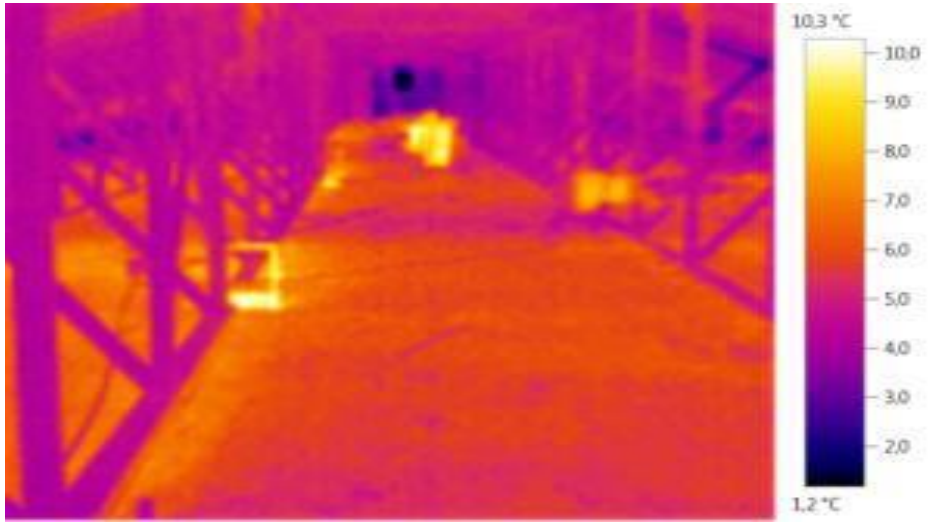
Entrance to polyclinic for which thermographing was carried out

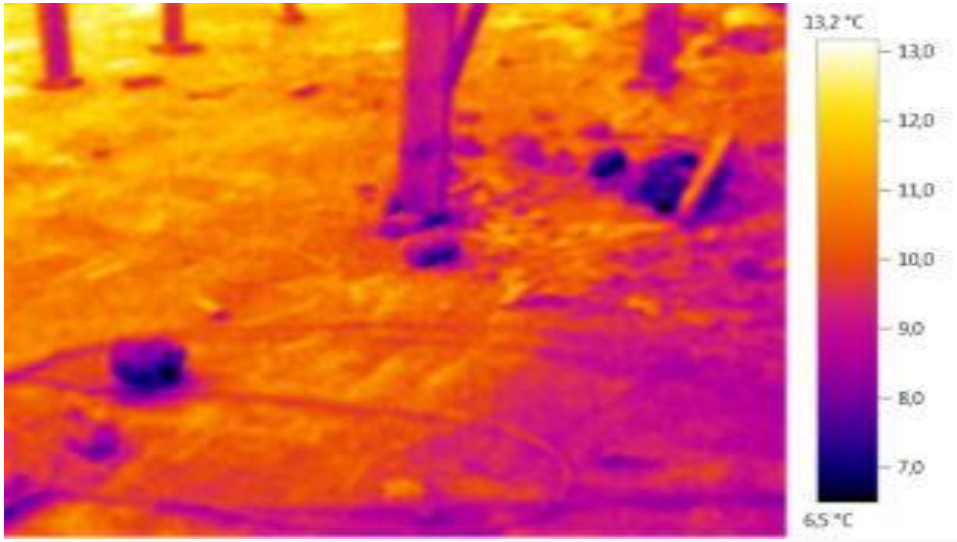
Entrance without double doors



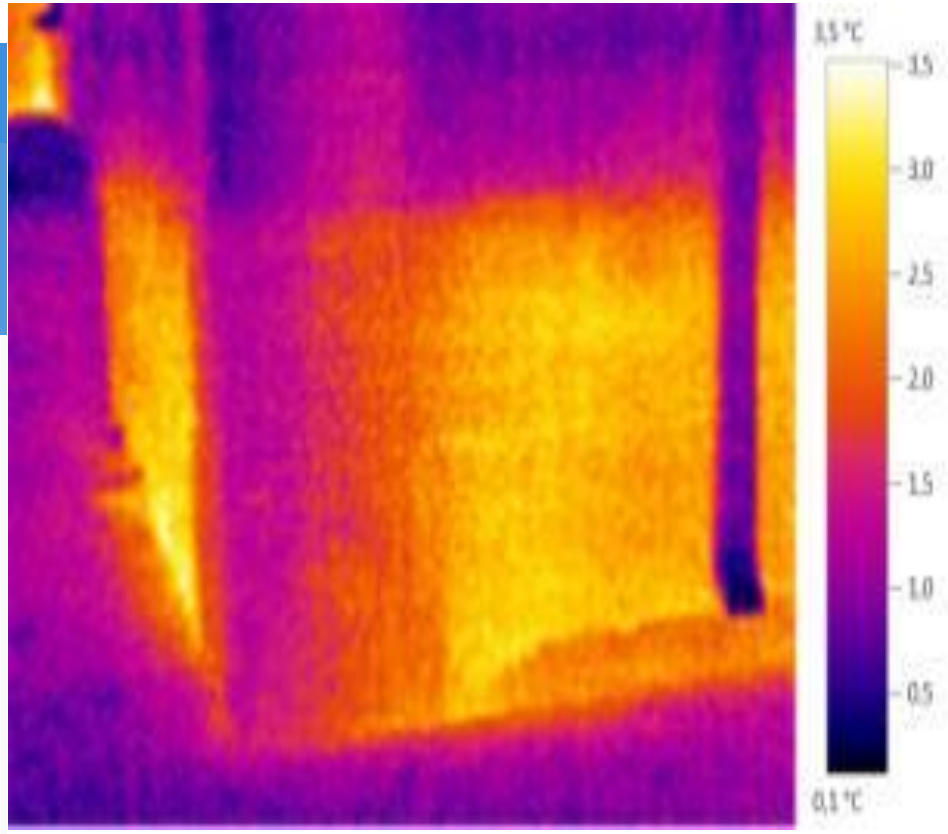
- Heat radiators are placed right after the first doors, which does not comply with requirements of KMK 2.04.05-97* “Heating, ventilation and air conditioning”
- Due to the absence of double doors, inside air temperature in public areas (staircases, hallways) varied between 10-12 °C
- Also, there are some entrances with double doors, where the distance between doors in vestibule of the polyclinic and diagnostics block does not allow to have a gateway to avoid cold air coming from outside in cold seasons.

Cold attic slabs



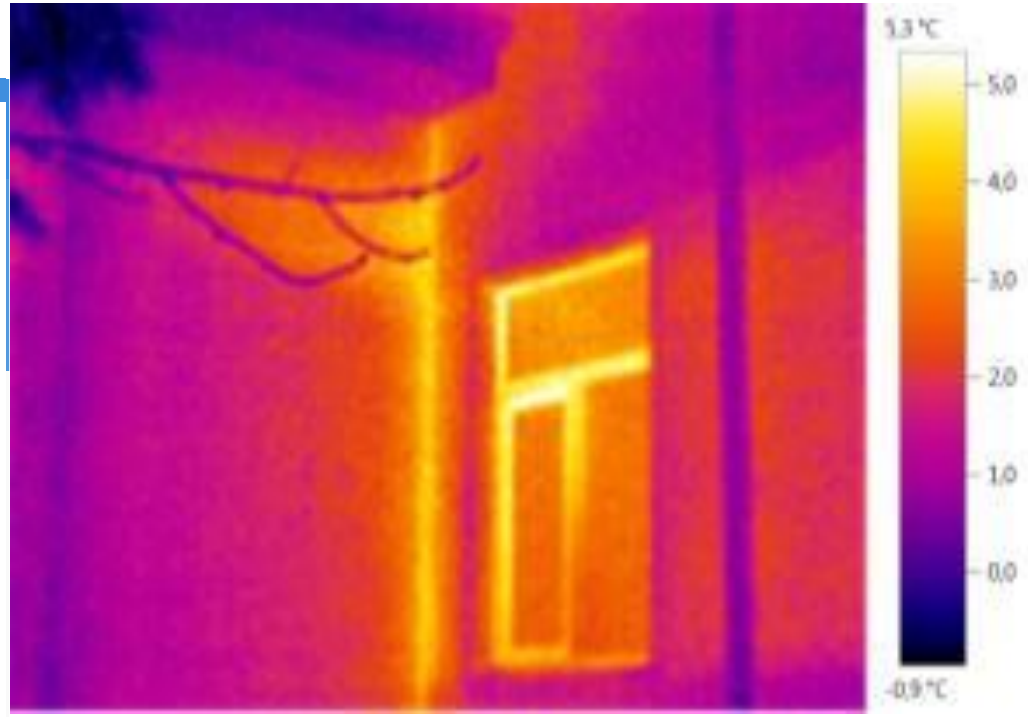


External wall of the building plinth



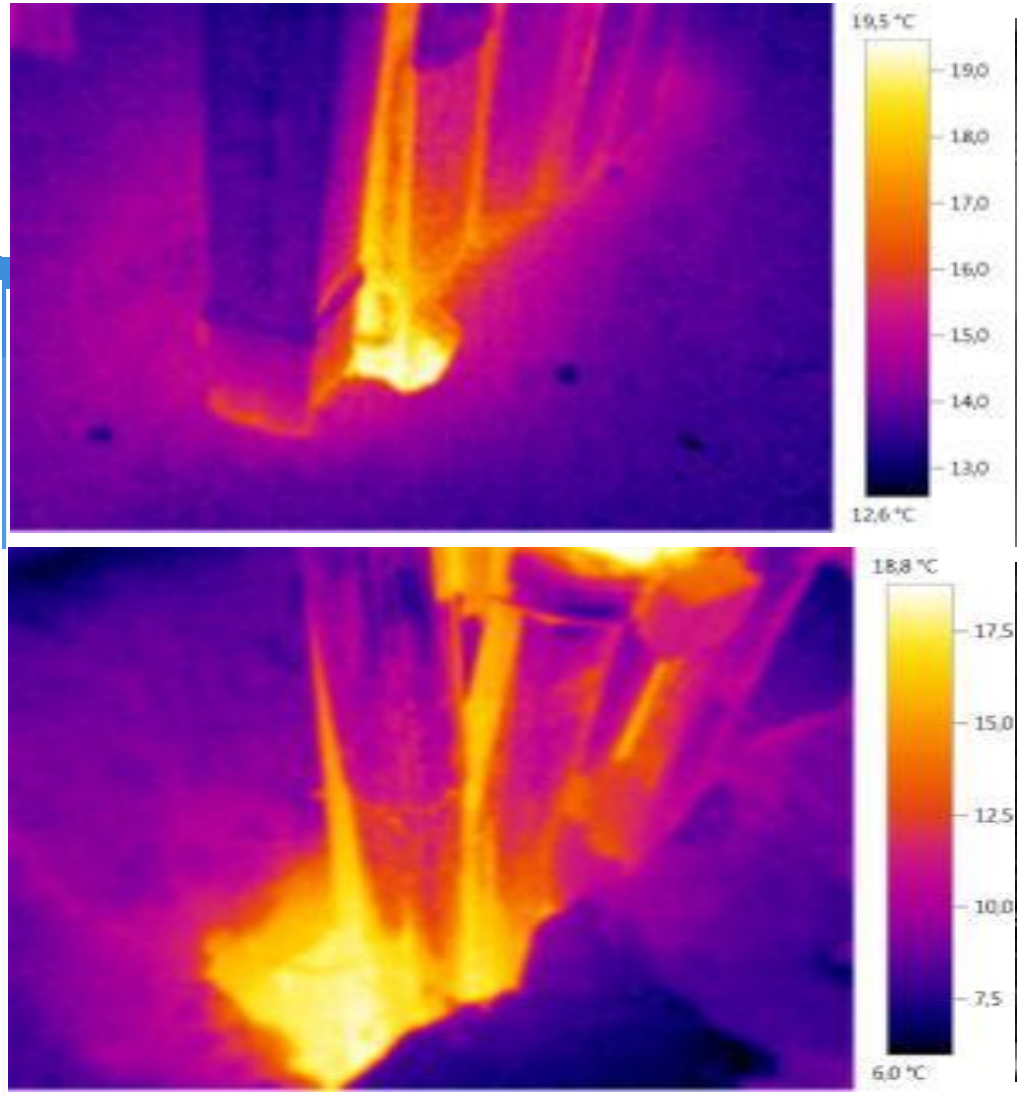
Thermal picture of polyclinic building plinth. Intense orange colour reflects heat losses through building envelope

Fragment of the plinth, for which thermographing was carried out



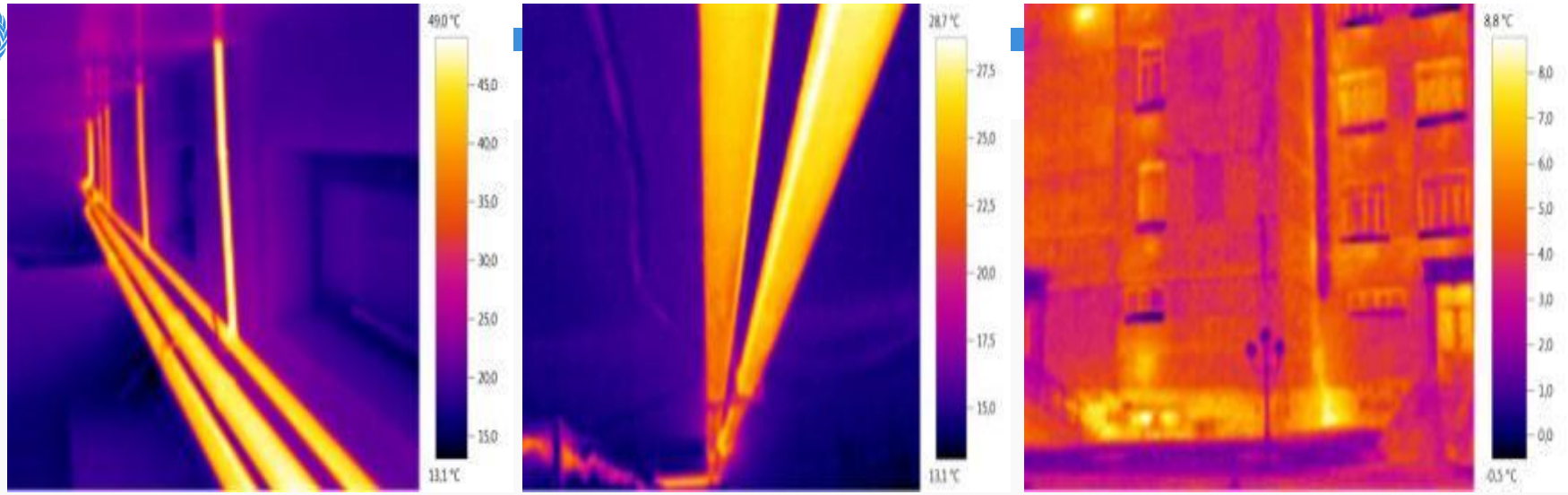
Thermal picture of polyclinic building external wall. Intense orange colour reflects heat losses through a junction between the panels.

Fragment of a polyclinic building external wall, for which thermographing was carried out



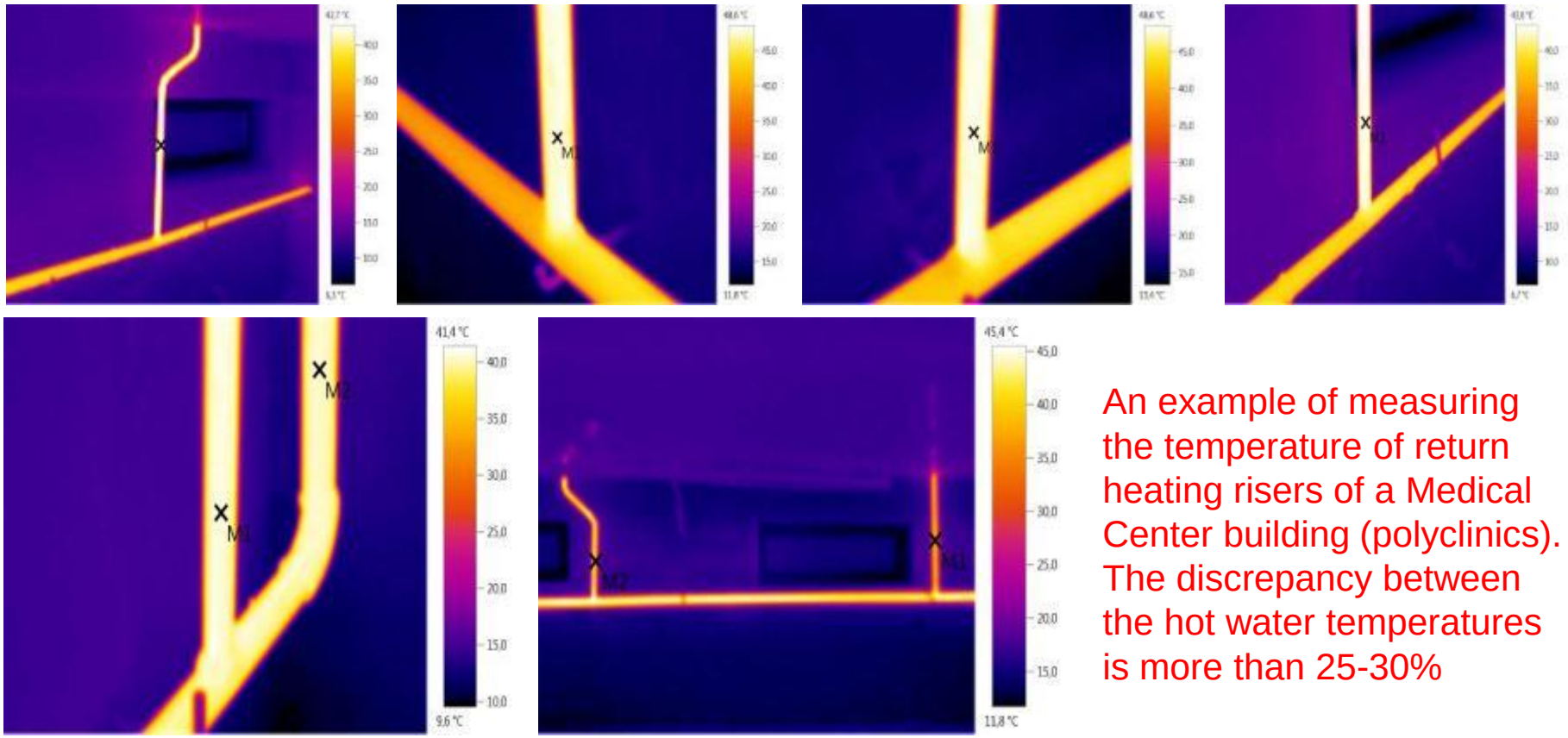
Thermal picture of cold attic slabs. Intense orange colour reflects heat losses through the gap between the output of the ventilation duct. It must be sealed.

Lack of insulation of heating system distribution pipelines



Thermographing of heating systems distribution pipelines of polyclinics. The orange colour shows the heat loss from the pipes

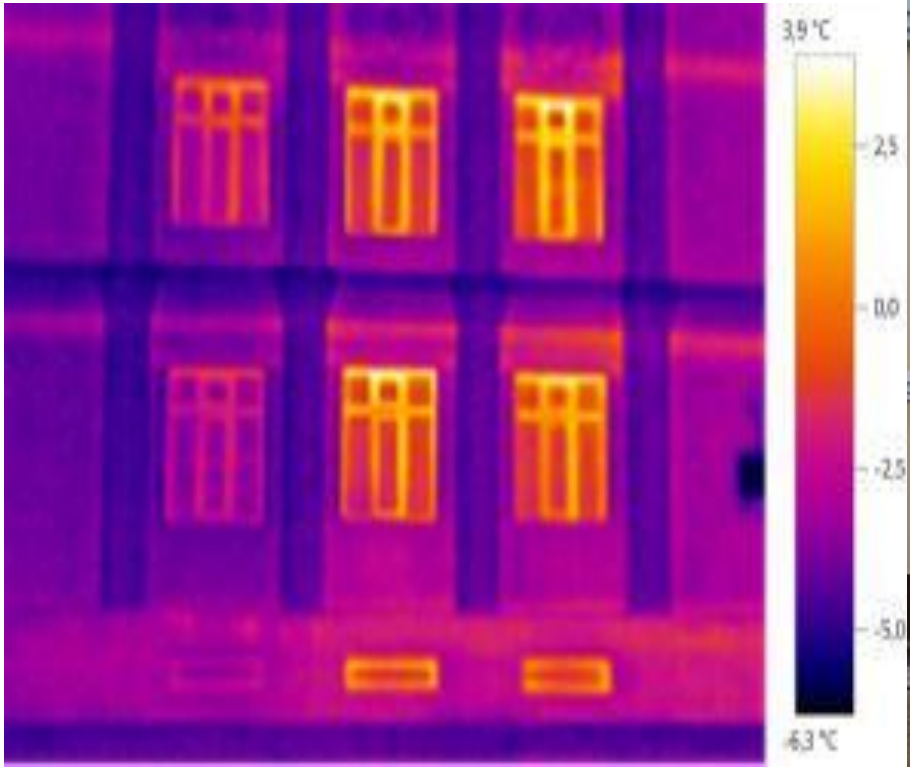
Uneven distribution of hot water in the heating system risers



An example of measuring the temperature of return heating risers of a Medical Center building (polyclinics). The discrepancy between the hot water temperatures is more than 25-30%

During energy audit of buildings of polyclinics in one of MMPCs we revealed imbalance of the heating system. While the required temperature in all risers of return heating system is 48°C, the temperature ranged from 37,2 to 48,2°C, i.e. difference is more than 11°C.

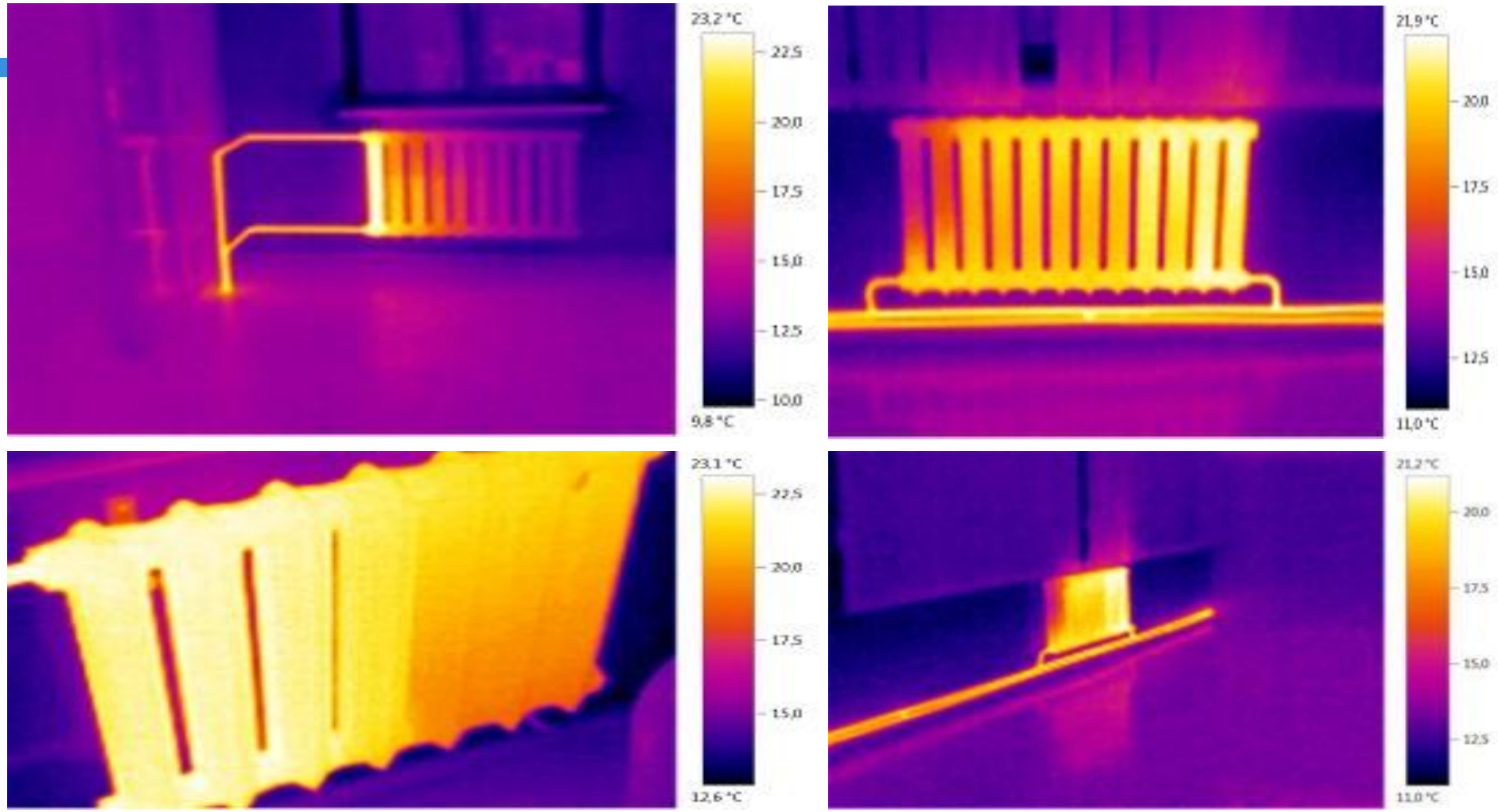
Uneven distribution of hot water in the heating system risers



Uneven distribution of colour reflects the imbalance of the heating system

Fragment of the facade for which thermographing was carried out

Inadequate temperature pressure & circulation heating systems



Examples of Heat Radiators with Insufficient Heat Capacity due to Lack of Circulation in the Heating System

Absence of individual temperature control of indoor air as per as current standard KMK HVAC

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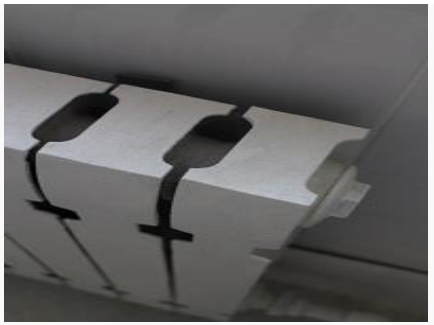
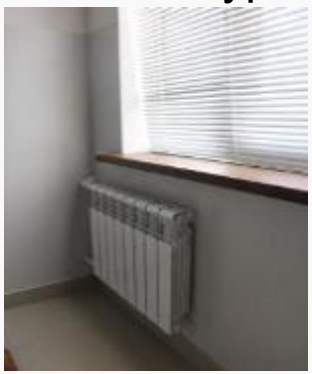


The main hospital and diagnostics block have old cast iron sectional heat radiators type MC 140 AO.



Regulation of heat radiators with thermostatic valves is not provided