SUNShINE
SAVE YOUR BUILDING
BY SAVING ENERGY

Renovation of multifamily buildings using Energy Performance Contracting

Documenting deep renovation

PROJECT REPORT

The situation before, the measures, the process

CONTENTS

Introduction

The renovation and the implementation of energy efficiency measures in buildings is a complex and interdisciplinary process, which requires detail planning, engineering studies, and strict supervision. All these aspects are important for achieving the expected levels of energy savings.

As part of the SUNShINE project, ESCOs and Salaspils Siltums district heating company have been working for the renovation of more than 30 buildings, of which five projects were completed by 2020. The main objective of these renovation projects was the achievement of high energy savings at the most economically favourable conditions for apartment owners. The achievement of energy saving and therefore the quality of the construction works was of paramount importance.

This report documents the process of a deep energy efficient renovation of a multifamily building, from kick-off to commissioning; gathering field experiences from the ESCOs. It includes a documented description of the process flow, collection of practical experiences, typical problems encountered during renovation to reach high quality construction standards,

Chapter 1 presents a general description of multifamily buildings before renovation, including relevant technical data.

Chapter 2 gives an overview of the renovation measures, including important aspects of the renovation process and description of the adopted solutions and technologies.

Chapter 3 focuses on the process

103 series

467 series

316 series

464 series

Typical multifamily buildings in Latvia as they were built

1. The situation before renovation

Multifamily buildings made from the 60ies to the late 80ies in Latvia have several common problems. Building technical condition largely varied case by case, having some of building rather well maintained and other in critical conditions with years of deferred maintenance. However, even for well-maintained buildings, the energy efficiency potential and the needs for energy efficiency improvement measures are recognised. In some cases, building owners already took the initiative to implement few easy energy efficiency measures, such as the technical insulation of heating and domestic hot water pipes or the loft thermal insulation. In several buildings apartment owners year by year have already been replacing old leaky windows with new plastic profile windows. Low quality, wrong installation and poor consideration regarding indoor air exchanges, often increased indoor relative humidity rate leading to condensation problems and the risk of mould growth.

Here a quick overview of the current situation. As example for description, a 467 series building, renovated as part of SUNShINE is used as reference. This is a very common building type in Latvia.

1.1 Walls

The outer walls of the 467 series buildings are made of expanded-clay concrete panels (*keramzītbetons*). Wall thickness was measured in different places of the building during the energy audit. Table 1.1 shows these values, including the relative heat transfer coefficient[1] and the calculated value for specific heat losses.

Table 1.1. Constructive parameters of outer walls.

Place of measurement	Material of outer wall	Thickness, m	Heat transfer coefficient*, W/(m²K)	Heat losses through 1 m² during heating season, kWh/m²
End walls	Expanded-clay concrete panels	0.30	1.18	124.3
Facade walls	Expanded-clay concrete panels	0.30	1.18	124.3
Staircase walls	Expanded-clay concrete panels	0.30	1.18	124.3
Blocks between windows	Aerated concrete	0.15	1.16	122.2

The data given in Table 1.1 shows that one square meter of outer wall during the heating season loses between 124.3 and 122.2 kWh/m² of heat energy.

The Latvian building code (LBN 002-19) indicates a heat transfer coefficient value of 0.23 W/m² K for new buildings. In general, these panel buildings are five times below current normative values, showing significant energy efficiency potential.

[1] Heat transfer shows how much energy in watts is lost through one square meter of wall if the difference between outside and inside temperatures is one-degree Kelvin.

1.2 Windows

There are two different types of windows installed in this building:

- double-glass window units with plastic frames, recently replaced by apartment owners with heat transfer coefficient ranging from 1.1 to 2.4 W/(m^{2}K).
- double-glass windows with joined wood frame flap with a heat transfer coefficient of 2.8 W/(m^{2}K).

These last types of windows are outdated and warped, therefore cannot be closed properly and allow great air leakages.

The Latvian building code (LBN 002-19) indicates a heat transfer coefficient value of 1.1 W/m^2 K for new windows.

1.3 Roof and attic

The slab of the attic is made of hollow reinforced concrete panels (220 mm). These slabs were typically covered with a 100-150 mm layer of a mixture of slag and ashes and then with 30 mm of concrete. The heat transfer coefficient for this construction is estimated at 0.82 W/(m^{2}K). The Latvian building code (LBN 002-19) indicates a heat transfer coefficient value of 0.2 W/m^2 K for this building element. Moreover, the roof presented different technical problems. The hydro insulation cover was heavily weathered and damaged, resulting in rainwater infiltration. During the re-construction works structural problems of the roof appeared to be even more serious, with corrosion reaching steel bars in the reinforced concrete panels.

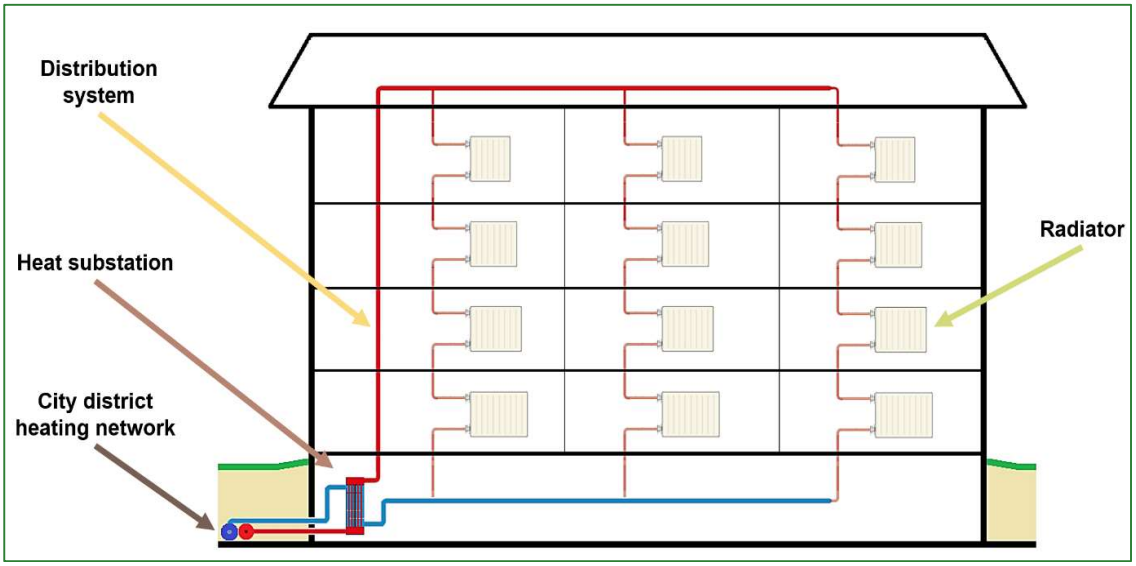
1.4 Basement

The basements of these building are not heated. Unheated basement means that heat energy losses occur between the basement and the apartments of the 1st floor through the basement ceiling. Heat transfer coefficient for ceiling is in the range of 1.36 W/(m^{2}K). The basement also houses the heat substation where energy from the district heating system is supplied to the building's space heating and domestic hot water (DHW) systems.

1.5 Space heating system

The space heating system of most of multifamily buildings in Latvia is called “one-pipe system”, because the heat transfer elements are connected to the heat source by a single, one-way, hydraulic loop. The main elements of the system are:

- Heat substation,
- Heat distribution system,
- Heat transfer element (convector / radiators).



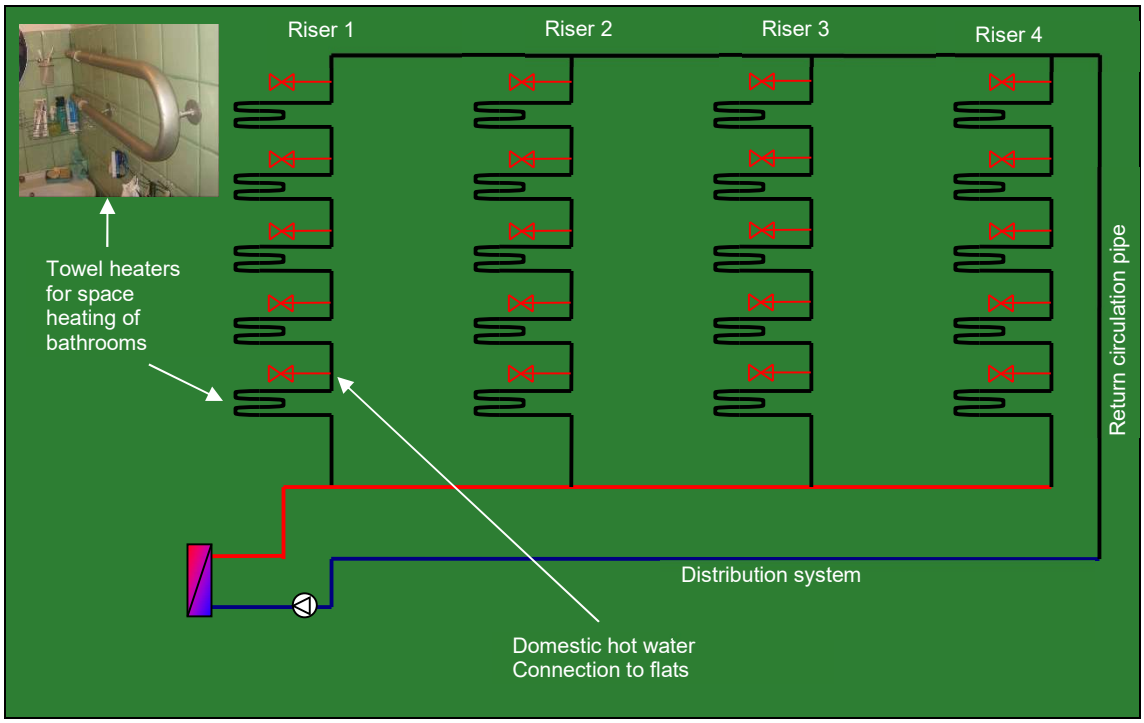
The space heating distribution systems are often in poor technical conditions, with very poor level of thermal insulation, rusted and leaking pipes, with considerable heat losses.

Heat energy delivered by the space heating system is transferred to the apartments both by radiators and convectors. The original system was designed with the use of convector only. Radiators have been installed later by apartment owner private initiative. The newly installed radiators are often oversized. This modification of the original design has strongly unbalanced the heating system, bringing uneven temperature distribution among the flats of the building.

Both radiators and convectors were not equipped with thermostatic control valves for room temperature regulation.

1.6 Domestic hot water system

The original domestic hot water system typically consists of one riser serving toilers and bathrooms and one riser for serving kitchens.



The risers supplying hot water to the flats are un-insulated pipes running in a vertical shaft. Also, towel heaters are connected to these risers. These towel heaters work as additional space heating units in wintertime, but also works in hot summer days!

1.7 Comfort level

Buildings are only effective when the occupants are comfortable, otherwise they will take alternative means of heating or cooling a space, such as auxiliary electric heaters or window-mounted air conditioners. This substantially worse energy performance. Low level of comfort also substantially affects people health.

Thermal comfort is subjective and typically difficult to quantify. It depends on the air temperature, humidity, radiant temperature, air velocity, metabolic rates, and on clothing.

Indoor air temperature is the first obvious and most important indicator, which characterize the comfort level. In residential buildings a minimum air temperature of 20°C is expected (and better if it can be set at different values in different rooms). Multifamily buildings can get unevenly heated due to uncontrolled replacement of terminal units and lack of proper hydraulic balancing solutions. Problems of overheating are not anymore detected as it was some 10-15 years ago. However, underheating of apartments most exposed to heat transfer is often an issue (first and top floor, apartment at the corner of the building).

2. Measures for building comprehensive renovation

2.1. Insulation of outer walls

High energy losses occur through the fabric of the walls. Improving insulation here is an important measure, which help both to save energy and to protect the building from further deprivation. In comprehensive energy efficient renovation, façade walls and plinth are important factors in the protection of a wall's structural components and energy efficiency of the building.

The first step in comprehensive energy efficient renovation is the preparation of the exterior walls, which is called substrate. Before the application of thermal insulation, the substrate must meet the necessary air tightness and mechanical strength requirements. All joints between panels (like in the 464 series) and brick (like in the 103 series) are adequately refurbished (application of sealing membranes, special plasters, and mechanical reinforcement).

In comprehensive renovation, for the thermal insulation of exterior walls, two methods are the most common:

1. External Thermal Insulation Composite System (ETICS), is one of the most common ways to insulate a solid external wall by applying thermal insulation boards to the external fabric of the building and protecting it with a specialist render. An important detail among other is the final finishing, which must be flexible and resistant to atmospheric agents (water, frost, temperature changes, UV).
2. Ventilated façade is a high-performance solution which takes advantage of mechanical anchoring elements. Thermal insulation boards are applied to the external fabric of the building and then protected with facades cladding mechanically fixed to the anchoring system. An air gap is placed between the facades cladding the thermal insulation, removing excess moisture.

To comply with current building codes, the thermal insulation of outer wall is carried out with at least a layer of 150 mm thick thermal panels. Mineral wool is the most common solution applied to these buildings, which is one of the safest and most durable insulation materials.

Strict supervision of the works and training of the construction company took place throughout the renovation works.

While the energy savings from foundation and plinth thermal insulation are less than that of above grade (for the same U-values), the effects of this measure is important; in particular because it goes side by side with moisture management of the basement. After digging works around the building, the foundation walls must be cleaned and if needed structural repairs must be implemented. Before the application of thermal insulation, the application of suitable hydro insulation is needed. When the basement is a heated area the wall shall be insulated for the full depth, otherwise a depth of 50-80cm is typically enough.

The implementation of these rehabilitation measures requires specialized workforce and must be carefully supervised to ensure that all the manufacturer's specifications are considered. For ETICS systems is important the preparation of the substrate, the installation of the thermal insulation boards, anchor density, proper use of support profiles, application of reinforcing fibre glass mesh and application of base coating and final specialist render. For ventilated facade a critical aspect is the installation of the frameworks and the installation of the cladding system.

The designer must pay attention to avoid thermal bridges, which are area with significantly higher heat losses than the surrounding materials. This results in an overall reduction of energy efficiency, but also can results in problem with water condensation and mould.

2.2. Replacement of windows

The replacement of doors and windows are necessary measures, which requires attention to site supervision during the installation phase. This must ensure effective sealing between sills, jambs and window frames for proper air tightness.

Old and poorly installed windows have been replaced in order to increase energy efficiency, to maintain indoor comfort level, to reduce noise level, radiation of cold surfaces, and to eliminate draught effect in the premises. The needed level of natural ventilation has been guaranteed by installing specific ventilation valves on all windows.

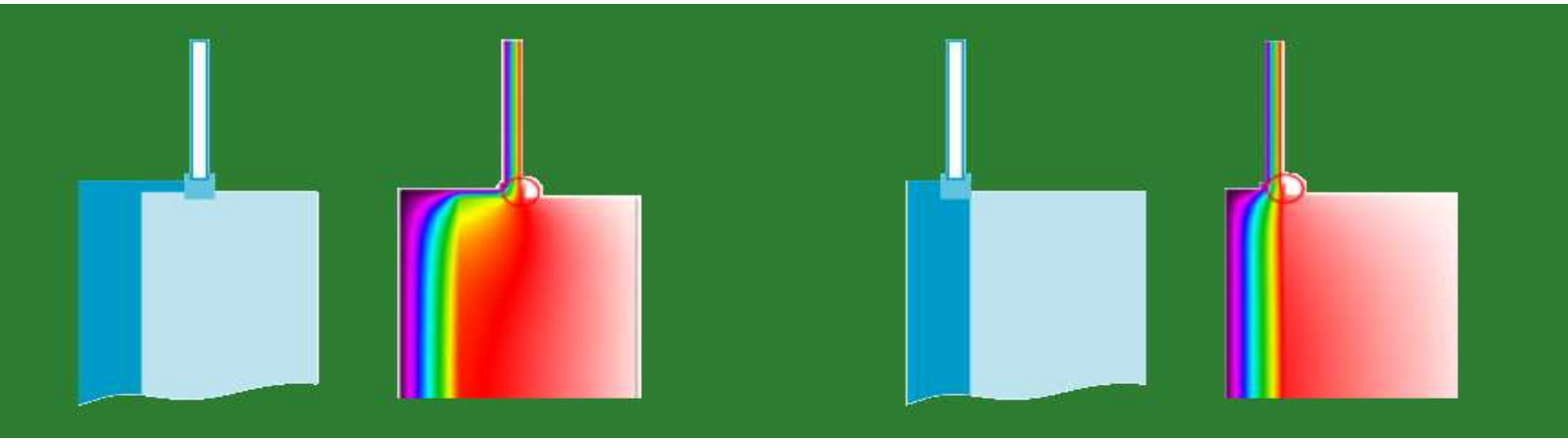
Window's performances then are function of:

- Number of panes of glass (double or triple);
- Specification of the glass, profiles and sealing used;
- Installation strategy.

Double glazing is now a minimum requirement when replacing windows but specifying triple glazing on all building or on the North facing sides of a building can offer further comfort and energy savings.

High performance glass is recommended ('low-E' glass). This has a coating applied to it to improve insulation properties, which reflect heat either back into the room or prevents it from entering the space from outside.

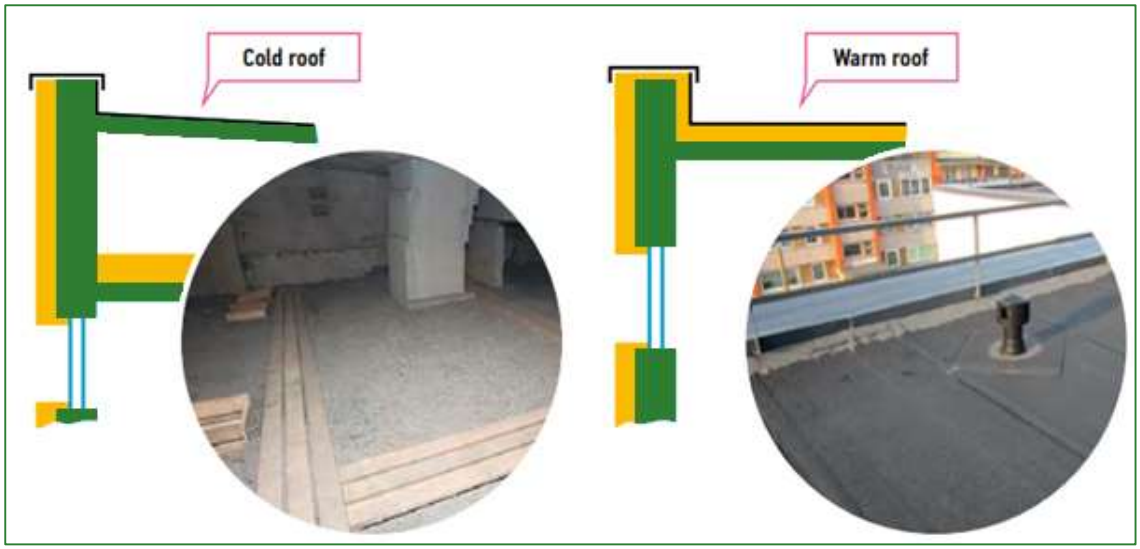
The installation strategy of a window is also very important; this must aim at minimizing thermal bridges.



2.3. Thermal insulation of the roof and technical attic

Installing lot insulation in an uninsulated pitched roof or technical attics (cold roofs) is likely to be the most cost-effective way to improve the efficiency of a building fabric. Loose thermal insulation materials (like 300mm of loose mineral wool or cellulose fibres) are typically the easiest options. For a walkable technical attic high density thermal insulation board protected with a concrete slab is a good, but more expensive, solution.

Flat roofs with warm deck (warm roofs) in building without lot and technical attics is more difficult and expensive to insulate than cold roofs; however, this measure is appropriate for uninsulated roofs. This is carried out with at least 200mm thermal insulation.



Before the implementation of this energy efficiency measure it is always important to ensure that the roof is in good technical conditions. In all cases the installation of thermal insulation must be carefully designed and planned to ensure there are no thermal bridging problems (in particular, between the wall studs and the attic slabs). For cold roofs it is imperative that the attic area is ventilated to prevent condensation.

2.4. Thermal insulation of the basement ceiling slab

The thermal insulation of the basement ceiling slab is particularly relevant for cold unheated basements. For implementing this measure is very important to empty the cellar, so that the insulation boards can be freely installed on the substrate. Also, electrical cable, lighting points and distribution pipes should not obstruct the application of insulation and be either removed or properly embedded in the insulation layer.

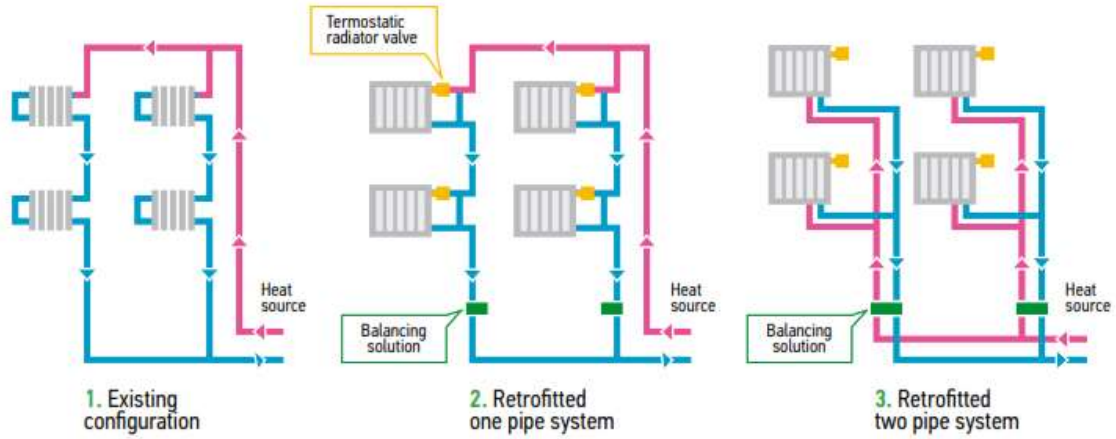
The most common construction method for this measure is the composite system by applying thermal insulation boards to the ceiling of the basement and protecting it with a base coating with emended fibre glass mesh. As alternative there are on the market solutions with visible surface of the insulation board already pre-painted/coated. The thickness of the insulation is typically at least 100mm.

2.5. Space heating system of the building

Most of the existing multifamily residential building in Latvia are equipped with one-pipe heating systems without by-pass for low control. These systems are most of the time outdated and needs substantial improvements. For renovating these systems there are two main options:

- The retrofit of the heating system using the same one pipe configuration,
- The installation of two pipe systems.

In most of the case the retrofit of the heating system using a one-pipe configuration is recommended, because it enables good control and heat distribution with more affordable investment costs. The main limitation is metering, as individual heat metering by flats is not possible.

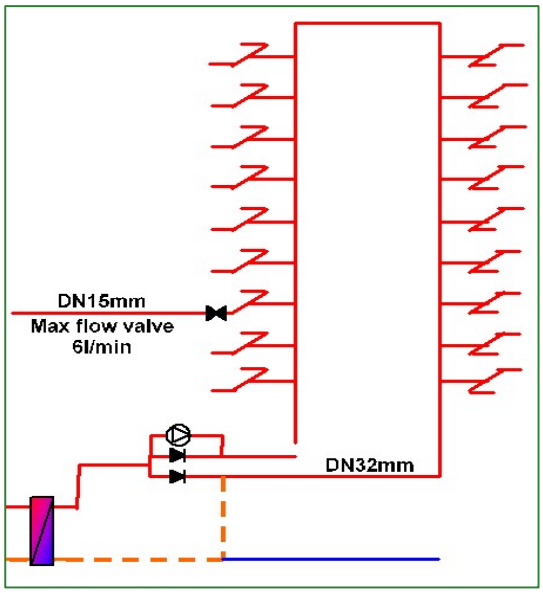


Independently from the system configuration, when renovating a heating system all main distribution pipes in the basement and technical attic must be insulated using ad-hoc technical insulation solutions. Then the system must include the installation of thermostatic radiators valves and suitable balancing valves for even temperature distribution throughout the building.

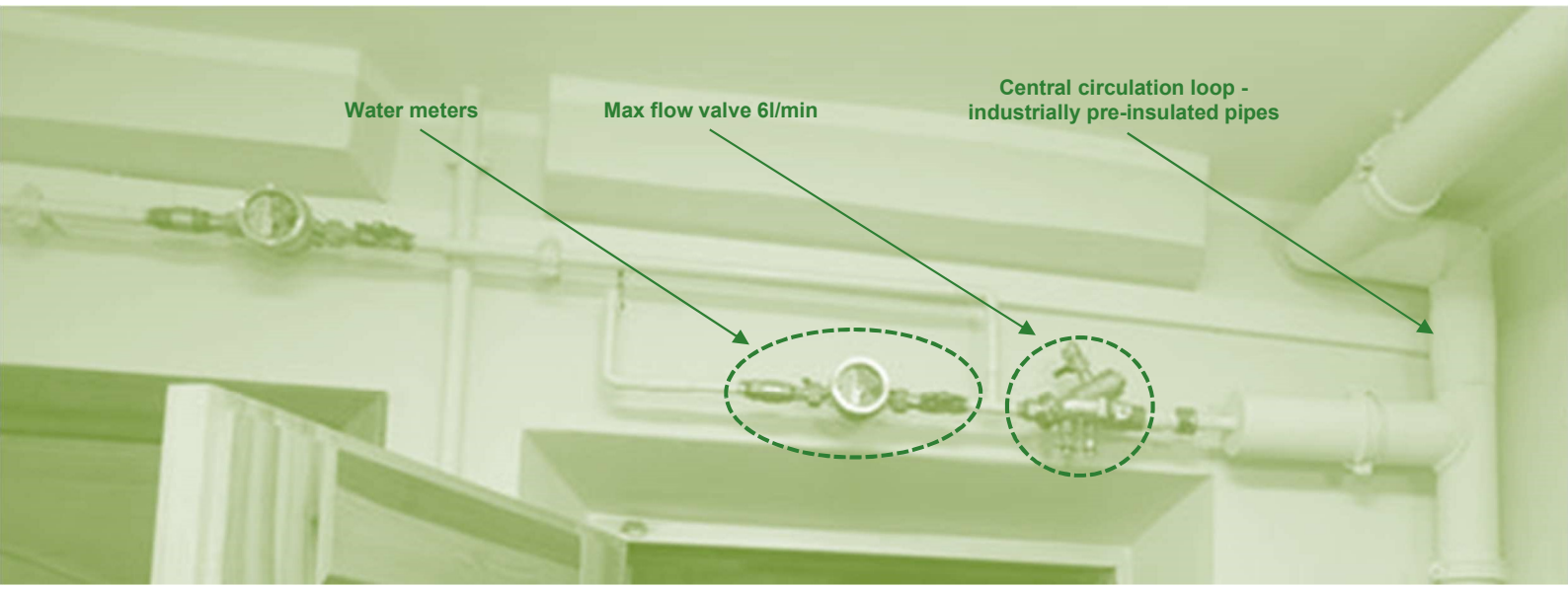
2.6. Domestic hot water system

In a comprehensive energy efficient building renovation, the old centralised domestic hot water system is renovated; these are possible solutions:

- The existing system is decommissioned. Bathroom towel heaters are connected to the space heating system and a new domestic hot water system is installed. The circulation loops of the new system is planned minimising pipe diameters and the total length, which will results in high energy efficiency levels compared to the original configuration.
- The existing system is retrofit, replacing all distribution pipes, but using the same system configuration.



For the first option, for example, the circulation loop can be installed in the staircase, consisting of industrially pre-insulated pipes, which guarantee the highest quality in terms of thermal insulation, performances and durability. The flats are then connected to the circulation loop with 10-15mm diameter pipes. The maximum flow rate was limited with flow limiter for better control of domestic hot water consumption. New water meters can be installed for each flat in the staircases.

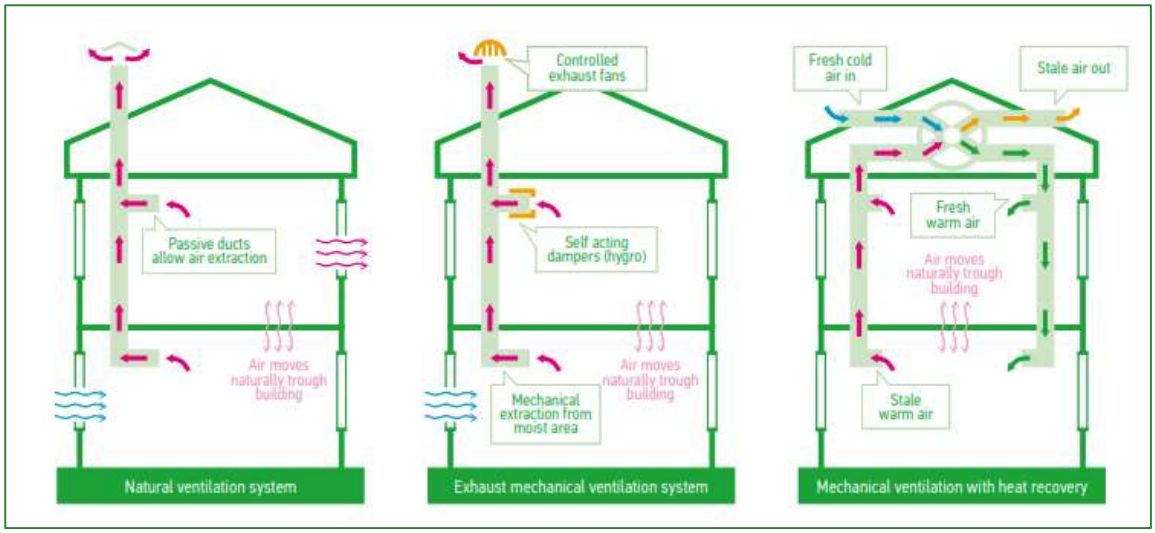


2.7. Ventilation system

Ventilation systems supply air to the space and extract polluted air from it. Ventilation systems vary widely in terms of size and the functions they perform. The ventilation system is very important, because proper ventilation avoids water condensation and mould in apartments.

The design and specification of a building ventilation system has a big impact on energy use. Sometimes natural ventilation provides the best solution, while in other cases mechanical ventilation with heat recovery is needed. This depends from building type, use and occupancy.

The specific system must be decided by ventilation experts during energy auditing and project design; looking at the different options ranging from a fully centralised balanced ventilation systems or a decentralised hybrid ventilation system.



2.8. Energy monitoring system

Energy monitoring is used for checking energy performance, temperatures in apartments and react on complaints. Depending on the complexity and requirement, a monitoring system for multifamily buildings can measure:

- outdoor temperature,
- temperature in the technical attic,
- room temperature in all, or a sample of apartments,
- temperature in the basement,
- energy consumption for space heating and domestic hot water.

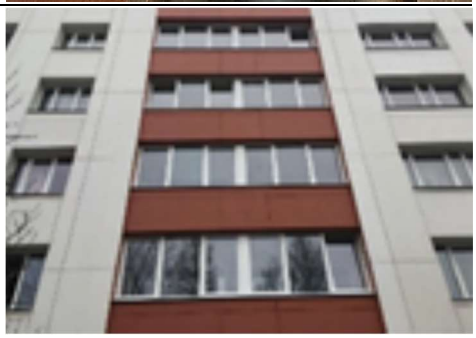
The monitoring system continuously checks for alarms. For example: if the temperature in an apartment goes below the contracted comfort standard, or energy consumption is above expected levels.

As the ESCO provides an energy efficiency guarantee, energy monitoring is an important aspect of its business.

2.9. Measures implemented to improve the technical and visual conditions of the building

Multifamily buildings in Latvia, need comprehensive renovation. This extends their lifetime for at least 30 years. Therefore, several other measures are needed besides energy efficiency measures. These measures improve the visual and aesthetical aspects of the building and solve any eventual structural, operational and maintenance issues. This is a list of issue of measures that may occur and be right to be implemented as part of the project.

Measure	Description	
Roof renovation	Roof renovation must always be assessed. Installing thermal insulation in the technical attic with a leaking roof is a waste of capitals. Sometimes also structural problem and latent conditions are present. For example, corroded reinforced concrete of the roof slabs is a potential problem.	
Renovation of ventilation shaft	Ventilation shafts often suffer from deferred maintenance and are in critical technical conditions. In the technical attic shaft are not insulated. Insulation of shafts in the technical attic prevents formation of possible and unwanted cold air lofts. Chimney on the roof shall also be refurbished as part of roof renovation works	
Refurbishment of building entrances	As part of façade renovation works, the renovation of the entrances to the building must be included. If not, this area will be source of future localised problems to the façade. A new walkway for carriages, bikes and disable people shall also be planned, as during the construction works this will be partly removed or demolished.	

Refurbishment of the staircase	Windows replacement, piping works for the heating and domestic hot water system, workers waking through means that at the end of the renovation works, the staircases must be refurbished. Re-plastering and painting of the inner walls and deep cleaning of the stairs are needed.	
Engineering networks	The refurbishment of the space heating and domestic hot water systems are obvious energy efficiency measures. However, during a comprehensive building renovation, addressing cold water, sewerage and electrical systems is an option to consider.	
Reconstruction, closing of loggias	Buildings with inner loggias typically have fences in very bad technical conditions, with rusted metal frames. Closing these loggias with energy efficient glazing solutions is an efficient and appreciated measure.	

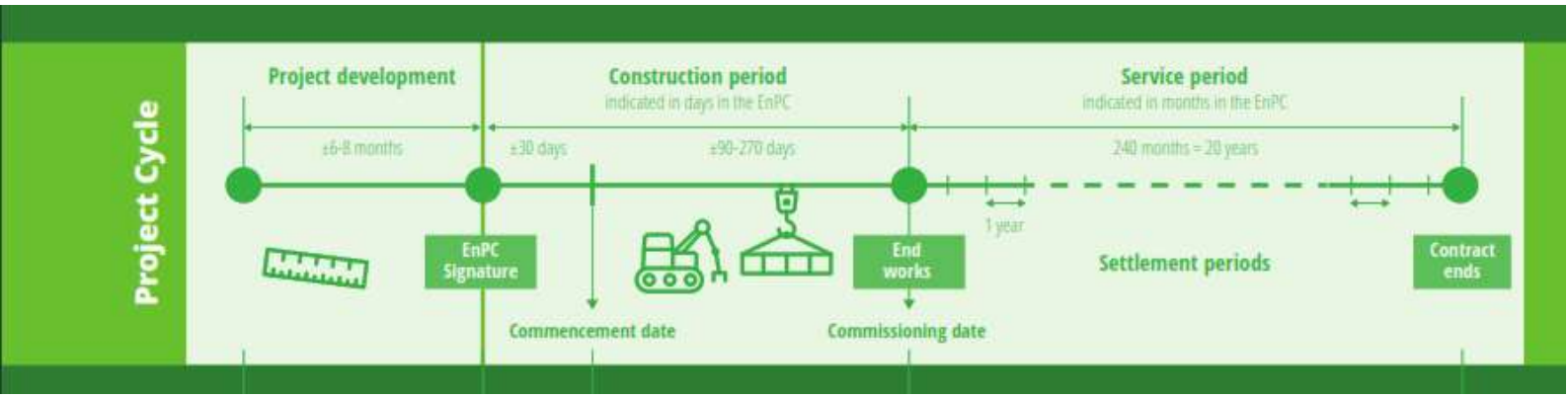
3. Project process for comprehensive building energy renovation

The project cycle for the renovation of a multifamily building is divided between three main phases (see Figure 1):

1. project development,
2. construction and installation phase, and
3. service period.

The main milestone of an ESCO is to reach the signature on the Energy Performance Contract (EPC), which will ensure a long-term service contract. This requires substantial preparation works and marketing activities for convincing apartment owners. During this phase also project financing must be arranged and agreed. The development phase, which brings to the signature of an EPC is long, time consuming and with uncertainty regarding the final output: the signature of the EPC. On the other hand, apartment owners would not sign a 20 years long term contract without the project being clearly developed and visualised. Therefore, in SUNShINE, ESCOs have divided the process in two parts:

- marketing and project development: here the ESCOs reach apartment owners, explain the project outline and try to sell an agreement called: Accession contract to energy performance contracting or in short Pre-EPC. This Pre-EPC is a short-term service contract for the development of the project technical documentation, ALTUM funding application, selection of Contractors for building and installation works, arrangement of funding options, etc…
- energy performance contract: here the ESCOs based on the developed project offer an EPC for the construction and installation works, project financing, maintenance service level and the energy guarantee. This is the long-term contract of typically 20-years.

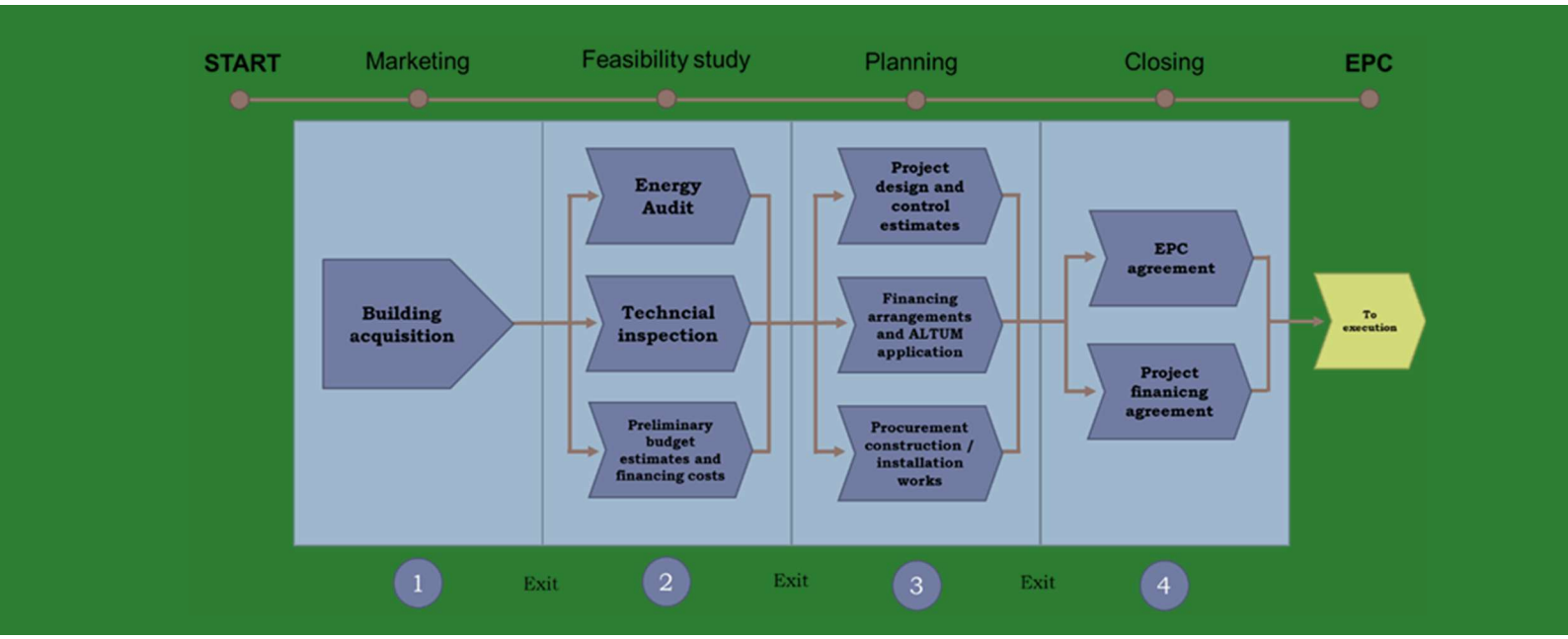


3.1. Project development phase

Renovating a residential building is a very time-consuming and difficult process. It takes a lot of time for apartment owners to agree and decide on this long term and complex projects. During this phase, the project can take unexpected turns, from one general assembly meeting with everyone in favours of a renovation project, to the next meeting with the majority of apartment owner pushing for more information or for stopping the project.

Project development for a multifamily building has four main phases:

1. Marketing, where the provides information to apartment owners and try to sell its services
2. Feasibility study, where the gains information about the building and presents the results to apartment owners
3. Planning phase, where the results of the feasibility study are translated in a full project design, project financing is secured and a Contractor for works is selected.
4. Closing, where the provides a service level agreement for the execution of the works, operational and maintenance service and energy efficiency guarantee.



Box 1 - Experience from Salaspils

*Apartment owners who live in **7 Meža Street** have been considering the idea of thermal insulation for long time. Their first interest date back to 2012, but several aspects were prevented the project to kick-off: project budget and sceptical homeowners among all. The persistent work of Salaspils Siltums in leading and professionally streaming the development process paid back. At the end of February 2018, the apartment owners voted in favour of a comprehensive renovation, with 77% consensus. The key role for this positive vote was played by few leading homeowners, fed with right information by Salaspils Siltums, who were able to convince even the most sceptics opposing the project. After finishing of the construction works, everyone is now extremely positive about the project.*

*The renovation of the multifamily building in **2 Daugava Street** is special for several aspects. The bank financing the project required at least 80% of apartment owners voting in favour of renovation, because investment costs were high due to the critical conditions of the building. This building is one of the larger in Salaspils, with 120 apartments. The challenge of convincing all these people was overwhelming. The homeowner association together with Salaspils Siltums has endless discussions with each owner personally, feeding detailed information and also warning about the structural problems of the building. Finally, the required 80% were reached and the project implemented! A key factor in this positive result was the awareness raised between all apartment owners on the serious structural problems of the buildings. They all understood that a comprehensive renovation was the only means they had to preserve their properties.*

Box 2 - Experience from Dobele

In Latvia, the solvency of some of the residents living in multifamily buildings is low, so any topic that touches monthly expenditures is very sensitive. Thus, these people get easily scared by any proposal regarding building renovation, and often decisions are emotional rather than rational. The project development process in 12 Muldava Street is an example of this problem. The project development process in this building followed standard steps:

1. *From August to September 2016: Energy Audit and Technical structural Survey;*
2. *From January to May 2017. Development of technical documentation and project design;*
3. *From May 2017 to September 2018. Financial arrangements and selection of construction company;*
4. *From September to November 2018. Financial and grant agreement with ALTUM.*

ALTUM, is the Latvian Development Financial Institution, which provides a support programme for building renovation. Each of the above-mentioned steps was time consuming and verified by ALTUM as part of the grant application. This also protect apartment owners from possible overinflated project costs, as ALTUM check cost estimates against market current levels.

At the end of November 2018, the general assembly of apartment owners the partner in SUNShINE (eco.NRG) presented the project and related costs, with detailed information on the financial impact on the monthly payments for apartment owners. The majority (35 in favour, 4 against, 4 abstentions) of the assembly decided to implement the project and continue. However, two apartment owners, who had voted against the project, could not accept this decision. Within three weeks they turn the positive decision into a negative decision. They distributed fake information, playing with people emotions and unfounded rumours: "project implementation costs are artificially inflated", "the selection of the building contractor has not been lawful" and "some home owners has been purchased by the and benefited financially from project" are few of the messages spread over.

The 10 December 2018 a second general assembly was organised, during which one of the two opponents to the project, a police officer, continued to actively scare all apartment owners, regarding project costs. No one asked for supporting documentation, all meeting run on emotions. As a result, the majority decided against the project.

In January 2019 emotions were settle and apartment owners are perplexed by what happened and the consequences of their decision. The opponents to the project are missing and the building keeps losing energy and its condition to deteriorate. The ESCO will re-propose the project later, because in this sector persistence is the key. Apartment owners needs time for this sort of decisions.

3.2. Construction phase

The construction phase of a project has three main milestones

1. Start of the construction works
2. Implementation phase
3. Commissioning

I – START OF CONSTRUCTION WORKS

The first step is to conclude a construction contract with the general contractor. Based on this the Contractor will ask from the municipal construction board the authorisation for the commencement of works. The construction site can be prepared only after this approval. Prior to the commencement of works, a deed of acceptance of the construction site in conformity with the requirements settle in the construction contract is signed. This deep stipulate the initial conditions of the site and adjacent territory.

The construction contract includes the detailed implementation schedule, to ensure that the project is implemented in a timely fashion and to the required quality. In the work plan, the contractor shall:

- plan resources necessary for carrying out planned measures,
- prepare a timetable for apartment owners and tenants for activities which require access to their flats, like replacement of windows and plumbing works. The schedule is prepared to minimise discomfort to apartment owners, for example having both the plumber and windows installed working in one flat the same days.
- determine the organisational structure of the management of the construction site and the division of responsibility,
- prepare the documents necessary for the commencement of works,
- inspect the construction site, order the equipment and material needed for the works,
- perform a training of the workers regarding environmental, health and safety (EHS) requirement and procedures on the construction site. As the building is used during the construction works, it is very important that the EHS plan provides specific advise on action in emergency situations which could pose a risk to human life or health, material values on the construction site, or which may pose a risk to the environment and apartment owners.

In this phase of the project, apartment owners are required to remove disturbing or valuable items and objects from the basement, from balcony and loggias and from common property rooms and areas. All cables, satellite-TV and antennas attached to exterior walls must be removed.

Beside the construction contract for the implementation of the measures, a contract for technical supervisor and the author supervision signed. With this contract the supervisors represent the contracting party throughout the construction phase.

DOCUMENTS REQUIRED BY THE ESCO:

- Constrction contract with the general contractor;
- Contract with the construction supervisor;
- Contract with the author supervisor;
- The Acceptance-Transfer Act of the construction site;
- Building Facade Certificate Part I

II – CARRYING OUT CONSTRUCTION WORK

The implementation of the measures indicated in the project design take place sequentially based on the agreed schedule and timeline. The solutions are carried out in accordance with the harmonised map of the building's facade and a proof card for civil engineering. However, during construction works, latent conditions may show up or unexpected delays and problems occur. The most common problems are presented below including some suggestions and solutions.

Challenges/Problems	*Solutions/Recommendations*
1. Delays in delivery construction materials. During the pick of the construction season this risk is high.	Immediately after the notification of this problem the best solution is to agree on equivalent solutions and material. If the project is funded by ALTUM, any changes from the specification in the project design need a “no objection” response.
2. Lack of workers at the site	The shortage of workers at the site leads to a delay in the time period for completion of the works, which means that the Construction Supervisor must follow the number of workers employed in the weekly building meetings. If the number of workers is insufficient or shrinks within a week, the ESCO must verify the activities of the contractor to correct this problem.
3. Unqualify workers on site and poor quality of works	The Construction Supervisor must accept all covered works and inspect the materials used, according to the project design. The financial amounts for completed works must not be paid until all defects specified by the Construction Supervisor are corrected. The ESCO must follow quality control. To involve and listed to apartment owner in this phase is also recommended. The ESCO must incentive apartment owners and tenants to immediately report noted defects or other violations at the site.
4. Apartment owners do not cooperate and do not let workers in their flats	If one of the apartment owners of the building refuses to let the worker in for replacing the engineering networks this a possible actions from the ESCO: 1. Notification letters referring to the common decision taken by the general assembly, 2. Involve other home owners to put pressure, explaining for example that the space heating system can be connected only is access to all flats is granted.
5. Apartment owners’ discontent with the quality of construction processes	The construction phase involves noise, scaffolding, dust and discomfort. It is important

	during this phase to organise 2-3 information meetings for apartment owners and give them the opportunity to ask questions, make claims and discuss grievance plans together.
6. Errors or shortcomings in the project design	Errors and shortcomings in project design shall be addressed with the author supervisor. In case this has a financial effect, project design insurance shall be used.
7. Need for additional financing to implement the project	Although the project design has been developed in detail and quality, during the construction phase latent conditions may occur, which requires additional financing. The Contractor shall provide a costs estimation, which is then agreed with the ESCO and Construction Supervisor.

DOCUMENTS REQUIRED BY THE ESCO:

- A list of quality controls;
- Report form for building meetings;
- Form of material matching;
- Window/radiator replacement act




III – COMPLETION OF CONSTRUCTION

After completion of the construction work, all equipment, unnecessary soil and construction debris left during the construction works are removed. The site must be clean and ready for commission.

The Contractor submits a signed installation performance documentation including all the covered work acts and execution files to the ESCO and supervisors, which will form the commissioning team. The Contractor also develops a manual for the operation and maintenance of the implemented measures.

Upon completion of the work and final commissioning inspection the Acceptance-Transfer Act between the ESCO and the Contractor is signed. On the basis of this document, the Contractor submits to the Construction Board the work journal, which includes important construction and covered works approval act, certificates of conformity of the built-in construction products, copies of the works implementing acts and a temporary certificate of energy performance of the building. The Construction Board makes a note regarding the completion of the works (Part II of the Certificate of the Facade of the Building) when examining all submitted documentation as approval for conformity.

Upon receipt of the opinion from the Construction Board, the works are officially considered finalised.

DOCUMENTS REQUIRED (To the customer):

- Act of recruitment-transfer;
- Building Facade Certificate Part II

SUNShINE: Save your bUildiNg by SavINg Energy towards 202020m^2 of deeply renovated multifamily residential buildings. - Grant 649689

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Authors: RenEsco, Ekodoma

Editor: Riga Technical University

More Information: www.sharex.lv

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