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Estonian grant scheme for renovating apartment buildings

Kalle Kuusk[a,b,*], Targo Kalamees[a]

[a]*Chair of Building Physics and Energy Efficiency, Tallinn University of Technology, Estonia*
[b]*Fund KredEx, Estonia*

Abstract

In Estonia there is a total of approximately 27,000 apartment buildings, and approximately 90% of all apartment buildings were built before 1990. The majority of those buildings have same typical problems: high energy consumption levels, insufficient ventilation, uneven indoor temperatures, and insufficient thermal comfort levels. Therefore, a pretty extensive, or 'deep' level of renovation is required. Any large-scale and systematic renovation process for apartment buildings in Estonia is complicated due to the fact that a total of 82% of dwellings are privately owned. Apartment buildings are generally managed by apartment associations which means that all of the apartment owners in each building must agree on the volume of any renovation work and also on the budget for such work.

During the period between 2010-2014, a total of 663 apartment buildings have undergone renovation work in Estonia thanks to a support scheme that is joint-financed by Assigned Amount Unit trading and a government budget, administered by Fund KredEx. The total of investment in relation to apartment associations and the grant scheme amounted to 151 million euros, of which 38 million took the form of grants. Average energy savings per apartment building were 43% and the total annual energy saving was approximately 60GWh. The main lessons learned have been that preparation with an apartment association in regard to renovation work takes time - up to two years - and there is no direct way in which apartment associations can be guided when it comes to renovation work; this can only be managed through raising awareness and though good example.

A total of 102 million euros of European Union Structural Funds will be used in a new grant scheme which started in 2015, to renovate existing apartment buildings in Estonia. This paper describes the new grant scheme and measures to avoid and overcome the main problems which occurred in previous grant schemes.

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Keywords: apartment buildings; renovation work; renovation grant

* Corresponding author. Tel: +372 620 2402
Email address: kalle.kuusk@ttu.ee

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1. Introduction

It is estimated [1] that there is 25 billion metres squared of useful floor space in the EU27 countries, plus Switzerland and Norway. Residential buildings account for 75% of that building stock. Approximately 17% of total primary energy consumption and 25% of final energy consumption figures are used in residential buildings [2] and energy use in buildings is constantly rising. Energy consumption in European building stock has increased at a rate of 1.5% per annum [3]. Large energy consumption levels also introduces a range of possibilities when it comes to making energy savings, and the residential sector has the biggest potential for cost-effective savings [2]. At the European level, over 40% of energy savings could be obtained by having residential building stock applying a 'standard' renovation programme, and in some countries up to 86% could apply an 'advanced' renovation programme [4].

The full estimated saving potential is often no achieved. A study conducted in Lithuania [5] concluded that potential savings in renovation work were not being achieved due to a lack of transparency in the building modernisation process. Apartment owners were unable to receive any tangible guaranties that the declared energy saving benefits would actually be reached. One way to overcome this problem is the ESCO scheme, but in Europe ESCO has mainly be used in public, commercial, and industrial buildings [6]. A study covering the various options available when it comes to renovating large residential districts in Russia [7] concluded that large-scale district renovation work is required and, compared to simply renovating individual buildings, industry participants could be more interested in utilising a holistic approach due to the much greater scale involved. For the public sector, district-wide renovation work would provide greater opportunities when it comes to enforcing higher-level environmental and social policy targets. In addition, inhabitants will profit through an upscaling of the entire district. The same study also highlighted the fact that, although technical solutions do exist, the main barriers to any large-scale renovation work are financing the work and joint decision-making between apartment owners.

Estonian housing stock is no exception when it comes to high energy consumption. Previous studies [8 & 9] have shown that average heating energy consumption levels for apartment buildings falls between 136-150 kWh/(m^2·a), while when preparing domestic hot water the figures are 27-39 kWh/(m^2·a), and for electricity they are 32-35 kWh/(m^2·a). Low energy efficiency level is only one of the problems in existing apartment buildings. Common problems also include insufficient ventilation, uneven indoor temperatures, and insufficient thermal comfort levels. Therefore it is clear that extensive, 'deep' levels of renovation work are required. A study that was conducted in order to develop the Estonian energy roadmap, ENMAK 2030+ [10], pointed out that in order to realise the full potential in terms of energy saving, support schemes are necessary, especially in residential buildings, as financial support allows requirements to be set out for the required renovation measures and helps to promote extensive integrated renovation work. Setting up the correct requirements is crucial in any renovation scheme. Experiences in Germany [11] have shown that compulsory renovation standards can lead to a slower rate of renovation work than expected due to mismatches between policy, the nature of existing residential buildings, and the normal financial aspirations of home owners.

Financial incentives is the primary method for achieving energy saving targets and, when public funds are used, renovation work should focus on extensive renovation work. Support schemes for renovation projects which have only minor energy savings should be abolished due to their ineffectiveness and inefficiency [12]. Subsidies for minor energy savings targets create barriers against achieving the more ambitious energy savings goals, and buildings that have undergone minor renovation work will probably not be fully renovated within the next fifteen to thirty years. So the full energy saving potential for those buildings will not be realised.

During the period 2010-2014, a total of 663 apartment buildings underwent renovation work in Estonia under the umbrella of a support scheme that was joint-financed by Assigned Amount Unit trading and a government budget, with administration of the scheme being handled by Fund KredEx [13]. In addition to the renovation grant, there was also renovation loan with low interest rate and long repayment period. Renovation loan was financed by European Structural Funds. Total investments from apartment associations and the grant scheme was 151 million euros, of which 38 million euros were grants. Average energy savings for each apartment building were at 43%, and the total annual energy saving was approximately 60 GWh [14]. A total of 102 million euros of the European Union Structural Funds will be used in the new grant scheme that started in 2015, which will focus on renovation work for existing apartment buildings in Estonia. This paper describes the new grant scheme and measures to avoid and overcome the main problems that occurred in the previous grant programme.

Fig 1. Main building types (from left to right): wood, large block, brick, and large panel.

2. Estonian apartment buildings stock

According to the National Register of Construction Work [15], there are 264,000 residential buildings in Estonia with a total net area of 66,700,000 m^2. Apartment buildings account for 51% (34,300,000 m^2) of the total net area and detached houses account for 41% (25,100,000 m^2) of the total net area accounted for by residential buildings. Based on the main construction materials that have been used, there are four main apartment building types: wood, autoclaved aerated concrete large blocks, brick, and prefabricated reinforced concrete large panels: see Fig 1.

A significant share of apartment buildings in Estonia were built during the industrialisation construction period 1970-1990; see Fig 2. The main construction types were brick and concrete large panel. These buildings have similar thermal transmittance levels: external walls: $U_{wall} \approx 0.8\text{-}1.1$ W/(m^2·K); roofs and ceilings: $U_{roof} \approx 0.9\text{-}1.1$ W/(m^2·K); windows (old): $U_{window} \approx 2.9$ W/(m^2·K); windows (replacements): $U_{window} \approx 1.6$ W/(m^2·K). Approximately 70% of existing apartment buildings in Estonia are heated by means of district heating and usually have a one-pipe heating system with hydronic radiators and no thermostats. The indoor temperature is often regulated only in heating substations and depends upon outdoor temperatures. The ventilation system being employed is mainly natural passive stack ventilation with mechanical kitchen hoods installed by apartment owners.

In Estonia, a total of 82% of dwellings are privately owned [16]. This makes any large-scale and systematic process of renovating apartment buildings a complicated one. Apartment buildings are generally managed by apartment associations, which means that apartment owners in each building must agree on the volume of any renovation work and also on the budget for any such work.

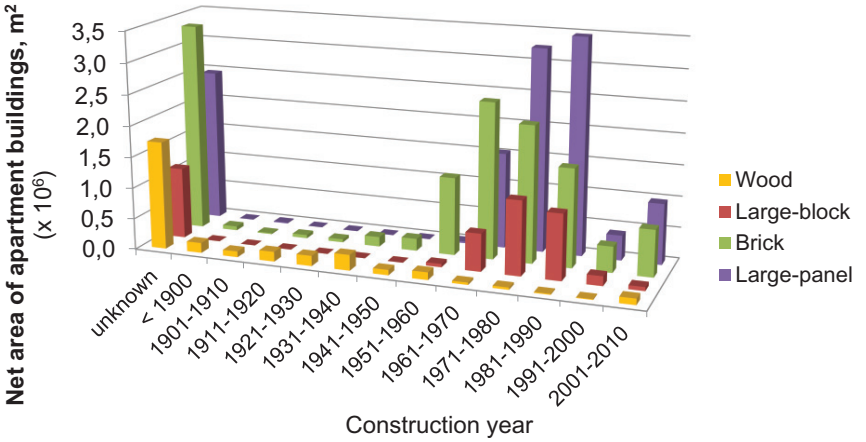

Fig 2. The distribution of apartment buildings in Estonia according to age group and construction type.

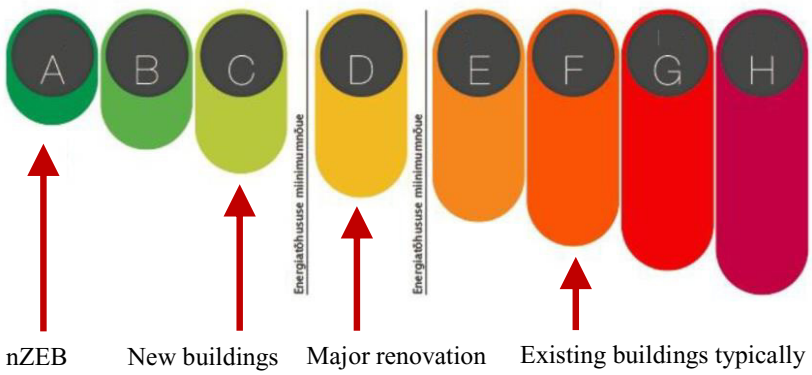

Fig 3. Energy Performance Certificate classes for apartment buildings.

3. Renovation grants

There are three renovation grant share levels for construction work (15%, 25%, and 40%). These are divided based on the designed energy efficiency level that will be achieved after renovation work has been completed. In Estonia, energy efficiency levels in buildings are expressed through primary energy (PE) usage. Primary energy takes into account the energy used for space heating, ventilation, domestic hot water, all electricity loads - including lighting and appliances - and the environmental impact, with weighting factors according to the energy supplier. Residential buildings are divided into eight 'Energy Performance Certificate' (EPC) classes (see Fig 3), in which Class A denotes the highest energy efficiency levels (the nZEB level, PE ≤ 100 kWh/(m^2·a)), and Class H the lowest level. Existing apartment buildings are for the most part located in EPC Class F. EPC Class C (PE ≤ 150 kWh/(m^2·a) represents energy efficiency requirement for new apartment buildings and is calculated to be the cost effective for new buildings [17].

A 15% grant can be applied when EPC Class E (PE ≤ 220 kWh/(m^2·a) - minor renovation work) will be achieved after the completion of any renovation work, while a 25% grant can be applied when EPC Class D (PE ≤ 180 kWh/(m^2·a) - energy efficiency requirement for major renovation work) will be achieved after the completion of any renovation work, and a 40% grant can be applied when EPC Class C (PE ≤ 150 kWh/(m^2·a) - energy efficiency requirement for new apartment buildings) will be achieved after the completion of any renovation work.

4. Grant requirements for renovation work

In addition to the EPC class, requirements are also in place for thermal transmittance in the building envelope, the heating system, and the ventilation system. Requirements for the thermal transmittance levels of the building envelope are shown in Table 1. A 15% renovation grant does not come with any additional requirements for the building envelope because this grant share is used mainly for minor renovation work and improving the indoor climate which may not include the renovation of the entire building envelope. Although there are no specific requirements for the building envelope, heating energy reduction at least 20% is required. The main difference between the 25% and 40% grant is that 40% grant also has a requirement for the window and external wall thermal bridge. To fulfil these requirements, windows must be moved into the insulation layer. Another option is to insulate the window jamb with an insulation layer that is at least 50 mm thick, which in practice is often impossible. Fulfilling the thermal transmittance requirements for external walls usually means the creation of an insulation layer that is between 150-200 mm thick. Fulfilling the thermal transmittance requirements for the roof usually means 300-400 mm of insulation layer. The requirements for windows are only for those windows that are going to be replaced and only for old wooden frame windows that have not been replaced so far and which certainly do have to be replaced.

Table 1. Requirements for thermal transmittance in the building envelope.

Renovation grant share levels	15%	25%	40%
Thermal transmittance of external walls, W/(m^{2}K)	-	0.25	0.22
Thermal transmittance of the roof, W/(m^{2}K)	-	0.15	0.11
Thermal transmittance of windows, W/(m^{2}K)	-	1.1	1.1
Linear thermal bridge in connection of window and external wall, W/(mK)	-	-	0.05

The heating system has only two requirements: the system must be balanced and radiators have to be equipped with thermostats in order to allow room-based indoor temperature control.

Ventilation and indoor air quality were the main problems in the previous renovation grant scheme [18]. Therefore, special attention was paid to the requirements and the compliance of the ventilation system. Two grants, the 15% and 25% levels, have the following requirements for the ventilation system:

- Continuous average ventilation (for each apartment in total) 0.5 1/h
- Supply or intake air flow rates are to be at least 10 l/s in bedrooms, with living rooms exhibiting sound levels that are no more than 25 dB(A)
- Extract air flow rates at least 10 l/s in the WC, 15 l/s in the bathroom, and 8 l/s in the kitchen (or 10 l/s in the bathroom and 6 l/s in the kitchen in one room flats)
- Preheating the intake air is preferable (ventilation radiators are recommended, but intake air vents are also acceptable)
- Heat recovery is not required (but depending on the building type, EPC Class D may be difficult to achieve without a heat recovery system being in place)

A 40% grant generally has the same requirements with one principle addition: a mechanical supply and exhaust ventilation with heat recovery or exhaust air heat pump with fresh air radiators is required.

5. Grant application process

A grant can be applied by apartment associations and bay local municipality. The process can be divided into three steps:

- Preparation:
  - An energy audit and an EPC for the building
  - A renovation work decision being taken by the apartment association - with a simple majority of 50% +1 in a general assembly meeting
  - A qualified technical consultant for steering the process
  - A designer for the developed buildings design (including the calculated EPC for compliance approval)
  - A building permit
  - An estimation of the renovation cost
  - A preliminary credit decision from the bank

- Grant application:
  - The grant application
  - A review of developed design documents by third party experts in order to ensure that all technical requirements have been fulfilled
  - A revision of improved developed design documentation if required
  - A funding decision if all requirements are met
  - Tendering with contractors (consisting of at least three tenders)
  - A credit decision from the bank

- Renovation work:
  - Construction
  - Commissioning protocols for ventilation rates and the heating system
  - Loan payments
  - Grant payments in two parts - the first part when 80% of the renovation work is handed over and the second part when all of the renovation work is completed
  - An EPC based on measured use after one year in operation

In order to pay more attention to the preparation and commissioning process, the new grants scheme has three main differences when compared with the previous measure. The first innovation is the technical consultant for apartment associations. These individuals have undergone training in a special course which focuses on the problems involved in the renovation of apartment buildings and the solutions that can be applied. The purpose of technical consultants is to help apartment associations make the right choices and steer a rather complex renovation process that involves a good many parties (such as the board and members of the apartment association, the energy auditor, the designer, the contractor, and the bank). The second innovation is the review process for a developed design by third party experts in order to ensure that all technical requirements are fulfilled and design documents are prepared to an adequate level of quality. The third innovation is the commissioning of ventilation requirements. A measuring protocol must be drawn up in order to confirm that the required ventilation rates are achieved.

6. First year results

Although various stakeholders were sometimes pessimistic regarding the new technical requirements (especially when it came to moving windows into the insulation layer and in regard to strict ventilation levels), the first year results show that the grant scheme has started better than expected. From approximately a hundred grant applications, eighty are for the 40% grant which refers to extensive integrated renovation work. This shows that with the help of a financial incentive, apartment owners are willing to invest in order to carry out extensive integrated renovation work. Data covering average costs from first year grant applications for 25% and 40% grants is shown in Table 2. The data covering 15% grants is excluded from further analysis because only four applications for the 15% grant were submitted in the first year.

Table 2. Data showing the average cost of 25% and 40% grants.

Renovation grant share levels	25%	40%
Total cost for renovation work, €/net m^2	170	268
Grant, €/net m^2	44	106
Apartment association investment, €/net m^2	126	162

The average apartment building that is part of the grant scheme has a net floor space of about 2,000m^2 and contains thirty apartments. For renovation work that fulfils the requirements of a 40% grant, average apartment buildings with average renovation costs will need a total investment amount of around 500,000 euros and an apartment owner´s investment (loan) of around 300,000 euros, which is a significant investment for the apartment association. Grants for renovation work should allow such renovation work to progress without significantly raising the costs for apartment owners. In order to test this, twelve completed renovation projects were analysed: two 25% grant projects and ten 40% grant projects. Data showing average buildings and costs for completed renovation work has been compiled in Table 3.

Table 3. A characterisation of case studies covering completed renovation work.

Renovation grant share levels	25%	40%
Building details		
(sample photos are taken after the completion of renovation work)		
Average net area, m^2	1,669	1,253
Average heated area, m^2	1,271	995
Average apartment area, m^2	1,154	899
Renovation work	Insulating building envelope, swapping out old wooden windows, installing a new heating system and a new mechanical ventilation system without heat recovery	Insulating building envelope, installing new windows and moving existing windows into the insulation layer, installing a new heating system and a new mechanical ventilation system with heat recovery
Average renovation cost, €/net m^2		
Total cost	192	265
Grant	50	107
Apartment association investment	143	158

Energy efficiency figures before and after the renovation work (Fig 4) reveal that renovation work on a 25% grant provides an approximate reduction of 30% in terms of heating energy. More than half (approximately 50 kWh/(m^2a) of heating energy in renovation work on a 25% grant is used to heat up the ventilation airflow as the ventilation system does not have its own heat recovery system. Heat loss through the building envelope and windows is reduced but heating up the increased airflow rates will not allow any higher reductions in the use of heating energy. For extensive integrated renovation (a 40% grant), a ventilation system with a heat recovery facility is required, which will provide a reduction of over 70% in the use of heating energy. Electricity consumption increases due to the electricity being used in the newly-installed mechanical ventilation system.

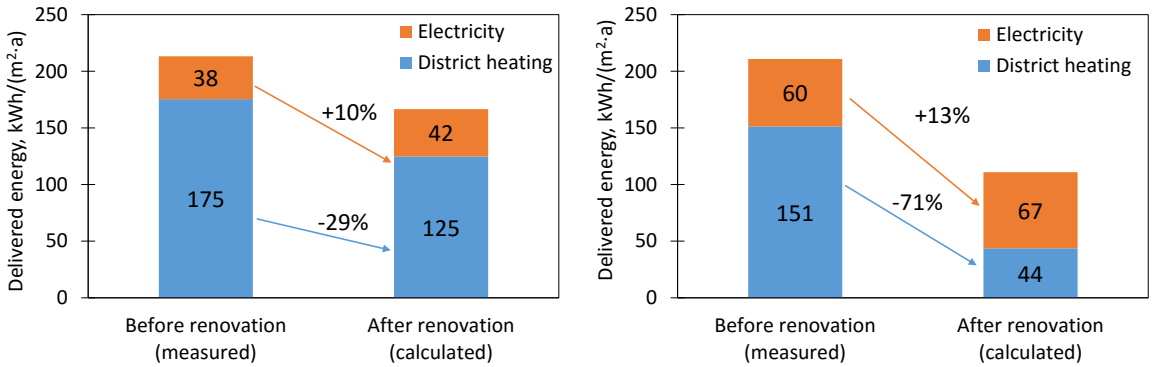

Fig 4. Delivered energy use before and after renovation work for a 25% grant project (left) and a 40% grant project (right).

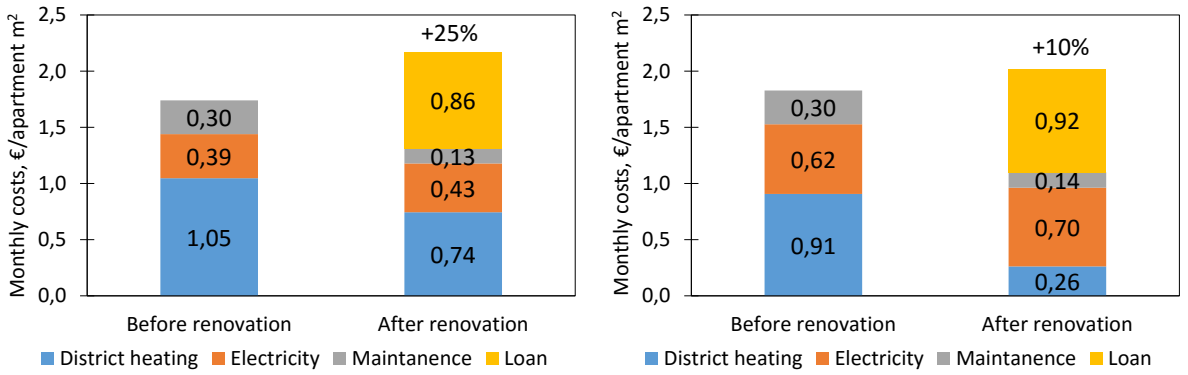

Fig 5. Monthly costs per apartment m^2 before and after renovation work for a 25% grant (left) and a 40% grant (right).

A cost analysis was carried out both before and after renovation work, with regional heating costs being 65 €/MWh (including VAT), and an electricity price of 113 €/MWh (including VAT), and for the funding of the renovation work a loan period of twenty years and an interest rate of 3%. The results of the cost analysis (Fig 5) for completed renovations showed that although work carried out under a 40% grant requires fairly high initial investment levels, the 70% reduction in heating energy use and the financial help from grant scheme will keep the monthly costs for apartment owners almost at the same level as before the renovation work was carried out. Monthly average costs were 10% higher than before the renovation work was carried out. Renovation work carried out under a 25% grant requires a lower initial investment, but it also results in lower energy savings and therefore the monthly costs for apartment owners were 25% higher than before the renovation work had been carried out. These results also explain why most of the grant applications are for the maximum grant share of 40%, although this requires extensive integrated renovation and higher initial investment. In a twenty year period, extensive integrated renovation using the 40% grant is more profitable for apartment owners than renovation work that is carried out under a 25% grant.

7. Ventilation solutions used in renovating apartment buildings

The main problems involved in the previous renovation grant scheme were with low ventilation airflow rates [18]. In order to avoid this problem, and in addition to new requirements and commissioning, a guidebook for designers and technical consultants was prepared [19]. This guidebook (downloadable from http://www.kredex.ee/public/Uuringud/Korterelamute_valispiirete_lisasoojustamise_solmejoonised_ja_tuupkorterite_ventilatsioonilahendused.pdf) provides guidelines on how to select a suitable ventilation solution. It also includes calculation principles and has sample drawings of three ventilation systems:

- supply-exhaust ventilation with heat recovery and an apartment-based air handling unit (AHU)
- supply-exhaust ventilation with heat recovery and a central AHU on the roof and ventilation ducts inside the facade insulation layer
- exhaust ventilation with exhaust air heat pump for heat recovery

All of the model drawings are accessible and downloadable in *.pdf and *.dwg formats so that designers can copy and customise the guidebook's model solutions.

A supply-exhaust ventilation system with an apartment-based air handling unit and an exhaust ventilation system with an exhaust air heat pump for heat recovery were previously used in standard renovation work practices. A new solution in Estonia was the central air handling unit with ventilation ducts inside the facade insulation layer. This solution has become one of the main ventilation solutions in the current renovation work grant scheme. Fig 6 shows the main elements of this system.

Fig 6. Ventilation ducts in the façade insulation (left), ventilation ducts in the roof insulation (centre), and a central AHU on the roof (right).

8. Conclusions

The execution of the renovation work grant schemes in Estonia has shown that extensive integrated renovation is possible in situation in which buildings are managed by apartment associations and apartment owners have to agree on the extent of any renovation work and also on the budget for the project. New innovative solutions can be implemented and apartment owners are willing to invest in order to renovate their apartment and building. Financial support keeps the cost of renovation work to an acceptable level. Preferably, costs after the renovation work has been completed should be at approximately the same level as they were before the renovation work was carried out. The grant scheme also allows requirements to be set out for the measures involved in any renovation work and to promote extensive integrated renovation work. The main general lessons that have been learned from grant schemes are as follows:

- A combination of different measures is required (including various grant shares, technical requirements, and awareness raising work)
- Information has to be easily accessible and understandable to all market participants and apartment owners
- An emphasis must be made on the preparation phase (the energy audit and building design work)
- Preparation by an apartment association for renovation work to proceed takes time - up to two years
- A commissioning process is required in order to guarantee the expected outcome
- There is no direct way to guide apartment associations when it comes to getting an agreement in place to proceed with renovation work; only raising awareness and providing examples will do this
- Good examples of completed renovation work are needed in order to promote further renovation work

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