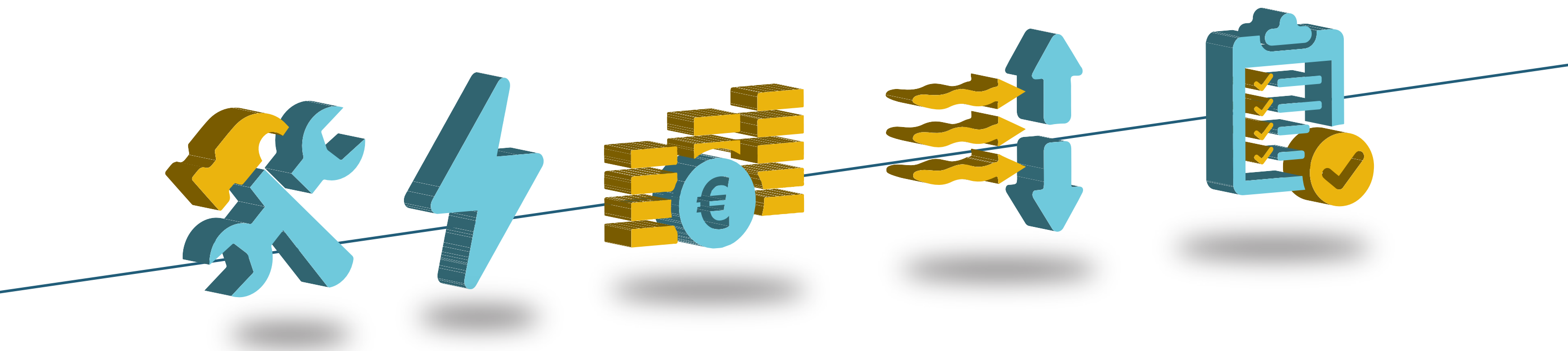
ACCELERATING THE RENOVATION OF THE BULGARIAN BUILDING STOCK

THE PRESENT AND FUTURE OF THE NATIONAL ENERGY EFFICIENCY PROGRAMME FOR MULTIFAMILY RESIDENTIAL BUILDINGS



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The European Climate Foundation, in coordination with the Bulgarian government, financed an extensive research project to further optimise the National Programme for Energy Efficiency of the Multi-family Residential Buildings, in order to support the achievement of maximum long-term sustainable effects from its implementation.

This study was carried out by an international team of Bulgarian and other European organisations. The overall coordination was carried out by the Buildings Performance Institute for Europe (BPIE), based in Brussels, and the Center for Energy Efficiency EnEffect - Sofia, in close cooperation with Technische Universität Wien (TU Wien) and "Za Zemiata" - Sofia. Modelling was undertaken using the model Invert/EE-Lab of TU Wien.

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State of the sector before the Programme

The analysis of residential buildings in Bulgaria gives the opportunity to outline options for planning the next stages of the "National Programme for the Energy Efficiency of Residential Buildings". Some of the findings go beyond the scope of the current programme and can feed into a long-term strategy for the renewal of all residential buildings, outlining clear priorities and deadlines and determining the necessary investments.

Structure of the building stock. The analysis of the structure of the building stock confirms that,

> **through the focus on multi-family residential buildings, most of which are located in cities, and through the adoption of a centralised approach to their renovation in the early stages of the programme, rapid and visible results could be achieved.**

The technical audits of the pre-fabricated panel apartment blocks will provide a realistic understanding of their structural condition, and, where necessary, measures will be taken to strengthen the blocks and extend their lifetime expectancy.

Heating. The significant share of solid fuels (wood and coal) and electricity used to heat Bulgarian homes and the widespread use of burners with low efficiency create serious environmental problems, such as air pollution by fine particles.

> **The introduction of highly efficient heating devices (boilers and stoves for central and individual heating) using wood and wood biomass is an effective instrument to restrict the use of electricity and reduce the harmful impacts on the environment.**

Renewable energy sources (RES). The use of renewable sources of energy (particularly solar, geothermal and wood biomass) is severely hampered by the lack of appropriate technical infrastructure of buildings. The installation of suitable building systems could exercise a strong positive impact on the integration of facilities for the production of renewable energy.

Energy efficiency measures. Among the new and renovated buildings where ambitious energy efficiency measures are already implemented, those owned by private legal entities effectively stand out, while serious delays are evidenced in public buildings. Against this background, private individual initiatives to insulate the facades of individual dwellings or even separate rooms in residential buildings are a contradictory phenomenon. On one hand, these interventions in buildings are unacceptable, and the effect of retrofitting is quite controversial, but on the other hand, they are a sign of the emergence of a real market for energy efficiency, which urgently needs regulation and utilisation by public authorities.

Comfort. In many residential apartment blocks, a voluntarily lowering of thermal comfort in individual dwellings is evidenced as a result of the desire to reduce energy costs. It can be expected that, after refurbishment, residents will begin to increase the temperature in their homes and thus, to reduce the expected energy savings. If the renovation is limited to low energy efficiency levels (Class C), the energy consumption could even increase in some cases.

> **Raising comfort requirements in dwellings, in particular in relation to internal air quality, should be established as being an important element of the communication strategy for the Programme.**

Energy efficiency standards. The new Bulgarian energy efficiency standards were recently introduced, and their vitality and applicability could be evaluated only after 1 or 2 years of active implementation in the design practice. This does not exclude the possibility to discuss the precision of the energy classes' scale and the appropriateness of

including the energy used by home appliances. Meanwhile, benchmarks for the electricity consumption of appliances could be introduced in order to unify the designers' approaches, especially in the design of new buildings with high energy performance. The national definition for a nearly Zero-Energy Building (nZEB) should also be clarified, especially in terms of required energy consumption and minimal share of renewable energy.

Analysis of the options to evolve the Programme

In order to ascertain the impact of different variables on the overall effectiveness of the Programme, a wide range of options and scenarios are modelled. The results are intended to serve policy-makers and experts in shaping of the further development of the Programme, with a view to increase its efficiency and achieve greater energy savings by reaching more residents, while gradually limiting public spending.

Methodology. In order to determine the effects of various policies, the team of experts used a methodology based on the test model Invert/EE-Lab of Vienna University of Technology (TU Wien). It was combined with additional analyses and summaries of the results carried out by the Buildings Performance Institute for Europe (BPIE), based on the data relating to the characteristics of residential buildings provided by EnEffect and TU Wien. Then, the effect of various economic scenarios to 2020 and 2030 was simulated. In the course of the modelling, the following variables were considered:

a) future energy prices;
b) the extent (depth) of renovation;
c) the level (proportion) of the public subsidy;
d) the co-benefits;
e) the indoor temperature (thermal comfort);
f) discount rate;
g) administrative costs; and
h) the learning curve (the decrease of costs through gained experience).

Scenarios. Based on numerous combinations of the exploited variables, 14 scenarios for renovation covering all types of residential building (individual houses and apartment blocks) were compiled and analysed. As a result of the multifactorial assessment, five scenarios were selected and further limited to multi-family residential buildings in order to provide the basis for a comparison with the current Programme (the numbering of the scenarios is not continuous because they are indicated with the same numbers that appear in the complete list - see Annex 2):

1. Business as usual (BAU) with 100% grant component, called "100% BAU".
2. Business as usual with 75% grant component, called "75% BAU".
5. Business as usual with 50% grant component, called "50% BAU".
7. 50% subsidy with a set of soft measures and an evaluation of comfort, called "50% soft + comfort".
10. 25% subsidy with a set of soft measures, an evaluation of comfort and normal temperatures, called "25% normal temp".

The comparative analysis of the five scenarios shows that,

> **in the long-term perspective, the most economically beneficial renovation is to be carried out according to energy class A. This is the only way to significantly reduce the energy costs of households and to provide the biggest financial returns on the renovation investment.**

Long-term goal. If energy class A is perceived as a long-term goal within a "step-by-step" renovation approach, the accelerated introduction of incentives to increase the individual contribution of residents becomes of critical importance to offset the decreasing share of State subsidy and to facilitate and accelerate the upgrade to higher energy classes. The minimum requirements (energy classes) for the renovation projects and the period of their

action are subject to expert assessments and political decisions at each stage, as their duration is of secondary importance.

Mid-term goal. In addition to the long-term analyses (up to 2030), three scenarios to 2020 were developed, according to which the subsidy is decreased to 75% and then to 50%. Thus, the short-term viability of some of the considered options is determined, and the expected energy savings for the period of the current National Programme are calculated. The comparison between these scenarios suggests that,

if favourable economic conditions are provided, higher requirements for renovation can be set up, even in the short-term.

Development trajectory. As a result of the comparative assessment of the reviewed scenarios, the following possible development trajectory of the "National Programme for Energy Efficiency of the Residential Buildings" can be outlined:

2017-2018 – reducing the level of subsidy from 100% to 75% of the total investment and introducing tools to promote co-financing by residents, together with measures to improve the economic environment. Start an extensive communication campaign with the goal of informing residents about the wider benefits of building renovation and the improvement of living conditions (comfort).

2019-2020 – further reducing the share of subsidy to 50% of the total volume of the investment and implementing packages of "soft" measures to improve general economic conditions for renovation with a continued active communication campaign.

After 2021 – gradually reducing the subsidy to 25% of the total volume of the investment and raising the minimum requirements for retrofit projects to a high energy class.

Further development and optimisation of the Programme

Based on the initial information and the comparative analysis of possible scenarios for programme development, the study sets out proposals for further development of the housing renovation policy, with the aim to

ensure the start of a smooth transition to deeper energy renovation carried out in stages, without limiting the scope and the impact of the Programme and without slowing down the pace of its implementation.

Comfort. The benefits of improved comfort in dwellings have to be explained and promoted through active communication with the residents as part of the Programme.

Level (depth) of the renovation. Regarding the depth of renovation, it is necessary to explain the long-term economic, environmental and sanitary effects coming from reaching the highest energy classes, as well as the technical and financial possibilities for the homeowners' contribution to this goal.

For the adoption of higher energy classes, by maintaining at the same time the total volume of renovated residential areas without increasing the annual initial investments, the step-by -step renovation approach could be successfully introduced.[1]

Step-by-step retrofitting. Besides the indisputable long-term economic and environmental impacts, "step-by-step" retrofitting can significantly simplify the Programme and facilitate its organisation and implementation, as well as

[1] In partial step-by-step renovation, separate prescribed packages of measures are implemented in phases, whereby the level of the specified energy class is achieved by gradual (step-by-step) upgrading.

intensify the direct participation of the owners. At the same time, it is necessary to provide appropriate training to energy auditors, designers and builders.

Focusing on insulation. The initial focus on building insulation can further simplify the programme without reducing the number of dwellings renovated and without increasing the annual volume of investments. This approach will enable each household to individually plan the next steps of the retrofitting works according to its abilities, personal ambitions and expectations.

Constructions and installations. Along with the structural strengthening and reconstruction of the existing systems for centralised heating with horizontal access to the apartments, it is appropriate to examine the possibility to integrate new systems tailored to the utilisation of renewable energy (solar or geothermal energy and biomass).

Financing. It is appropriate that funding under the Programme is designed as directly dependent on the achieved energy and environmental results. For this purpose, State support must be based on the principle that:

> **the higher the energy classes achieved and the bigger the energy savings, the greater is the level of public subsidy.**

Technical assistance. The high responsibilities of municipalities as a major driving force of the Programme require the development of adequate capacity and tools for programme management and control. There is great potential to be found in the position of "Municipal Energy Manager", which, although set up by the Energy Efficiency Act for a long while now, is still not used effectively in practice. The study suggests the introduction of a new "Technical Assistance" component in the scope of the programme, through which the capacity of the key actors - municipalities, energy auditors, designers and builders – can be increased. A number of other national and European programmes can also be used in this direction.

Management and maintenance. In order to ensure the sustainability of the results, it is necessary to introduce professional management and maintenance in the renovated building funds. In this respect, the latest amendments to the Condominium Act already made the first steps in the right direction.

Monitoring of the results and long-term strategic goal-setting. By conducting a long-term monitoring of the buildings' performance after refurbishment, beneficial conditions will be created in order to multiply positive results and strengthen public confidence in the Programme. Development of a long-term strategy for renovation of residential buildings with clearly defined parameters and deadlines that are the subject of an active discussion and awareness raising campaign among the population could have a significant contribution in this regard.

Adjacent open spaces. In view of the inherent responsibilities of public authorities and in parallel with the reduction in the share of State subsidies, the National Energy Efficiency Programme can gradually be redirected to the revitalisation of open neighbourhood spaces, some of which could appear in striking dissonance with the newly renovated buildings.

Financing of the Programme

Initial impetus. The extraordinary Government support that is currently provided for the retrofitting of residential buildings aims to provide initial impetus to the renovation process, which, through the established positive examples, should continue to accelerate and deepen the engagement of citizens while continuously decreasing State participation in the future.

> **In Bulgaria, there are a number of financial instruments that have operated successfully for years which, with good organisation, could complement the Programme by encouraging personal involvement of homeowners.**

An example of the possible organisation of the financial flows within the Programme is demonstrated in

Figure ***1***.

Guarantee Fund. In order to encourage and facilitate the attraction of foreign investments for the goals of the Programme, it is appropriate to establish a specialised State guarantee fund. The possibility to attract financing from the new European Fund for Strategic Investments, which is more and more associated with the need to renovate residential buildings in European cities, deserves serious attention, alongside other existing sources.

Roadmap

The predictability and the clear objectives of the Programme are important conditions to build trust and ensure public support for its implementation. Therefore,

> **the Programme must be situated within a long-term strategy for the renovation of the existing building stock and within a roadmap for the development of its scope, objectives and instruments.**

On this basis, it would be possible to plan the necessary long-term investments as well as the political and financing tools to build the most appropriate socio-economic environment and maximise the effects of the Programme. The proposed indicative roadmap may serve as a basis for additional studies and expert discussions with a view to taking the most optimal and sustainable decisions.

Conclusions

This report summarises the results of a very broad study that contains many useful ideas for politicians and experts in the field of renovation. It identifies a number of additional actions, regulations and further research activities, which could bring a significant contribution to the renovation of the building stock and improve the quality of living conditions of Bulgarian citizens.

INTRODUCTION

Energy security is increasingly becoming an essential element of the strategy to create a common European Energy Union - a key political priority for European institutions. In February 2016, a package of measures for global energy transition was announced, aimed at strengthening energy security and at preventing risks of energy supply interruptions. Rightly, the main measures in this package include reducing energy demand, increasing energy production from renewable sources, a further development of the integrated internal energy market and a diversification of energy supply. These measures comply with the spirit of the global climate agreement from Paris 2015, which strongly reaffirmed that the road to clean energy is irreversible and that the global energy transition is increasingly recognised as the leading economic and social paradigm.

Taking into account the fact that nearly 40% of the energy in Europe is consumed in buildings, with heating and cooling in residential buildings and industrial sites using more than a half of the energy and 75% of which is produced by fossil fuels, energy efficiency in buildings is becoming a key element for the energy transition and essential for energy security.

Energy efficiency is an important priority of the National Development Programme of Bulgaria as well. For the first time in two decades, there is a strong political will to implement a large-scale national programme for energy efficiency in multi-family residential buildings. The serious energy, environmental, social and economic potential of this initiative is a prerequisite for its further development in the coming years, with a view to expanding it into a long-term programme for the renovation of the existing building stock, meaning a strong impact on the quality of life and on the appearance of the settlements.

This study examines the possibilities for further development of the Programme in the situation of gradually decreasing the share of governmental financial support and more active financing on the side of the homeowners. Based on an in-depth analysis of the energy characteristics of the multi-family residential building stock, it explores the economic benefits coming from deep retrofitting, and those included in its implementation in stages (step-by-step) in realistic time frames. Viable opportunities to prevent the lock-in effect of a “shallow” energy renovation are identified, together with measures mitigating the risks of reducing the speed and the scope of the programme. The proposed package of political, organisational, technical, financial and social measures and instruments has the potential and the ambition to provide predictability and sustainability for the National Renovation Programme, and to establish and affirm public confidence. The report reaches the point to suggest the development of a specific Bulgarian model for housing renovation, which could position the country among the European leaders and generate deserved recognition not only at social, but also at political and economic levels.

CHAPTER I - State of the sector before the Programme - Conclusions from the analysis of the available statistical information on the state of residential buildings in Bulgaria

The analysis of the state of the residential building stock in Bulgaria gives grounds for outlining the options for planning the next stages of the National Programme for Energy Efficiency in Residential Buildings. Some of the conclusions go beyond the scope of the current Programme, but they can be used for the development of a long-term strategy for the renovation of all residential buildings and for the determination of clear priorities, deadlines and necessary investments.

For greater clarity, we are reviewing two main groups of residential buildings:

a) individual (single family) houses – family houses of 1 to 3 floors, with separate entrances for each dwelling or individual dwellings on each floor and a common entrance.
b) multi-family houses – residential buildings of 4 or more floors and common staircases that are connected with the entrances of the separate dwellings.

(The full text of the analysis of the available statistical information can be found in Annex 1 of this report).

Structure of the building stock and selection of priorities

Individual houses (single family houses) in Bulgaria are prevailing in number in the country as a whole (86%), in towns and cities (77%) and especially in rural areas (93%). However, according to their general useful living area, individual houses and apartment blocks (multi-family buildings) have roughly an equal share within the country, while in cities, the useful living area of apartment buildings accounts for about two-thirds (64.7%) of the share of all buildings. Considering their number, residential buildings with 5 or more floors account for only 2% of the total number of buildings; however, the share of their useful living area exceeds half of the total useful living area (52%). Despite the lack of accurate statistics on the distribution of inhabitants in individual houses and multi-family blocks, it can be assumed that the highest density of settlement in multi-family blocks concentrates the majority of the population there, especially in cities. This means that,

by giving priority to multi-family blocks, most of which are located in cities, and by adopting a centralised approach to renovation, rapid and substantial results for the first stages of the "National Energy Efficiency Programme for Residential Buildings" can be achieved.

In the next stages of the Programme, however, if individual houses are included, policies and tools for individual promotion of building renovation should be developed and implemented.

Figure 1 - Distribution of the building types in cities

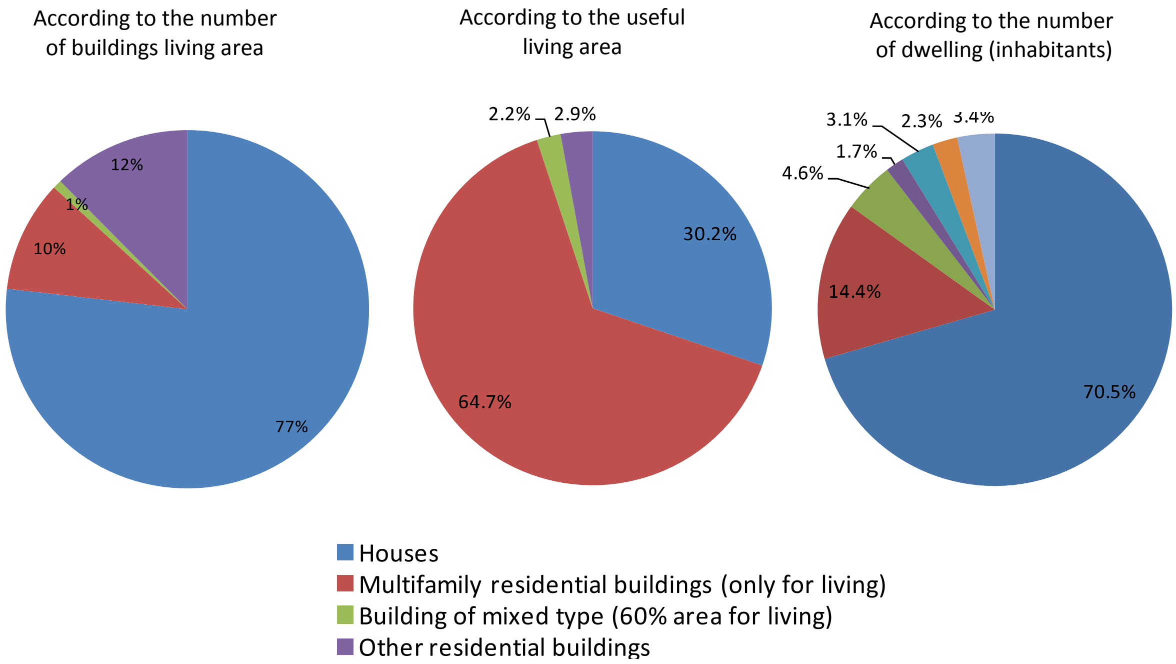


Figure 2 - Distribution of the living area in different types of buildings in cities according to the number of dwellings in them

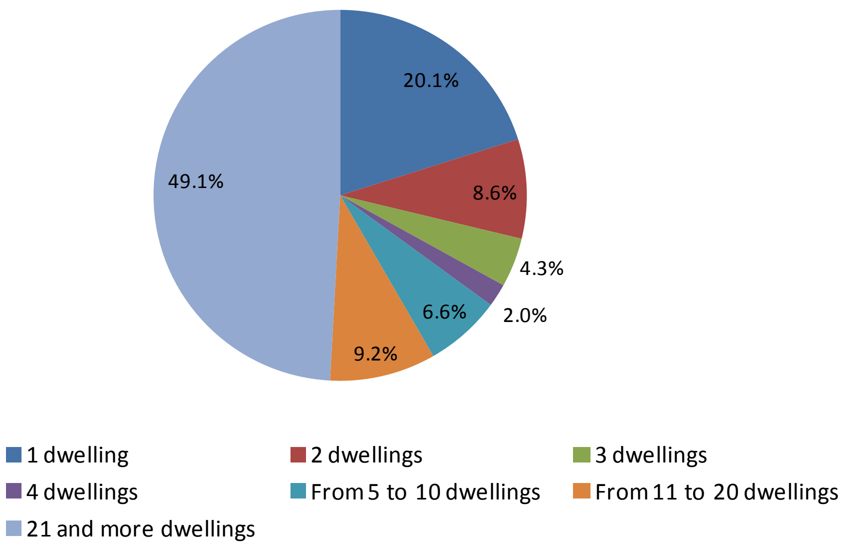
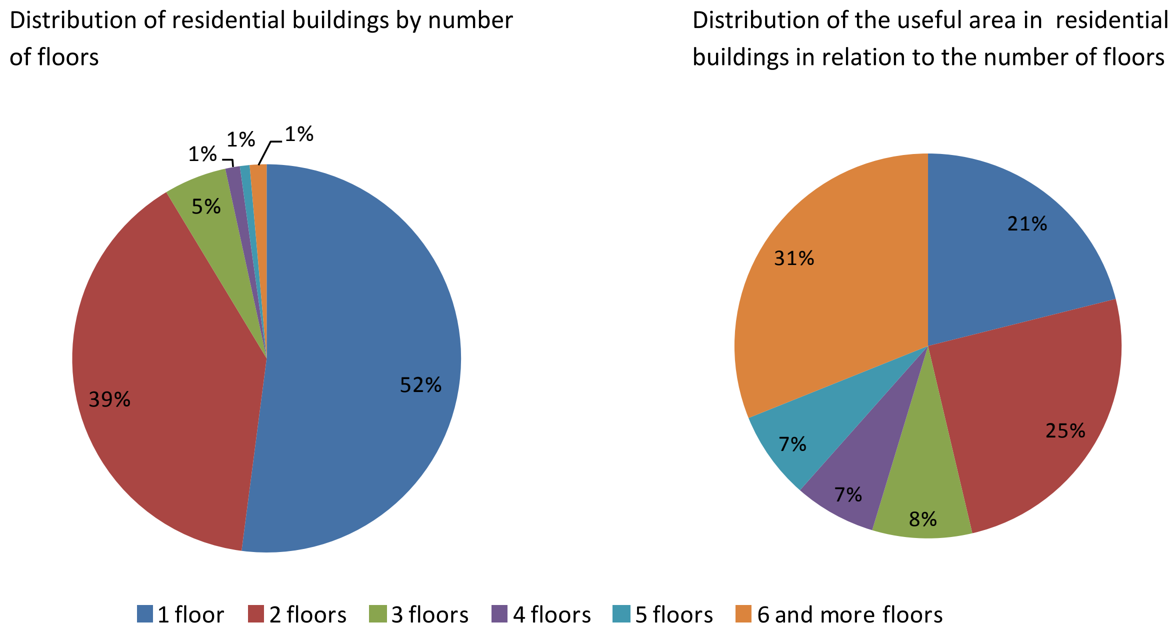


Figure 3 - Distribution of types of residential buildings in cities according to the number of floors



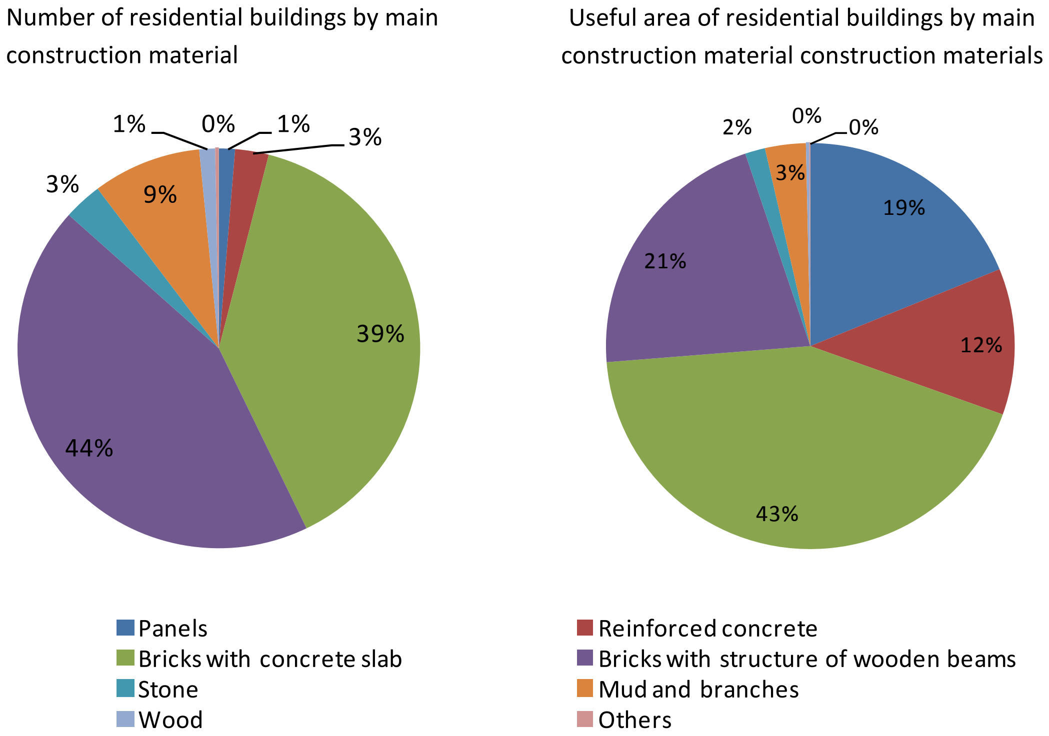
Specific features of the pre-fabricated apartment blocks

Generally, the residential blocks of flats are divided into several groups, according to the historical period of their construction. The analysis of energy efficiency standards effective in these periods, especially before 1990, and their actual implementation in the design and construction practice, do not give grounds for the use of different approaches to their renovation. More significant differences between the residential blocks can be found in accordance with the implemented construction systems. Among them, the prefabricated panel apartment blocks, which occupy 19% of the useful floor area of all residential buildings in the country, deserve special attention. The introduction of modern equipment to test the condition of the building structures of many pre-fabricated apartment blocks, and the results of the technical audits carried out so far, give us an increasing number of reasons to believe that the doubts about the stability and durability of their structures are not justifiable. If these findings are confirmed, the rehabilitation approach used for other types of building structures can be applied to the prefabricated panel apartment blocks as well.

> **It is important to execute a specialised and comprehensive investigation on the structure of the prefabricated panel apartment blocks in order to end the long discussion on their state and durability.**

This way, by partially reinforcing the structures (if and where necessary), possible negative social and economic consequences can be avoided in future.

Figure 4 - Distribution of residential buildings according to type of construction materials and structures



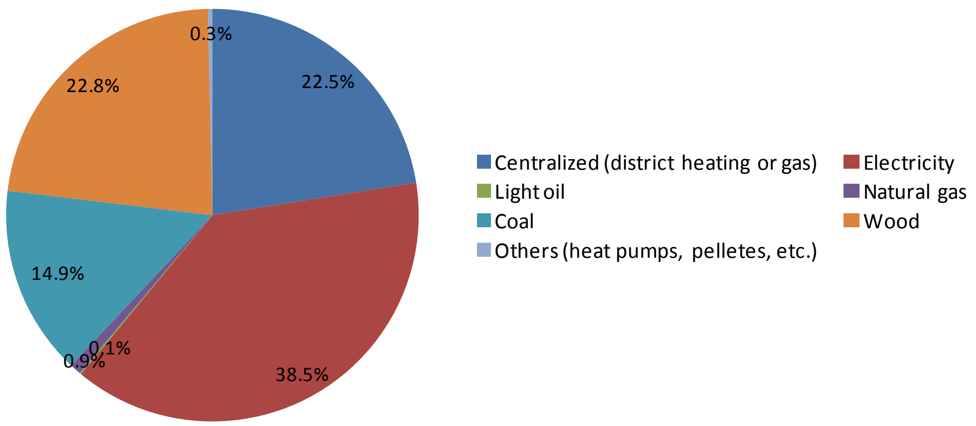
Space heating in residential buildings

Four main types of space heating are used in 99% of the dwellings in Bulgaria – wood, electricity, coal and central heating. The increasing share of wood used for heating (34.1%) testifies the potential for a gradual transition to other forms of wood use. When using wood chips or pellets, for instance, efficient modern technologies can be implemented to reduce harmful air pollutants. The share of coal used for heating (19.9% for the country and 14.9% for the cities) is still high and this is of concern, given the harmful and toxic emissions associated with this fuel. During the last years, the burning of wood with high humidity and especially of low-grade coal is the main reason for the increase of excessive air pollution with fine particles in villages and in several cities. Equally unfavourable is the fact that the share of dwellings heated with electricity is too high (by virtue of its high cost) and continues to rise. Currently, this share is 28.8% for the entire country and 38.5% for the cities. The increase in electricity consumption can be explained to some extent by the introduction of newer household appliances and communication devices. Despite their higher energy classes than older stock, they still increase the total consumption of electricity. The impact of the increasing consumption of electricity for heating, which also causes unfavourable environmental consequences, is greater.

It is necessary to introduce targeted policies aimed at reducing the use of fossil fuels to heat homes by traditional low efficient stoves and to replace these with high-efficient combustion equipment (boilers for

local centralised heating, stoves, etc.) for dry wood and especially for wood biomass. These policies should be accepted as tools to limit the level of electricity used for heating.

Figure 5 - Distribution of residential buildings in cities, according to prevailing type of heating

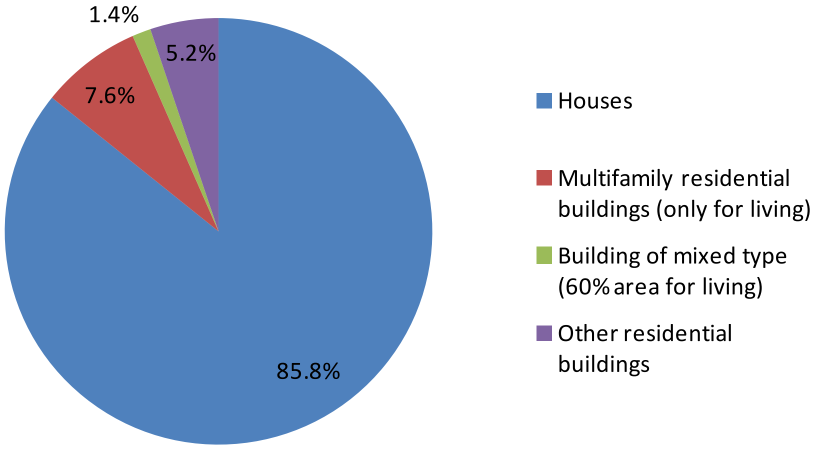


Renewable Energy Sources (RES) in buildings

While reliable data about the use of wood biomass and geothermal energy in buildings is missing, there is information on the use of solar panels. By 2011, solar panels for hot water and electricity generation had been installed in only 1.8% of all buildings, the majority (86%) of which are on single family houses. This indicates a very low penetration of this type of renewable energy. The exceptionally large untapped potential for renewable energy will require the implementation of targeted policies and specific technical measures to speed up their introduction in residential buildings. The lack of an appropriate building infrastructure (building pipelines) greatly increases the cost and prevents to a great extent the use of renewable energy systems in buildings. It is therefore appropriate to consider the opportunity for carrying out

preparatory activities for the inclusion of RES through the preliminary installation of building pipelines (following the principle "plug-in ready") in the frame of the current Programme. Such measure may become a prerequisite for a further upgrade of renovated buildings in order to achieve Class A.

Figure 6 - Distribution of residential buildings according to the availability of solar panels



Living Comfort

Given the relatively low average of household income and the unfavourable relationship between income and expenses (Figure 17 and 18 in Annex 1), the voluntary reduction of thermal comfort in dwellings to reduce the energy costs is understandable. This is confirmed by data available from energy audits in residential buildings (Table 7 in Annex 1). It can be assumed that for individual houses, the voluntary reduction of thermal comfort is more clearly expressed. The use of controlled ventilation in residential buildings is an exception rather than a common practice (Table 7 and 8 in Annex 1). In this respect, the practice of other European countries does not differ greatly from the Bulgarian one. This fact reflects the relatively low rigour of inhabitants towards the quality of indoor air. Little attention is also observed with respect to other parameters of comfort, such as heating and lighting of premises, impact of construction materials on health, etc. In non-renovated buildings, where the level of air infiltration is high, the compromises related to air quality are not so tangible. After building renovations, however, the indoor air quality can significantly deteriorate without the introduction of controlled ventilation. It is therefore necessary to take into account the fact that, for a higher energy class, building ventilation with heat recovery of exhaust air must be provided.

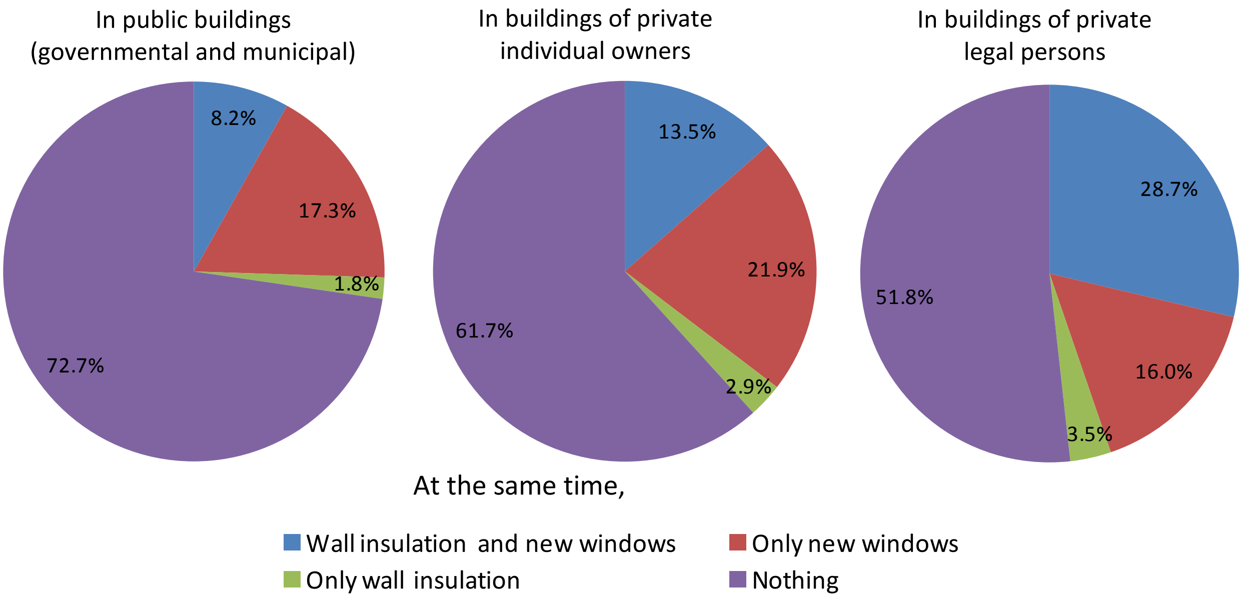
The increase in requirements for comfort in dwellings, in particular for indoor air quality, should be endorsed in the "National Programme for Energy Efficiency of Residential Buildings" as an important element of the communication strategy.

Emergence of a market for energy efficiency

Since there is no reliable information about the energy efficiency measures implemented in existing buildings, the data about the measures implemented in the whole residential building stock, including in new buildings, are summarised in Figure 11 of Annex 1. Such measures are implemented mostly in residential dwellings owned by private companies. In almost half of them (48.2%), the implementation of such measures is identified; 28.7% are entirely renovated (insulation and windows), while in 16.0% of the cases only energy saving doors and windows are installed. The implementation of energy efficiency measures is seriously lagging in State and municipally owned residential dwellings. In 72.7% of cases, such measures are not implemented at all, while in 17.3% only windows are replaced and just in 8.2%, these two main measures (insulation and windows) are implemented. The last figures indicate to a serious delay in implementing Article 5 of the European Directive on Energy Efficiency. According to

this Article, the buildings of public bodies should turn into models for energy efficiency by virtue of the requirement to renovate 3%, by floor area, of central government buildings every year.

Figure 7 Distribution of residential buildings according to the energy efficiency measures implemented



At the same time,

> **the progress in private residential buildings gives evidence of the emergence of a real market for energy efficiency, to which obviously the private owners are most sensitive. This sensitivity should be skillfully used and directed by the State in order to achieve the highest possible public benefits.**

With residential multi-family blocks, the partial renovation through the insulation of facade walls of individual dwellings or premises, besides causing unsightly harm to the architectural design, creates technical and organisational complications that can compromise the final results of a subsequent full renovation. It is appropriate to expertly reassess the technical solutions in the cases of partial renovation in order to reduce possible future risks.

Depth of renovation

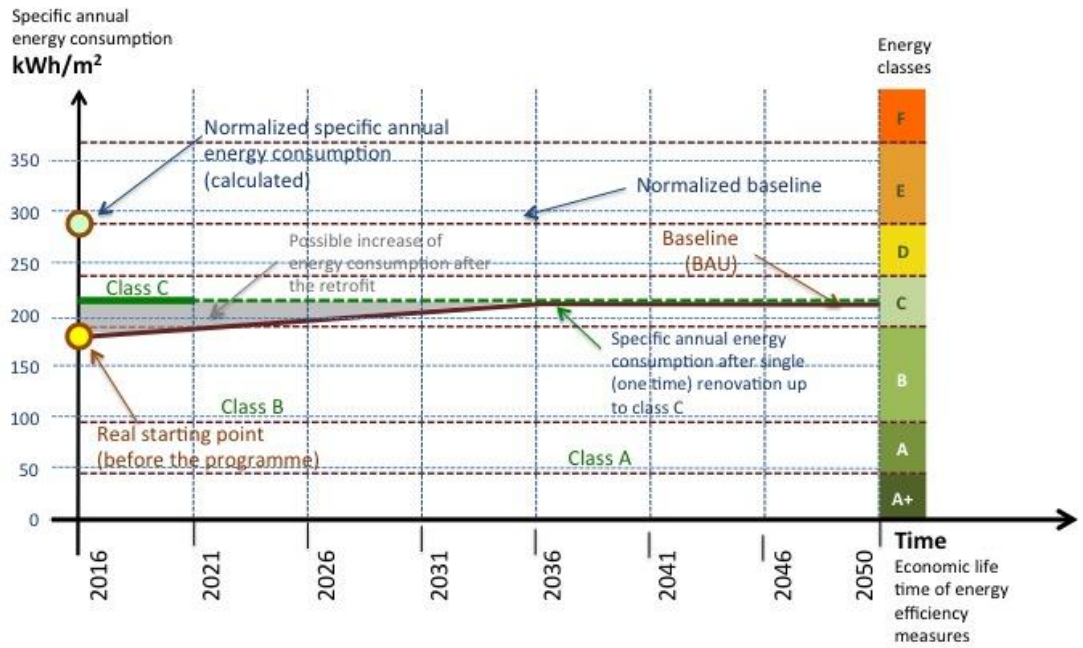
Analysis of the available statistical data and the conclusions from more than 400 energy audits of residential buildings (summarised in the database of the Sustainable Energy Development Agency) shows a drastic discrepancy between their targeted energy performance and their actual energy consumption. While the average integrated energy performance indicators of these buildings (kWh/m^2/a) corresponds most often to energy classes D and E, the energy consumption of the inhabiting households is equal to C and B classes. The reason for this discrepancy is well known and simply explained. Many of the heating devices in dwellings are voluntarily tuned off, turned down or removed and as a consequence, the premises are not heated to the established standards. This means that, if the renovation of these buildings is done in order to achieve Class C, their energy performance will improve and conditions for normal living comfort, without any additional energy consumption, will be created. However, actual energy savings will be achieved only if the inhabitants continue to maintain lower thermal comfort in their dwellings. That's why,

> **to achieve actual energy savings, which would contribute to the implementation of the national targets for energy savings, achievement of the highest possible energy classes should be required in the future stages of**

the Programme. Only in this way, a significant reduction of the households' expenses on energy, on one hand, and the return of the investments in renovation, on the other hand, can be achieved.

This is illustrated in Figure 8. A building with a design energy consumption of 290 kWh/m^2/a (on the border between class D and E, shown in the green circle, is actually consuming 180 kWh/m^2/a, equivalent to a class B (yellow circle). Over time, however, the comfort expectation of the occupants increases to the design temperature, so that a renovation to the middle of class C will actually result in a net increase in energy consumption.

Figure 8 - Blocking effect of the compromised complete renovation to energy class C



Energy efficiency standards

The regulatory legislation on the design and construction of new buildings in Bulgaria has undergone substantial development, especially in the last few years. New regulations introduced recently correspond to the general requirements of the Directive on Energy Performance of Buildings (2010/31/EC). By the end of 2018, their overall impact should be reviewed and, if necessary, the corresponding corrections and clarifications will need to be made. However, for existing buildings undergoing renovation, there is still no uniform regulation. In this regard, it is appropriate to control and periodically assess the current regulations on the basis of targeted monitoring and feedback from design and construction companies.

Special attention should be paid to the precision of the energy classes and the appropriateness of electrical household appliances' inclusion. Meanwhile, reference numbers for electricity consumption of household appliances that will conform with the designers' approaches, especially when they design new buildings with a very high energy performance, can be introduced. It is appropriate to specify the definition of nearly Zero-Energy Buildings (nZEB) concerning energy consumption and the mandatory share of renewable energy.

CHAPTER II – Analysis of the options to evolve the Programme - Summarised results of the comparative analysis of the scenarios

Modelling has been undertaken across a wide range of assumptions to explore the impacts of certain potential changes in the design of the National Renovation Programme. The results of the analysis are intended to provide information to policy makers regarding the potential implications of different options. With this knowledge in mind, it is possible to make a more informed decision regarding the future evolution of the Programme in a way that increases its effectiveness, by achieving higher energy savings and reaching more citizens while, at the same time, maintaining or reducing public spending.

(The full text of the conclusions of the study are contained in Annex 2 of this report)

Methodology

In order to explore various policy options, a team of experts made use of the well-established Invert/EE-Lab model of the Vienna University of Technology. This was supported by further analysis and presentations of results on the characteristics of the building stock, undertaken by BPIE and provided by EnEffect. With all this information, expertise and technical background, it was possible to simulate the effects of different economic scenarios, both to 2020 and to 2030.

As a starting point, a so-called "Business As Usual" scenario was defined by applying the prevailing economic parameters. These were then varied in the subsequent scenarios. The variables that were modelled are:

Future Energy Prices. Future energy prices play a significant role in the overall economics of renovation. Bulgaria currently has among the lowest energy prices in the EU, which acts as a disincentive for investing in energy efficiency. Therefore, the following two cases have been appraised:

- 2.8% per annum increase (as recommended[2] by the European Commission in the cost optimality guidelines);
- Convergence with neighbouring countries – Hungary, Romania and Croatia.

Renovation levels. A calculation of the expected costs and savings of three different levels of renovation (R1, R2, R3), that lead to energy label Class C, B and A respectively, is made. The costs and savings of the three options for each building are calculated and, in each case, the model chooses the most cost-effective. The only exception is the Business As Usual scenario where Class C is chosen in order to match the ambition level of the current Renovation Programme.

[2] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012XC0419(02)

Table 1 - Levels (depths) of renovation accepted in the scenarios

	Energy Class	Insulation				Heat Recovery
		Roof	Wall	Floor	Windows	
R1	C	8 cm	5 cm	0	Double glazing: GLASS: Ug= 1,7 W/m²K; FRAME: Uf=1,4 W/m²K	No
R2	B	20 cm	15 cm	10 cm	Double glazing: GLASS: Ug= 1,7 W/m²K; FRAME: Uf=1,4 W/m²K	Yes
R3	A	30 cm	20 cm	15 cm	Triple glazing: GLASS: Ug= 1,0 W/m²K; FRAME: Uf=1,0 W/m²K	Yes

Subsidy Levels. Subsidies are clearly an important variable influencing energy consumers to undertake renovations, given that the financing of measures is the largest single barrier to uptake. Subsides can take the form of a grant, a preferential loan, or others. While some low income households will be persuaded to renovate only with free measures (i.e. 100% grant), owners with the ability to pay will be influenced by variables such as payback period or return on investment. We therefore present results which assess a wide range of subsidy options, from 100% to 25%, as well as removal of all subsidies.

Other factors (collectively, "Soft Measures"). The cost of renovation depends on a number of factors, including the capital cost of measures. We examine three factors that affect the overall economics: discount rate, transaction costs, and learning curve. The factors which are varied in the modelling are summarised below:

- Discount rate: This reflects the cost of borrowing to finance the energy saving investment. It is also a perception of how risky an investment is.
- Transaction costs: Additional costs, such as the time and cost associated with the preparation of the renovation, including surveys, legal costs, application fees (e.g. for loans) etc.
- Learning curve: The reduction over time in the price of renovations due to increased sales volumes, more efficient installation procedures, improved productivity or R&D.

Co-Benefits. In addition to energy cost savings, there are many other benefits coming from the improvement of the energy performance of buildings. However, these are rarely evaluated in a financial appraisal of an energy saving investment, not least because of the difficulty, in many cases, of ascribing a monetary value to these other benefits, some of which accrue to the investor/occupier, while some others accrue to society at large. While efforts have been made to monetise their impact (see for example IEA's report on multiple benefits[3]), in the model we only consider the value of increased comfort. This is calculated as equivalent to the amount of energy expenditure required to generate the increase in internal temperature that is achieved following renovation. A modest value of 15% comfort has been applied – this means that, for every 8 units of theoretical energy saving, approximately 1 is used to increase the internal temperatures while the remaining 7 are taken as actual energy savings. In most

[3]http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf

scenarios, as in most conventional economic appraisals, only the 7 units of actual energy savings are taken into consideration. However, in the scenarios that include comfort, we base the savings calculation on all 8 units.

Internal Temperature. Bulgarian residential buildings are under-heated, and, therefore, the potential for energy saving is much reduced. However, extensive experience in other EU countries shows that, as citizens increase their wealth, their expectations of comfort increase, resulting in higher internal temperatures over time. The implications for Bulgaria is that, while building renovation may not initially achieve the full expected energy savings, they can be realised in the longer term as internal temperatures increase over time. Some scenarios apply the prevailing low temperatures (17°C is assumed), while others explore the impact of having internal temperatures at levels consistent with what is generally deemed a normal comfort level (21°C).

Modelling Parameters

This section focuses on a selection of five results taken from a total of 14 model runs undertaken as part of the evaluation process. The full description of all the scenarios is provided in Annex 2. This section covers only multi-family houses, as these are the current scope of the grant Programme and as our objective was to show how this might evolve. However, the full scenario analysis in Annex 2 covers single family houses as well as multi-family houses. Compared to the results presented below, single family houses are generally more cost-effective than multi-family houses, and furthermore, they represent 2.5 times the total energy saving potential in the multi-family housing sector. This suggests that, from both an energy saving and a social perspective, serious consideration should be given to providing support to single family houses.

All the selected scenarios run to 2030. This is consistent with the timeframe for the longer term renovation strategy required by Article 4 of the Energy Efficiency Directive. They are:

1. Business As Usual with a 100% subsidy – labelled “100% BAU”
2. BAU with a 75% subsidy – labelled “75% BAU”
5. BAU with a 50% subsidy – labelled “50% BAU”
7. 50% subsidy, with a range of soft measures and valuing comfort - labelled “50% soft + comfort”
10. 25% subsidy, with soft measures, comfort and normal temperatures - labelled “25% normal temp”

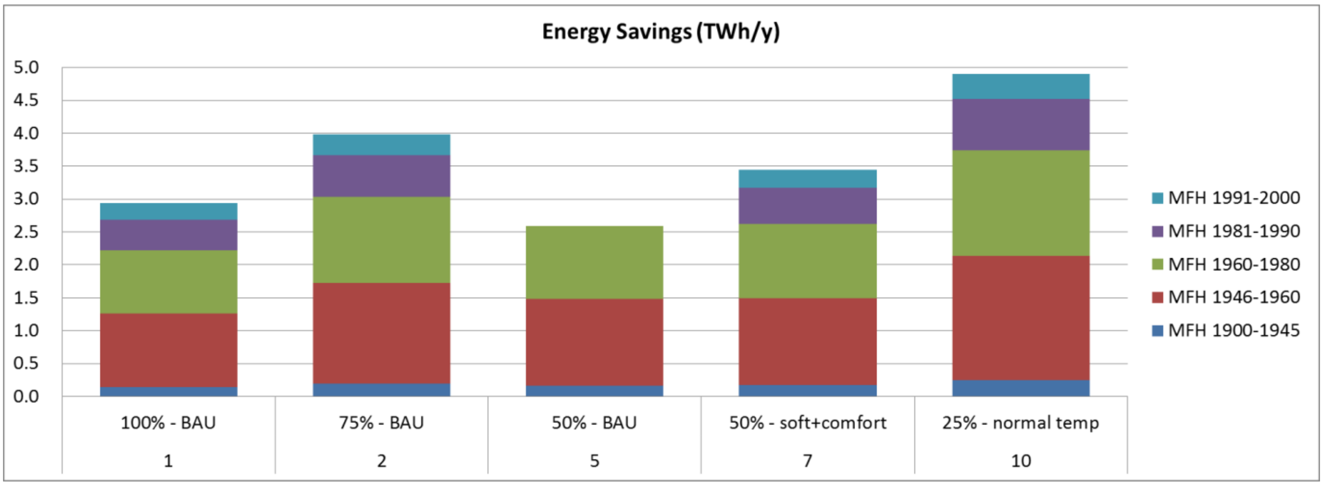
Table 2 - Basic parameters of the five selected scenarios

Scenario		Scenario Parameters							
No.	Short name	Subsidy	Renovation level	Energy price increase	Transaction costs	Discount rate	Learning curve	Co-benefits	Internal temperature
1	100% BAU	100%	to class C	2.8% real increase p.a.	20%	8%	5%	no	low (17C)
2	75% BAU	75%	determined by model	2.8% real increase p.a.	20%	8%	5%	no	low (17C)
5	50% BAU	50%	determined by model	2.8% real increase p.a.	20%	8%	5%	no	low (17C)
7	50% soft+ comfort	50%	determined by model	Convergence with neighbours	10%	6%	15%	15%	low (17C)
10	25% normal temp	25%	determined by model	Convergence with neighbours	10%	4%	15%	15%	normal (21C)

Comparison of Scenarios

The following series of graphs summarise the headline results for the five scenarios. Results are only shown for cost-effective building categories – i.e. where the present value of the lifetime energy cost saving exceeds the investment by the building owners. Savings are broken down by the different age bands of multi-family housing (MFH).

Figure 9 - Energy savings achieved under the five scenarios



In terms of energy savings, while the BAU 100% subsidy case (constrained to deliver renovations to Class C, as per the current Programme) generates annual savings of 2.9 TWh/a, reducing the subsidies to 75% generates higher savings, corresponding to 4 TWh/a. This is because the model selects the most cost-effective option, that, in this case, as in the remaining scenarios, is a Class A renovation. In other words,

despite the greater level of financial contribution from building owners, their net savings are greater.

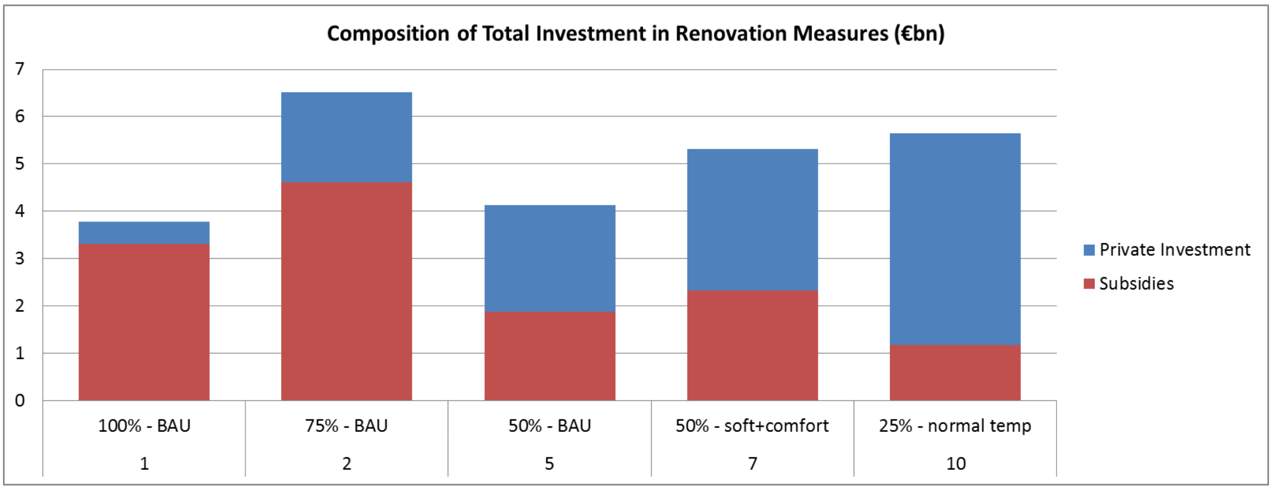
One can see that the same does not hold true when subsidies are reduced to 50%, all other parameters being equal (Scenario 5). Due to a lower economic attractiveness, the two newer age bands (1981-90 and 1991-2000) are no

longer cost-effective. However, considering soft measures, comfort and a 50% subsidy, Scenario 7 does deliver savings that are higher than the 100% BAU.

The final scenario selects the most optimistic set of economic parameters, and also assumes design internal temperatures. These favourable economic conditions enable the application of a lower subsidy level of 25%, which actually generates the highest overall cost-effective savings (4.9 TWh/a) for households.

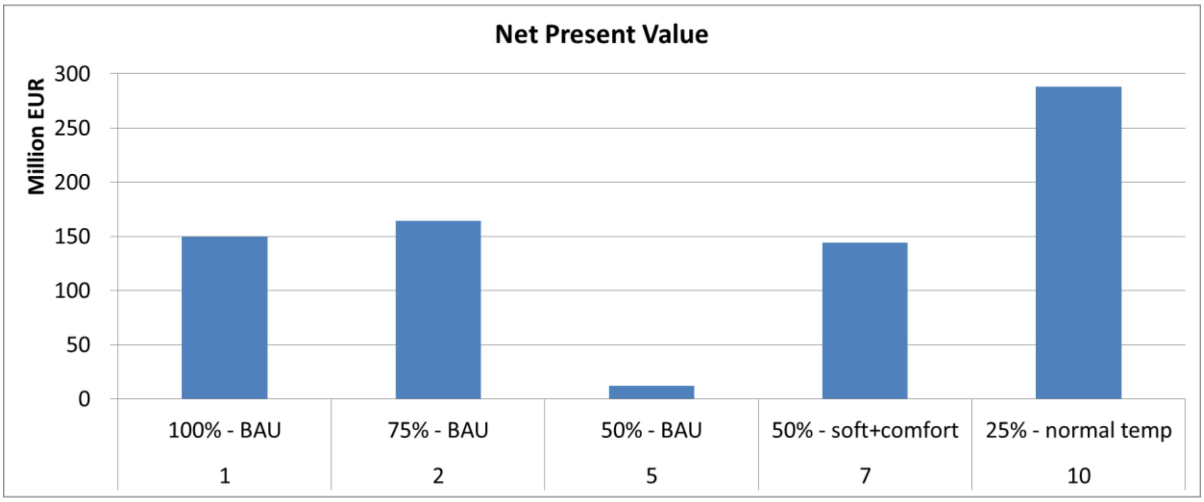
Turning to investments, the graph below shows that, compared to Scenario 1 (100% BAU), the additional investment in Scenario 2 (75% BAU) results in an overall increase in subsidies and total investment, both of which are the highest of the five scenarios. The other three scenarios also result in a total investment that is higher than Scenario 1, but require significantly less public investment in the form of subsidies.

Figure 10 - Total required investment and subsidy by scenario



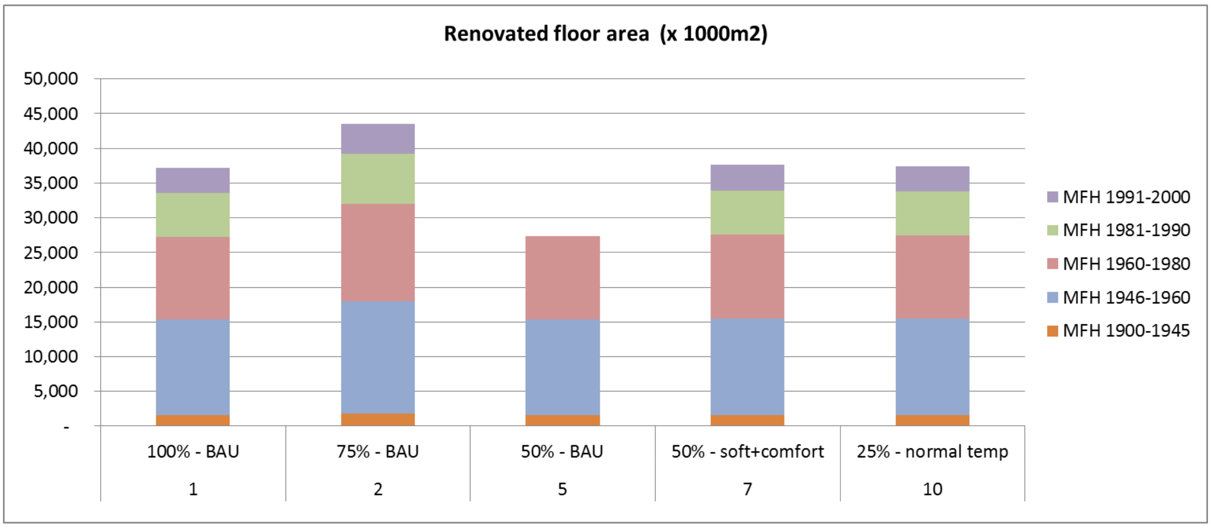
Clearly, a key motivation for making an investment is to receive a financial return. The difference between the returns of the different scenarios is shown in the graph below. A 50% subsidy (scenario 5), with prevailing business-as-usual conditions, can be seen to be only marginally attractive to investors, compared to the other scenarios. Scenario 10, whilst requiring the highest level of private investment, generates the greatest net financial return, largely due to the assumption of normal internal temperatures.

Figure 11 - Comparison of scenarios with different levels of subsidy according to the Net Present Value (NPV)



Finally, the graph below compares the floor area of renovated stock as a proxy measure for the number of people benefitting from a given scenario. It can be seen that three scenarios have essentially the same outcome, while the "75% BAU" case is slightly higher and the "50% BAU" case considerably lower.

Figure 12 - Comparison of renovated floor area by scenario



Appraising the scenarios

The above comparison graphs show that different scenarios have different characteristics. One scenario might have higher savings, but require more public subsidy. In order to assess the scenarios, it is necessary to score them against a number of criteria and thereby derive the one that achieves the best overall balance, given a variety of factors and policy objectives.

The table below ranks the scenarios against five key criteria, with a view to establishing an overall ranking. The criteria are:

- Total government expenditure on subsidies (*lowest = best*);
- Leverage, i.e. the amount of total investment stimulated per € of government subsidy *(highest = best);*
- Total annual energy saving *(highest = best);*
- Net present value to investors *(highest = best);*
- Volume of renovation, measured by renovated floor area *(highest = best).*

The scoring methodology is to ascribe 5 points to the scenario with the best result for a given criterion, 4 for the 2nd best, and so on down to 1. To get to the overall ranking, the individual scores are simply summated.

Table 3 - Ranking of scenarios

	Scenario 1	Scenario 2	Scenario 5	Scenario 7	Scenario 10
	100% BAU	75% BAU	50% BAU	50% soft measures	25% normal temp
Total government subsidy	2	1	4	3	5
Leverage	1	2	3	4	5
Annual energy saving	2	4	1	3	5
Net present value to investors	3	4	1	2	5
Volume of renovation	3	5	1	3	3
TOTAL SCORE	**11**	**16**	**10**	**15**	**23**
OVERALL RANKING	**4th**	**2nd**	**5th**	**3rd**	**1st**

Scenario 10 (25% subsidy with normal temperatures) is a clear winner overall, as it scores top in 4 out of 5 categories. It represents the ideal case of low government subsidy, high leverage, high energy savings and the greatest economic benefit. However, because it relies on a number of favourable conditions that will take some time to be established in Bulgaria, it is not considered a realistic scenario to be adopted in the short term, though it should remain a longer term goal (say, in 5 years).

Scenario 2 (75% BAU) achieves the next highest overall score, and notably achieves the highest volume of renovation, but requires the greatest financial contribution from the public purse. Scenario 7 (50% soft measures) scored just one point less than Scenario 2, and is characterised as achieving good scores across most parameters. It is considered a scenario that could be adopted in the medium term (say, within 2 year), albeit requiring some preparation in terms of creating a more favourable economic climate for building renovation.

The lowest scoring option is Scenario 5 (50% BAU), which does have the benefit of reducing public expenditure and increasing third party leverage, but overall is not an attractive option for building owners, because it brings a very

low return to investors, and also achieves the lowest volume of renovation. This shows that cutting subsidies to 50%, without improving the economic conditions for renovation, is too aggressive at the present time.

Policy recommendations

Based on the above appraisal of scenarios, the following observations can be made.

a) Reducing to a 75% subsidy (the 75% BAU scenario), and requiring more ambitious renovation (to Class B or A) is an attractive option for building owners by virtue of higher net present values. Furthermore, it achieves better third party leverage, higher energy saving and a greater volume of renovation than the current 100% BAU programme.

b) Reducing to a 50% subsidy (the 50% BAU scenario) is NOT an attractive option at the present time without other support measures and is unlikely to attract sufficient investors for it to be a viable initiative.

c) A reduction to a 50% subsidy can, however, be achieved if and when the economic conditions for renovation have improved (the 50% soft measures scenario). This requires action to make it easier, cheaper and quicker for homeowner associations to invest in the renovation of their multi-family housing blocks, for example by establishing a hand-holding or "one-stop-shop" service, coupled with attractive rates to reduce the cost of borrowing. At the same time, raising awareness on the value of comfort, for example, by providing calculation tools which include comfort, will help building owners to place an economic value on their increased temperatures. Longer term reductions in the cost of the measures can also be achieved with concerted action to reduce investment costs, for example, by encouraging the development of standardised solutions.

d) In the longer term, once householders have adopted normal internal temperatures, the increased potential for energy savings will increase the overall financial viability of renovation investments. Alongside the more favourable market and economic conditions mentioned above, this will enable a reduction to a 25% subsidy level.

In conclusion, the results of the modelling indicate a possible trajectory for the evolution of the renovation Programme:

2017-2018 - reducing subsidy levels from 100% to 75%, and raising performance requirements to be consistent with ultimately achieving class A or B (either directly or step-by-step). At the same time, introduce instruments to promote co-financing from home owners and measures to improve the economic environment. Set up an extensive communication campaign to inform households about the wider benefits of renovation and the improvements in terms of comfort.

2019-2020 – further reducing the share of subsidies to 50% of the total volume of investments and strengthening of supportive "soft" measures to improve the general economic conditions for renovation with a continued active communication campaign.

2021 onwards – gradually reducing subsidies to 25% of the total volume of investments and raising the minimum threshold of upgrading to a higher energy class.

Insight from scenarios to 2020

In addition to the above analysis over the longer timeframe to 2030, the team ran three scenarios to 2020, in order to examine the short-term viability of certain options and to quantify the potential energy savings over the period of the current National Energy Efficiency Action Plan. The scenarios were:

Table 4 - Scenarios to 2020

11	no subsidy, BAU conditions, renovation levels fixed at R1 level
12	75% subsidy, favourable economic conditions[4], renovation levels fixed at R3 level (Class A)
13	50% subsidy, favourable economic conditions, renovation levels fixed at R2 level (Class B)

For Scenario 11, the removal of subsidies resulted in a lack of cost effectiveness for all building categories. This is a consequence of two main factors: the low internal temperatures, meaning that the potential for significant energy saving is simply not there; and the low price of energy in Bulgaria, meaning that the cost savings from reduced energy use are low. These are the two main factors working against the economic renovation of Bulgarian residential buildings. The other factors which make the market framework not particularly favourable are the high transaction costs, the high cost of borrowing (discount rate), and the non-valuation of comfort benefits.

By contrast, Scenarios 12 and 13 apply the most favourable economic conditions: energy prices converging with neighbouring countries; low discount rate; low transaction costs; high learning curve; inclusion of co-benefit; and normal internal temperatures. In these scenarios, the level of renovation is fixed to Class A in the case of Scenario 12, and to Class B in the case of Scenario 13. The reason for this is to assess the viability of raising the minimum energy performance threshold from the current Class C to one that is more consistent with achieving deep renovation of the residential building stock. Both scenarios have subsidies applied to them – Scenario 12 has a higher subsidy rate of 75% to offset the higher cost of achieving the top level of energy requirement (Class A), while Scenario 13 has a 50% subsidy.

As shown in the table below, the results of the two scenarios are very similar. The main conclusion from this analysis is that it would be feasible to mandate higher renovation requirements in the short-term, if more favourable economic conditions are applied.

[4] The favourable economic conditions comprise: energy prices converging with neighbouring countries; low discount rate; low transaction costs; high learning curve; inclusion of co-benefit; and normal internal temperatures.

Table 5 - Key features of scenarios 12 and 13

Scenario	Scenario 12	Scenario 13
Short name	**75% - R3 (2020)**	**50% - R2 (2020)**
Total government subsidy (€bn)	0.8	0.7
Leverage (private investment stimulated per € public subsidy)	1.3	1.3
Annual energy saving (TWh/a)	1.59	1.55
Net present value to investors (€M)	64.1	60.9
Volume of renovation (km^2 floor area)	11.9	11.9

CHAPTER III – Further development and optimisation of the Programme - Summarised policy recommendations

These recommendations for further development of the “National Programme for Energy Efficiency in Multi-family Residential Buildings” are drawn from its current characteristics and aim,

> **without limiting the scope and impact of the Programme and without slowing the pace of its implementation, to ensure the start of a smooth transition to deeper energy renovation, carried out in stages.**

At the same time, the recommendations aim to support the formulation of clear and realistic energy, environmental and economic objectives, able to preserve and further develop the social dimension of the Programme, while ensuring economic stability and showing a **constructive portrait** to the main stakeholders – end-users, local authorities, funding and European institutions.

(The full text of the policy recommendations is in Annex 4 of this report).

Comfort and savings

The analysis of the available statistical information and the energy audits of multi-family residential buildings conducted so far reveals that their average energy consumption corresponds to the level of energy Classes C and B (equal or better than the levels pursued by the Programme – Class C). However, considering their physical (energy) characteristics, these buildings are actually in Classes D and E and therefore need renovation (Figure 8). The main reason for this discrepancy is the under-heating of a significant part of the dwellings as a result of voluntarily stopped or removed heating devices (stoves or radiators). This means that, after the renovation of these buildings to energy Class C (as required by the Programme),

> **there will be conditions for the improvement of thermal comfort, but not for substantial energy savings; in some cases, after the renovation, energy consumption may even be increased.**

Meanwhile, the increased wall insulation and especially the better sealed windows will slow down the exchange of indoor air and therefore create the conditions for the formation of condensation and mould on parts of the inner surfaces of the walls. The deterioration of the microclimate in the premises can be prevented if energy Class A is

achieved through the renovation, which means provision for significantly better insulation, higher air tightness and, importantly, ventilation based on heat recovery (recuperation).

Renovation depth

The analysis of the scenarios[5] for the optimisation of the Programme to 2030 shows that,

in the long-term, the most economically profitable solution is renovation to energy Class A.

In this case, an optimal relationship between the investment and the resulting effects - energy savings and reduced CO_2 emissions - is achieved, and complies with the requirements of the European Energy Performance of Buildings Directive (2010/31/EC). According to this Directive, starting from 2021, new buildings must meet the definition of a "nearly Zero-energy building" (which corresponds to energy Class A/A+ according to the current regulations in Bulgaria). The recommendation is to implement "deep renovations" of existing buildings, taking into account the cost-effective levels. These two requirements can be achieved by choosing Class A as a long-term objective of renovation. Thus, the two discrepancies that are currently included in the programme - the choice of the lowest possible degree of renovation (Class C) and the economic inefficiency of the adopted goal - will be eliminated with the requirements of the Directive 2010/31/EC.

"Step-by-step" renovation

Although in the long-term the renovation to Class A is the most economically profitable solution, insufficient resources for the required level of initial investment are a serious obstacle to its implementation. Public authorities and private building owners have the following alternatives:

limit the scope of renovation to a few buildings, or

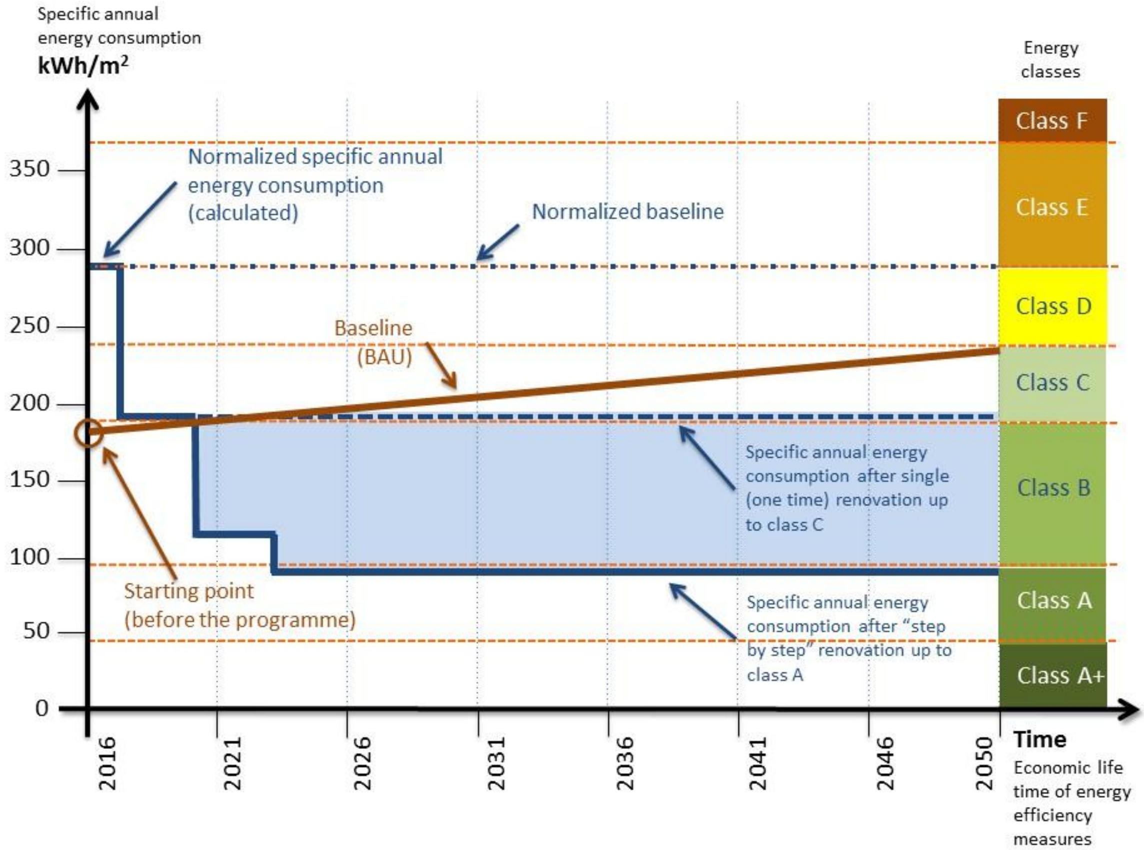
accept a compromise on the renovation level and carry out a complex renovation (energy retrofit)[6] to a lower energy class (e.g. Class C).

The first option leads to an unacceptable delay or extension of the process, while the second one blocks further renovation for the economic lifecycle period of the implemented measures (usually about 30 years).

[5] Modelling of scenarios was performed by the Building Performance Institute Europe (BPIE) in Brussels and the Vienna Technical University with the participation of EnEffect, Bulgaria.

[6] With complex renovation (energy retrofit), a full package of energy efficiency measures, recommended by the energy audit and through which the specified energy class is achieved, is implemented.

Figure 13 - Long-term effects on the perception of energy Classes C and A of the renovated residential buildings



To achieve a higher energy class, while keeping the same volume of total renovated residential floor area and without increasing the annual level of initial investments, stepwise (step-by-step) partial renovation (energy retrofit) can be introduced[7].

Under this approach, energy efficiency measures that correspond to Class A, but implemented in steps (stages), with each next step providing an upgrade to a higher energy class (from C to A/A+), are recommended. In this case, the measures should be planned and implemented so that each next step does not damage or impair the effect of the previous one. This practice is increasingly gaining grounds in several European countries and some pilot projects are being implemented in Bulgaria as well. In order to ensure the predictability of the expected results, time limits for the achievement of minimum levels of energy efficiency (see Figure 15 - sample Roadmap) should be defined. Upon joining the Programme, each condominium should undertake the implementation of the whole renovation of the building to Class A within the period specified in the roadmap. It is advisable to provide additional incentives (e.g. in the form of temporary tax incentives) for those who achieve the ultimate goals earlier.

[7] With partial renovation (energy retrofit), separate measures of the recommended packages are executed and the final energy class determined is achieved through gradual upgrade.

Initial focus on insulation

In order to facilitate the implementation of a "step-by-step" renovation,

> **the "National Energy Efficiency Renovation Programme for Residential Buildings" can focus on the energy retrofit of the building envelope (roofs, walls and foundations)**

as a first stage of the renovation. This energy efficiency measure is the most difficult in terms of organisation and implementation by building owners. It requires comprehensive and simultaneous execution, as well as specialised equipment (scaffolding), and cannot be effectively done individually by the households. This is why the building envelope insulation is the most suitable for centralised financing and implementation. The possibility to achieve relatively quick and radical positive improvement in the appearance of the buildings is an additional advantage of this approach, and may attract new participants to the Programme. The rest of the energy efficiency measures can be divided in the next two steps (for example):

- second step – replacement and sealing of windows and doors;
- and third step – installation of ventilation systems and RES facilities.

The measures of these last steps allow individual organisation and implementation by each household and can take place at different times, but not later than the deadlines set and announced in the roadmap. After the execution of each step, the building will consequently pass from one to another energy class until it reaches Class A/A+. The number of steps and the distribution of the measures in each of them will be determined by energy audits and projects.

Programme funding

During the next years, the National Programme may preserve its focus on the building envelope insulation. In spite of the full subsidy (100%) for building insulation, the share of the State financial support (the subsidy) will decrease as the self-participation of the owners for the next measures will increase. For the implementation of the next steps,

> **various financing tools, which have been successfully used in Bulgaria for years, exist and, in case of good organisation, can supplement the Programme.**

For instance, the BEERECL facility of the European Bank for Reconstruction and Development (EBRD) finances energy efficiency measures with 20% to 30% grants. This tool is used directly by households, making it very suitable for financing the measures of the next steps (replacement of windows, installation of ventilation systems and RES facilities). A similar instrument is the Bulgarian Energy Efficiency and Renewable Sources Fund (EERSF), which finances both full renovation of buildings and separate measures. The use of these additional tools should be guided by the following principle: the higher the energy classes achieved and consequently the more energy is saved, the greater is the public support (the grant share) for building owners.

It will be useful to explore other options for the provision of additional financial resources, such as:

- the sale of CO_2 emissions as a result of the Programme implementation;
- the utilisation of funds for energy efficiency of the obligated parties (i.e. energy suppliers) according to the Energy Efficiency Act;

- use of the European Fund for Strategic Investments (Juncker Plan), etc. (see Figure 14 – Sample financial scheme).

Building structures and systems

The reinforcement of building structures is an important component of the National Programme and it should be preserved. This measure may lead to the extension of the designed life cycle of buildings. It is appropriate, in the frame of this component,

> **and along with the reinforcement of the building structures, to explore the opportunities for laying new or reconstructing the existing heating pipelines with a horizontal feed to the apartments.**

This will not only facilitate the individual billing of energy costs, but it will also create opportunities for the installation of centralised (building) heating facilities (boilers) on biomass and of solar panels for hot water. These measures are the necessary conditions for the ultimate achievement of higher energy classes A/A+. At the same time, the costs for reinforcement of the structures must be separated from the costs for energy efficiency measures. This is needed to correctly quantify the energy savings and CO_2 emissions reduction in compliance with the adopted international verification protocols.

Technical support

If the Programme focuses only on buildings insulation, its management will be greatly facilitated. However, most municipalities do not have adequate capacity to manage its implementation. For this purpose, it is appropriate to include a "technical support" component in the Programme, which could serve to increase the capacity of the key participants – municipalities, auditors, designers and builders.

> **Municipalities must be provided with resources for the adoption of the "municipal energy manager" position, which has been introduced with the Energy Efficiency Act, but is not used in practice.**

In bigger municipalities (for example in regional centres), teams of trained experts should be organised around the energy managers to provide professional management of Programme implementation.

> **To give stability to the results achieved in the retrofitted buildings, professional management and maintenance of the renovated building stock should be introduced.**

The first step was done through the Condominium Property Act. It is necessary to put in place effective incentives to encourage owners to rapidly introduce this form of management both by capacity building of the management bodies of condominiums and by attracting (on a contract basis) specialised professional facility management companies.

Monitoring

The achievement of higher energy classes will bring considerable energy savings and sensitive reductions of CO_2 emissions. To ensure these results, it is necessary to determine concrete and measurable environmental, social and economic goals. The evaluation of the results from the implementation of these goals (the confirmation of the saved CO_2 emissions with regard to the international carbon markets in particular), besides the strict control of the programme implementation, requires also

> **carrying out long-term monitoring of the buildings' behaviour after the renovation.**

Monitoring data can be incorporated in the national energy efficiency database, maintained by the Sustainable Energy Development Agency (SEDA).

Public trust

Building public trust in the Programme is essential for its success. For this purpose, it is necessary

> **to create and widely promote the long-term strategy for the renovation of the residential building stock with clearly defined indicators and deadlines that should be actively announced and explained to home owners**.

It is necessary to develop a comprehensive communication plan with clearly differentiated messages and corresponding targets, approaches and tools. Special emphasis should be placed on working with children, because the Programme may teach them the right attitude towards the use of resources and energy in particular, and the management of the building stock as well as the adjacent areas.

Future reorientation of the Programme

The renovation of residential buildings will improve the appearance of residential districts, which will exert an educational effect on the residents, especially on children. At the same time, in some parts of towns, the renovated buildings could enter into drastic conflict with the neglected adjacent open spaces. After providing the initial boost to the renovation of buildings process,

> **central and local public authorities should focus on the open areas in the neighbourhood, as they are solely responsible for their state and maintenance.**

With the reduction of public support for the renovation of private dwellings, the efforts for the renovation of common open spaces around the buildings should be increased. Thus, an overall improvement of the conditions and of the living comfort, both within the homes and their surroundings, should be achieved. It is appropriate to seek opportunities to bind the obligations of the municipalities to renovate and maintain the open spaces around the buildings with the obligations of home owners to renovate and maintain the buildings themselves.

CHAPTER IV – Financing of the Programme - Sample financing scheme for the renovation of existing residential buildings in Bulgaria

(The full text of the proposals and the policy recommendations are in Annex 4 of this report).

The renovation of the existing residential stock requires considerable support from the State in the form of direct and indirect subsidies or other incentives. The current “National Programme for Energy Efficiency of Multi-family Residential Buildings” provides a 100% State subsidy and fully ensures the necessary funds for the renovation of approved condominiums.

This exceptional State support is intended to give the initial impetus for the renovation process, and, through the positive examples achieved, this impetus is expected to accelerate and deepen in the future, with decreasing State participation.

From 2017, the State subsidy under the National Programme is envisaged to be reduced on behalf of the self-participation of building owners. To establish the conditions to do this without slowing down the pace and scope of the Programme, it is necessary to provide more opportunities for building owners to gain access to financial resources with lower interest rates and favourable conditions. At the moment, the financial markets do offer forms of small project funding, including projects for energy efficiency, but they should undergo significant further development to fulfil the needs of the “National Programme for Energy Efficiency of Multi-family Residential Buildings” and make them sufficiently attractive to home owners in order to encourage participation.

There is a particular public interest in the renovation of buildings to higher energy class, B, A or A+, and for the owners to provide the necessary additional funding to reach them. This interest of the owners coincides with the public interest in terms of maximum energy savings and positive impact on the environment. That is why there are reasons, when considering the financing instruments intended for the renovation of the existing building stock, to accept the following guiding principle: State support is proportional to the results achieved or

the higher the energy class achieved and the bigger the energy savings, the greater is the level of State support.

Based on this principle, in order to encourage deeper renovation of residential buildings and corresponding to the spirit and requirements of the EC Energy Performance of Buildings Directive (recast of 2010), various incentives are introduced and widely applied in developed EU countries. Following this basic principle, the results coming from the analysis of the funding opportunities of the Programme for Renovation of Residential Buildings in Bulgaria are presented further below. Subjects of the analysis are both tools existing already in the country and others that are widely used in European countries and could be adapted to the specifics of the Bulgarian Programme.

The assessment of the general economic situation shows that, despite the growing interest in energy efficiency, a number of funding institutions still perceive this area as risky and therefore approach such projects very cautiously. Some inspirational examples are given by the operational programmes, which have financed a number of energy efficiency projects. The overall observations and experience from the work of the Bulgarian Energy Efficiency and Renewable Energy Sources Fund (EERSF) show that the availability of guarantee instruments can further intensify this market. Therefore, the study suggests the establishment of a dedicated guarantee fund that could encourage a number of commercial banks to enter this market more firmly.

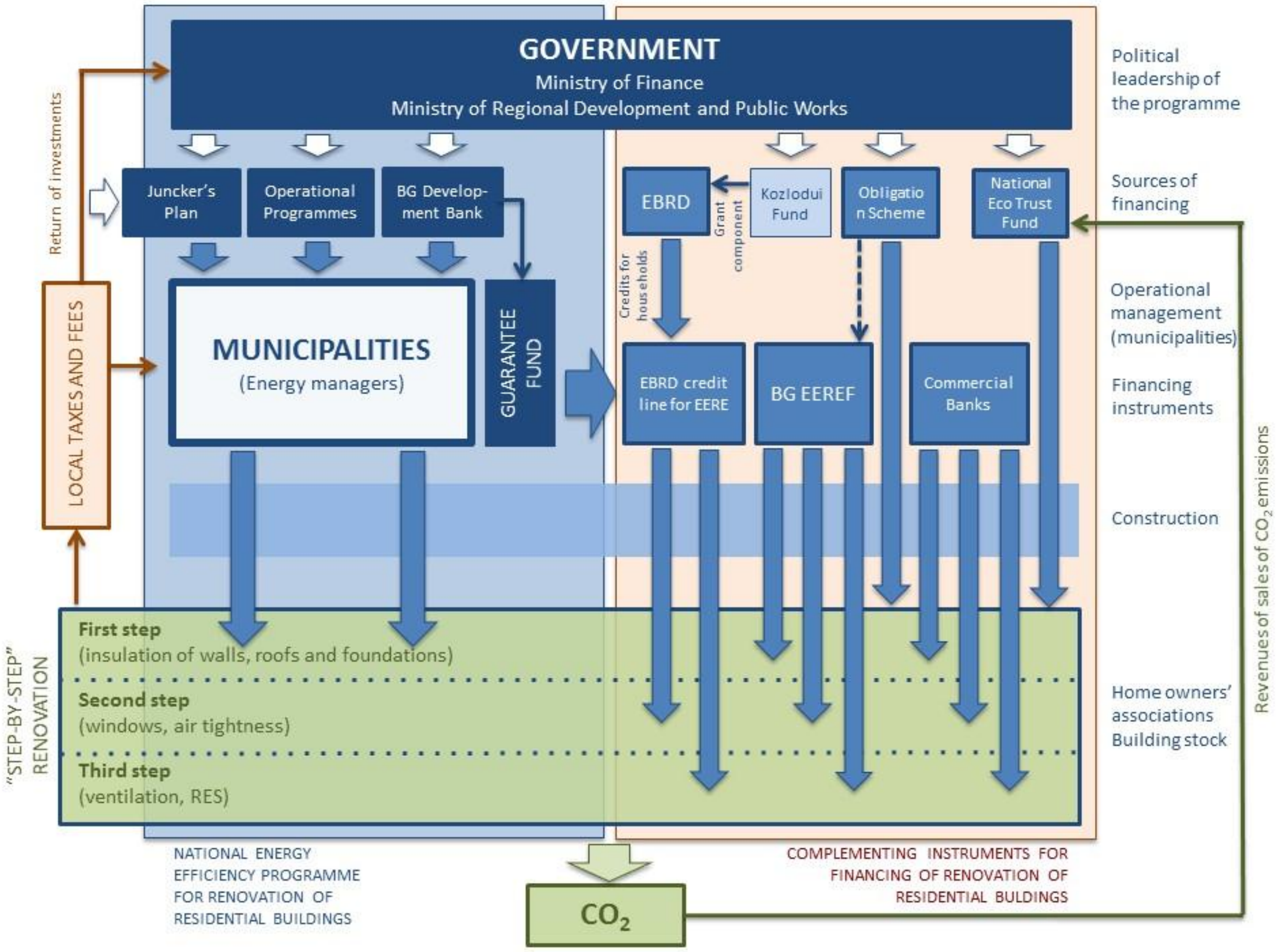
The adoption of higher energy and environmental objectives and the introduction of a phased implementation of the renovation projects with the "step-by-step" approach would help the Programme to establish itself as a leading European practice. This may give grounds to seek additional funding for the Programme through the European Fund for Strategic Investments (the so called "Juncker plan"). The growing interest in this fund is increasingly associated with the renovation of the residential building stock in European cities and this trend should be capitalised on in the

most appropriate way. In order to create conditions for its utilisation, solutions to mobilise additional private investments to implement the Programme should be actively sought.

The conducted review of the existing financial instruments and opportunities for their combination with other forms of financing gives reason to believe that the ground is ready for the immediate creation of an organisation tasked with the management and use of public and private financial flows to address the National Programme. The following figure shows a model organisation of these two streams, which can be enriched with new financing tools and mechanisms in the future (Figure 14).

The financial flows that are directly controlled by the state are shown on the left side of the scheme, and those related to private or public-private sources are depicted on the right. The funds directly controlled by the State are proposed to be utilised under the coordination of the "National Programme for Energy Efficiency of the Multi-family Residential Buildings" in the first phase of the renovation process, while the following steps (measures) could be financed through private or public-private sources in the future.

Figure 14 - Sample funding scheme of the National Energy Efficiency Programme for Multi-family Residential Buildings based on a mix of public and private financial resources



CHAPTER V – Roadmap - Contents and basic principles of the sample roadmap for the long-term renovation of existing residential buildings in Bulgaria

Predictability and clear objectives are important conditions for the Programme to build up trust and ensure public support for its implementation. Therefore, the Programme must be situated within a long-term strategy for the renovation of the existing building stock. It is also necessary to develop and adopt a roadmap for the development of its scope, objectives and instruments. On this basis, it would be possible to plan the necessary long-term investments and the political and financial tools for building the most appropriate socio-economic environment to maximise the effects of the Programme.

On the indicative roadmap below (Figure 15), only a part of the elements that should be subject to planning and policy decisions are included. Each of them can however be subject to potential additional studies and expert discussions with a view to take the most optimal and sustainable decisions.

Scope of the Programme. The conclusions for the future development of the Programme from the analysis of the scenarios clearly show that long-term renovation to Class A is the most economically beneficial approach, for both homeowners and the State. The timing of the different stages to achieve the ultimate goal will allow planning of the necessary investments and expected effects. As shown in the scheme, the Programme can continuously involve different types of buildings in order to achieve optimal economic indicators. It is appropriate to plan the gradual redirection of the resources for the rehabilitation of open spaces in residential complexes, which, after the renovation of the buildings, would look neglected in comparison to them. It should not be forgotten that

> **the design and the maintenance of the open spaces is the sole responsibility of local public authorities.**

Degree (depth) of renovation. The definition of minimum renovation levels (in terms of energy classes) must relate the separate phases with the opportunities for their achievement. The diagram shows exemplary periods for the gradual increase of minimum requirements from Class C to Class A/A+. The specification and acceptance of these periods is essential for well-founded policy decisions. It is important to note that

> **the perception of the "step-by-step" approach with the long-term objective of reaching Class A/A+ allows for flexible solutions in terms of minimum thresholds.**

Living comfort. Along with raising of the energy class, the living comfort for occupants will also improve. Although the quality of habitation and the comfort in dwellings is still greatly underestimated, it is actually directly related to the health of occupants and to the overall quality of life. The improvement of living conditions in dwellings will start with an increase in thermal comfort (after insulation of facades, roofs and foundations of buildings), will continue with the improvement of internal air quality and will end with the provision of a completely healthy microclimate (after the replacement and sealing of windows and the installation of controlled ventilation).

Necessary investments. Last but not least, the Roadmap could show the necessary investments for each stage of the Programme, based on which the resources needed for each subsequent year could be estimated.

Figure 15 - Sample Roadmap by 2050

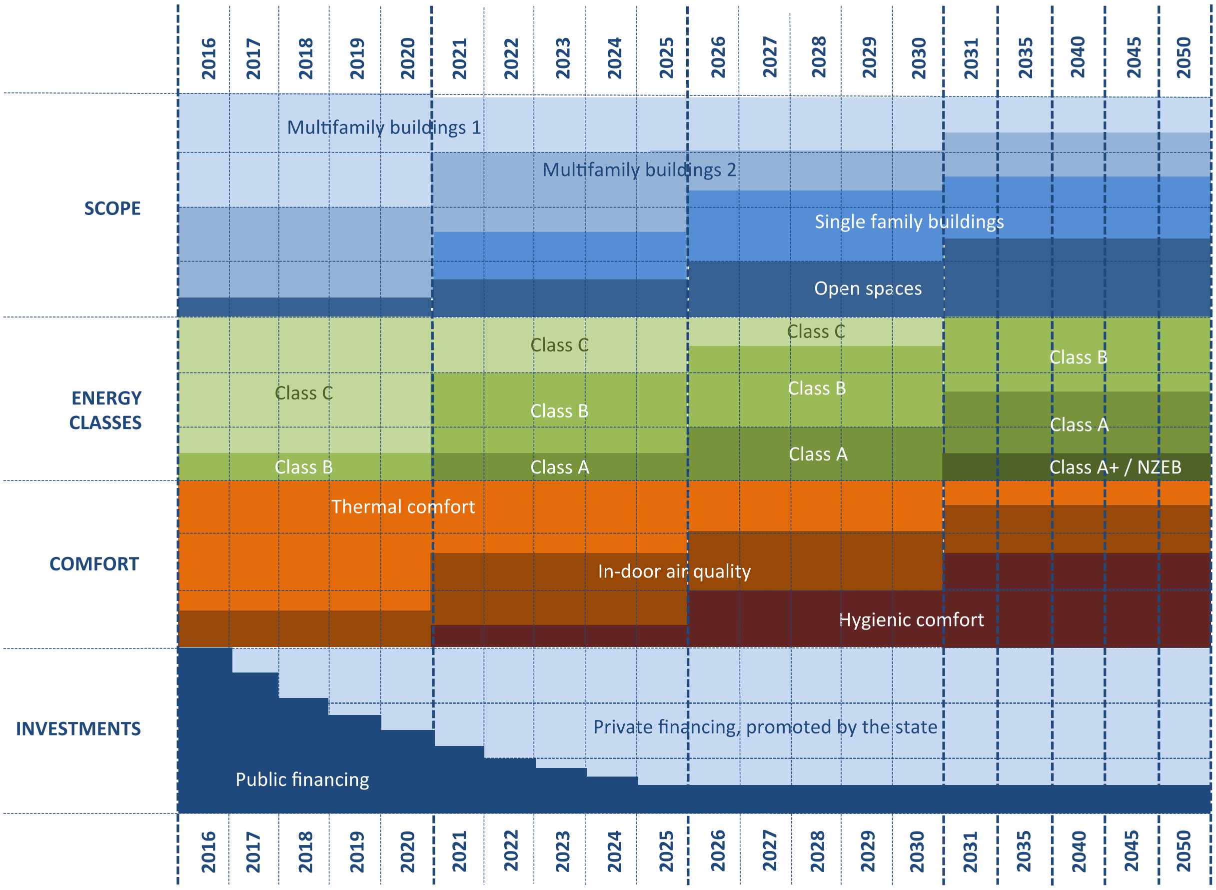
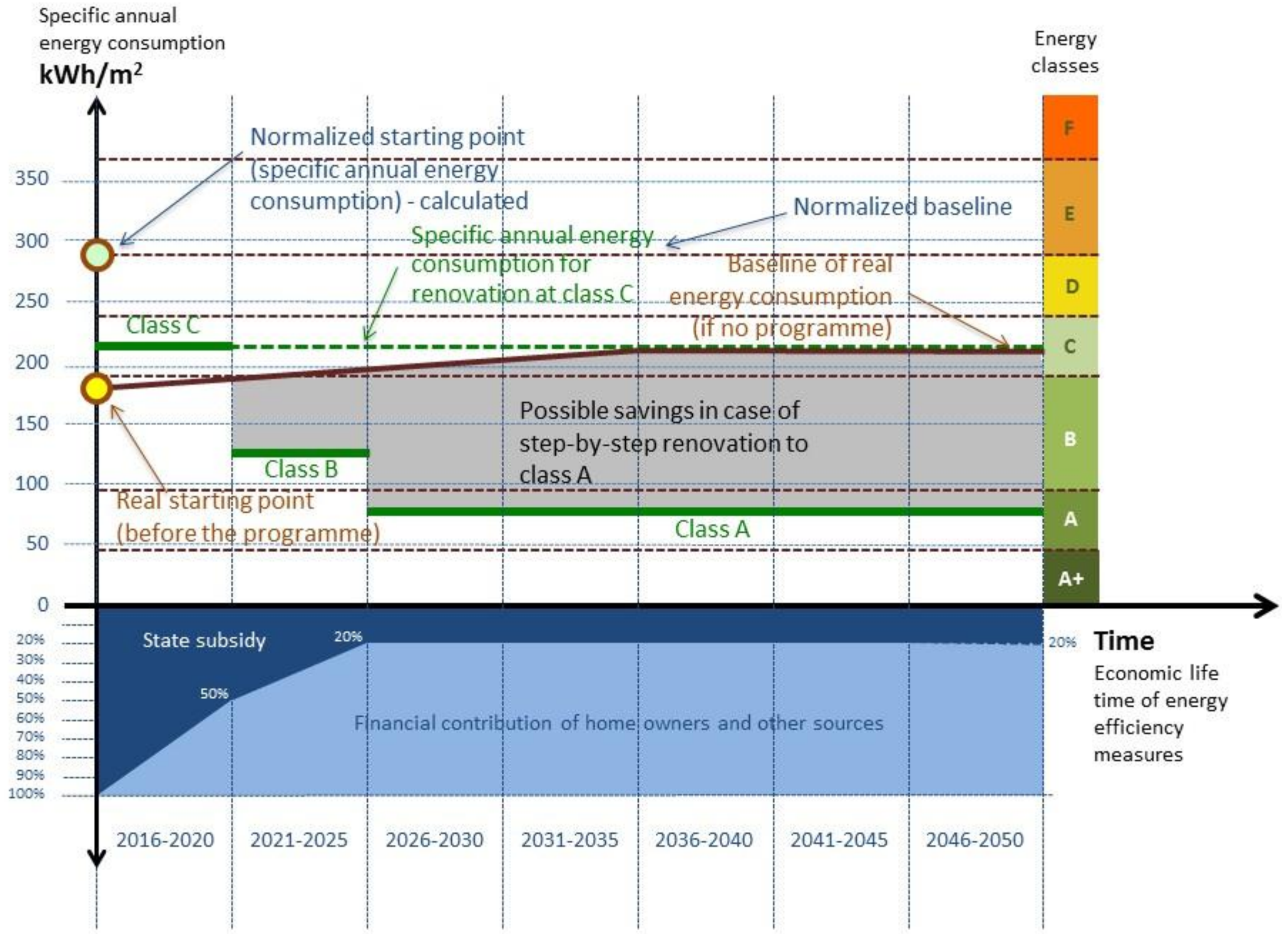


Figure 16 shows the energy savings (grey field) that can be implemented in the phased (step-by-step) renovation of residential buildings to an energy class A. These savings will not be achieved for the buildings that will be retrofited to Class C for the economic life period of the implemented measures (average 30 years). The reduction of the direct State support to 20% of the required investment is shown at the bottom of the chart.

Figure 16 - Possible long-term energy savings with step-by-step renovation to energy class A



CONCLUSION

The study strongly reaffirms that, in the long run, deep retrofitting to high energy efficiency classes is economically more beneficial than "shallow" renovation. Although this conclusion has been reached by a number of other influential studies, determined political actions to deep renovation are still slow to catch on in Bulgaria and in many other EU countries. However, the approach of gradual improvements to existing buildings attracts deserved attention, as it can deal with the most serious obstacle to ambitious projects and programmes – the higher initial investments needed to achieve ambitious targets. The rearrangement of the investment for longer periods of time and the ability to gradually upgrade the buildings to higher energy classes reduces the investment pressure early in the process and allows for flexible management of the next stages of renovation. The most important effect of this phased implementation, however, is the possibility to prevent the "lock-in" effect of the shallow complete renovations, which inevitably accompanies the low energy targets in the process of renovation.

Deep renovation, including the introduction of more renewable energy supply in buildings has other positive effects as well. It contributes to improved energy security as well as a reduction in greenhouse gas emissions and air pollution by fine particles. Indeed, there is much to be said for providing specific focus and support of the Programme on those municipalities currently suffering the worst levels of air pollution. The gradual concentration of the Programme on building insulation would help to rapidly and radically improve the appearance of Bulgarian settlements. Increasing the thermal comfort in the dwellings will inspire a fundamental change in the attitude towards living comfort and the overall quality of life in residential areas and adjacent open spaces. The energy savings would be economically significant and the investments in the construction sector will create new jobs and boost the development of local economies. In the course of the Programme, the capacity of local authorities and professional communities will substantially increase.

The transparency, predictability and the guarantees for quality performance, the technical capacity in municipalities and the ability to carry out systematic information campaigns on the benefits of energy efficiency are the necessary tools for establishing trust and confidence in the Programme and in the involved institutions. However, the most important factor remains the political will to improve the energy efficiency of residential buildings that gives us a reason to believe that Bulgaria can enter the forefront of the European energy transition by launching a concerted programme of building renovation, with increasingly active participation from individual owners.

ANNEX 1 - DESCRIPTION OF COLLECTED DATA

Description of collected data intended as an input to the Invert model in the context of the project for the Economic Appraisal from the Investors' Perspective of Energy Saving measures in the Bulgarian building stock

Definitions

The definitions regarding the residential building stock used in the report are in accordance with the definitions in the publication of the National Statistical Institute (NSI), presenting the results of the population census in the Republic of Bulgaria for 2011.

(Census and Dwelling fund in 2011, Vol. Dwellings fund, Book 1 Buildings, NSI, Sofia, 2012)

Houses – residential buildings from one to three floors (detached, semi-detached or twins, terraced, etc.), where each apartment has its own entrance directly from the adjacent terrain. This includes the buildings of three floors with one dwelling per floor and a shared entrance from the street / backyard.

Residential blocks, cooperative housing – buildings with an average (4 or 5) or high (>6) number of floors and common staircase, which leads to entrances to individual homes. This category includes three-storey buildings with two and more dwellings per floor. Residential blocks that have multiple entrances and those that are built in sections are considered as a single building.

Buildings of mixed type (over 60% living space) – those in which more than 60% of the gross floor area is used for residential purposes and less than 40% of the area is used for non-residential purposes (commercial, administrative and others).

The following types of buildings are included in the category **other residential buildings**:

- ***Dormitories*** - buildings for students and workers, where usually ordinary families live.
- ***Summer kitchen***, when it is a separate building with additional construction, whose premises are used by the household, constantly living in the residential building, to which the summer kitchen belongs. For this building, information on dwelling is not collected and the dwelling data refers to the main residence.
- ***Cottage*** - building, which originally is designed to meet specific needs of the population - to rest and restore health. The cottage can be located in an established colony, in an unstable colony, on private property (vineyards, gardens) etc.
- ***Buildings for collective housing*** - boarding houses, monasteries , homes for children, old people's homes, prisons and other similar cases.

The **useful area** of the dwelling is the area bounded by the external walls of the dwelling. The surrounding walls can be to neighboring apartments or common areas as well as external to the building. The useful area of the dwelling includes the floor area of balconies and loggias, and do not include the areas of basements and attics.

The **living area** of the dwelling is equal to the sum of the area of the rooms. When an entry hall is not separated by a barrier, its area is included in the area of the room, from where it is illuminated.

Residential building stock

The publications of the National Statistics Institute (NSI) which describe the results of the population census from 2011[8] are preferred as a major source of data on the residential building stock in Bulgaria. These publications include data on buildings and dwellings and provide valuable information regarding the energy renovation of residential buildings. No information about new buildings constructed in the period after 2011 is presented in the publications. All the data presented in this chapter of the report covers only the inhabited residential buildings and dwellings.

Residential buildings by building type

In Bulgaria there are over 1.5 million inhabited residential buildings, of which 641 thousand are in towns (urban) and 864 thousand are in villages (rural). According to the classification used by the NSI, the buildings are divided into seven types. For the purposes of this analysis, the types of buildings are reduced to four. Dormitories, buildings for collective housing, summer kitchens and cottages are grouped as **other residential buildings**. The reason for that is the insufficient number of the first two mentioned types of buildings and the functions of the remaining two types not serving as a main place for leaving. The data on the number of different types of buildings and their location is summarised in **Table 6**.

Table 6 - Total number of residential buildings by type and location

Building type:	**In Bulgaria**	**In towns**	**In villages**
Houses	1 291 549	492 667	798 882
Multifamily residential buildings	66 865	64 476	2 389
Buildings of mixed type	6 465	5 025	1 440
Other residential buildings	141 066	79 082	61 984
… of which cottages	*140 047*	*78 403*	*61 644*
TOTAL	**1 505 945**	**641 250**	**864 695**

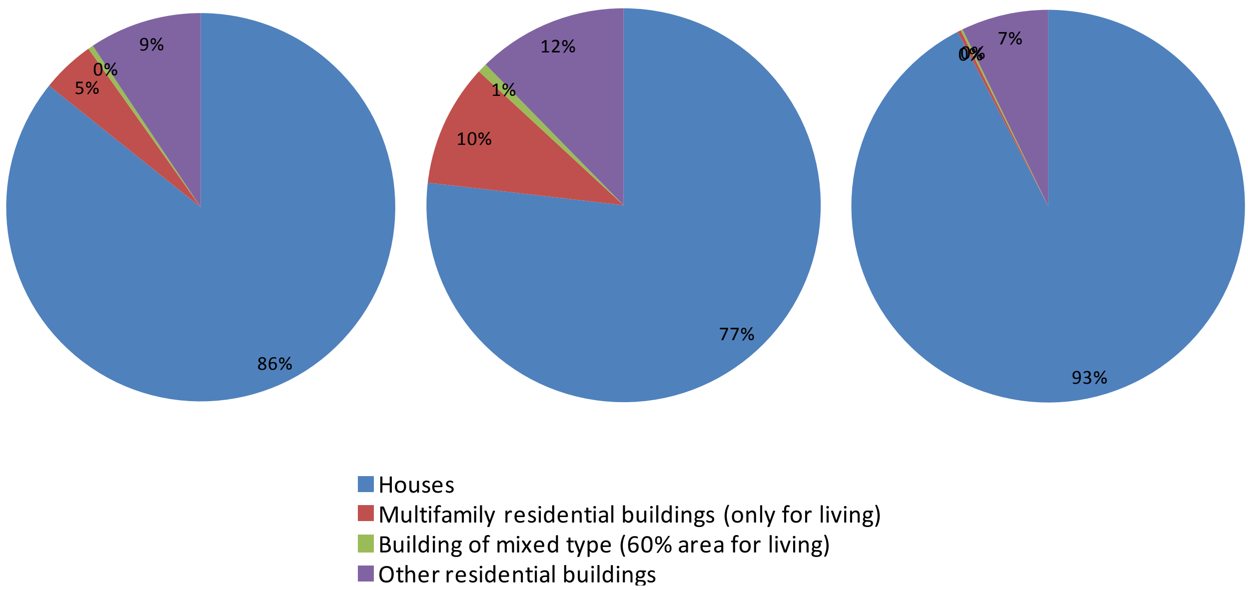
The predominant type of residential buildings in Bulgaria are houses whose share is about 86% of all residential buildings. This situation is especially pronounced in rural areas, where about 93% of all buildings are houses. In villages, multifamily residential buildings are insignificant – below 0.5%, but in towns their number reaches 10%. The shares of residential buildings based on the number of buildings according to location is shown in Figures 1a, 1b, 1c.

[8] Census and Dwelling fund in 2011, Vol. Dwellings fund, Book 1 Buildings, NSI, Sofia, 2012
Census and Dwelling fund in 2011, Vol. Dwellings fund, Book 2 Dwellings, NSI, Sofia, 2012

Figure 1a - Shares of buildings in the country

Figure 1b - Shares of buildings in towns

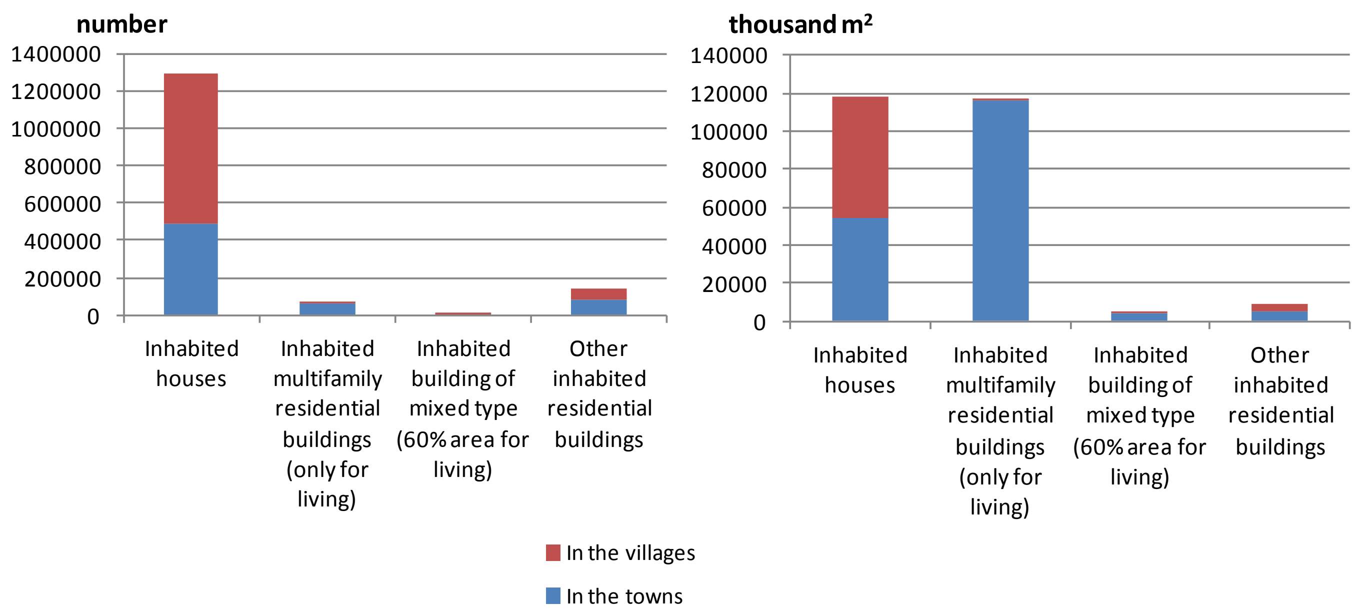
Figure 1c - Shares of buildings in villages



With regard to the useful floor area, multifamily buildings are almost equal to houses, despite their significantly lower number. Total useful floor area of dwellings in houses is 118 million m^2, of which about 54 million m^2 are in towns and about 64 million m^2 are in villages. The total useful floor area of dwellings in multifamily residential buildings is 117 million m^2, of which 115.5 million m^2 are in urban areas and 1.5 million m^2 in villages. Information on the number of different types of buildings and the useful floor area of dwellings located therein is summarised graphically in Figures 2a and 2b.

Figure 2a - Distribution of residential buildings according to their *numbers*

Figure 2b - Distribution of dwellings according to the *useful floor area*



The share between different types of buildings, based on the total useful floor area of all dwellings inside the buildings, is presented in Figures 3a, 3b and 3c.

Figure 3a - Shares by useful floor area of residential buildings in the country | **Figure 3b - Shares by useful floor area of residential buildings in towns** | **Figure 3c - Shares by useful floor area of residential buildings in villages**

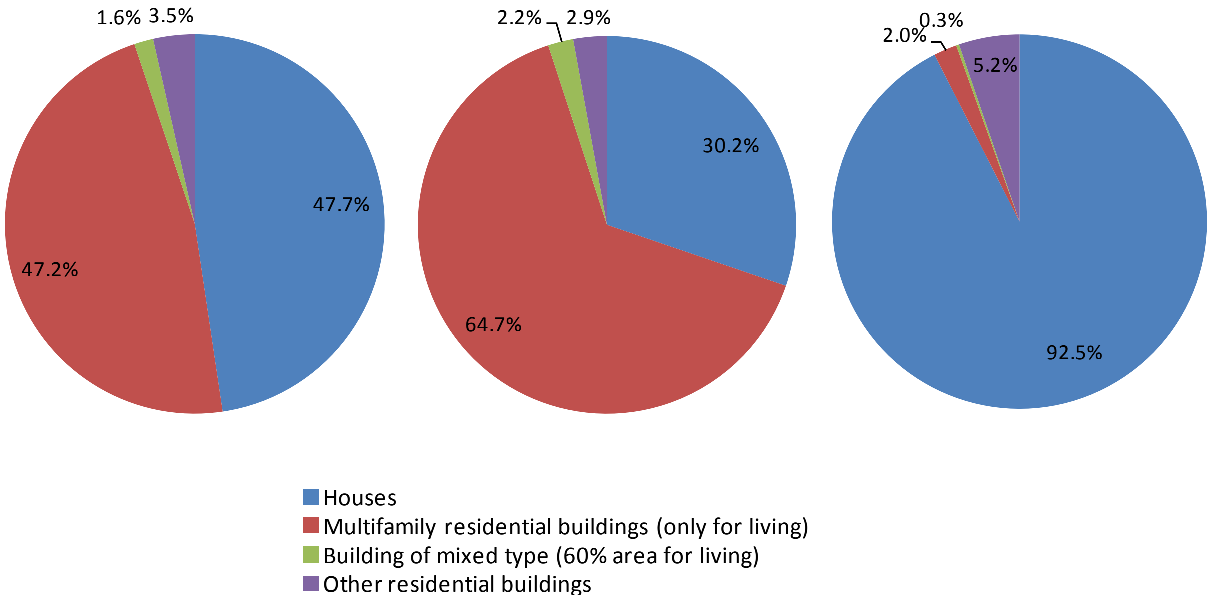


Figure 4a presents the average total useful areas in the different types of residential buildings. These are calculated as a ratio of the total useful floor area of the dwellings inside buildings and the number of buildings of the same type. The national average for the total useful area in houses is 92 m^2, and for multifamily buildings it is 1752 m^2. Similarly prepared information for the average total living area in the different types of buildings is presented in Figure 4b. For houses, the national average total living area is 70 m^2, and in multifamily buildings it is 1301 m^2, where the average size of one dwelling is 71.4 m^2.

Figure 4a - Average useful area

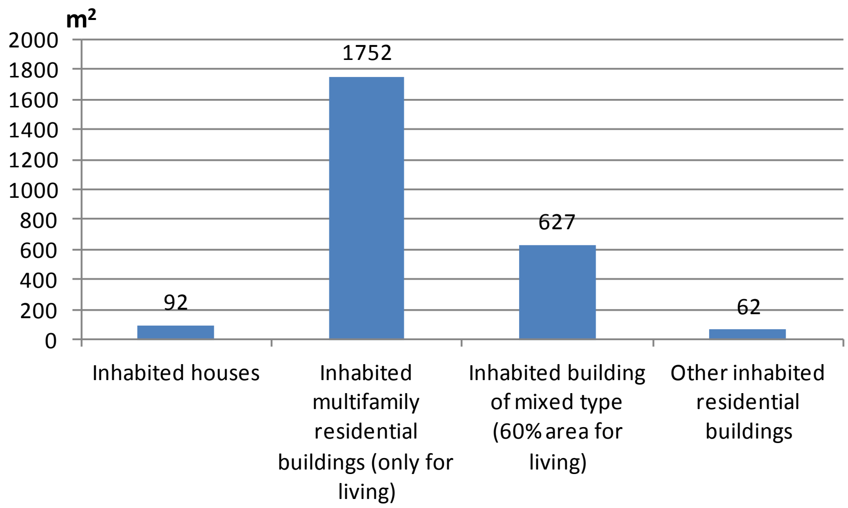
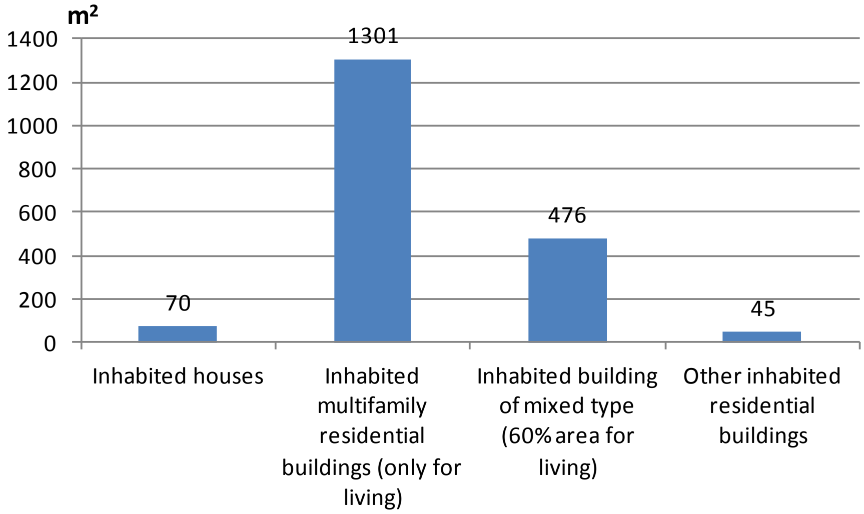


Figure 4b - Average living area



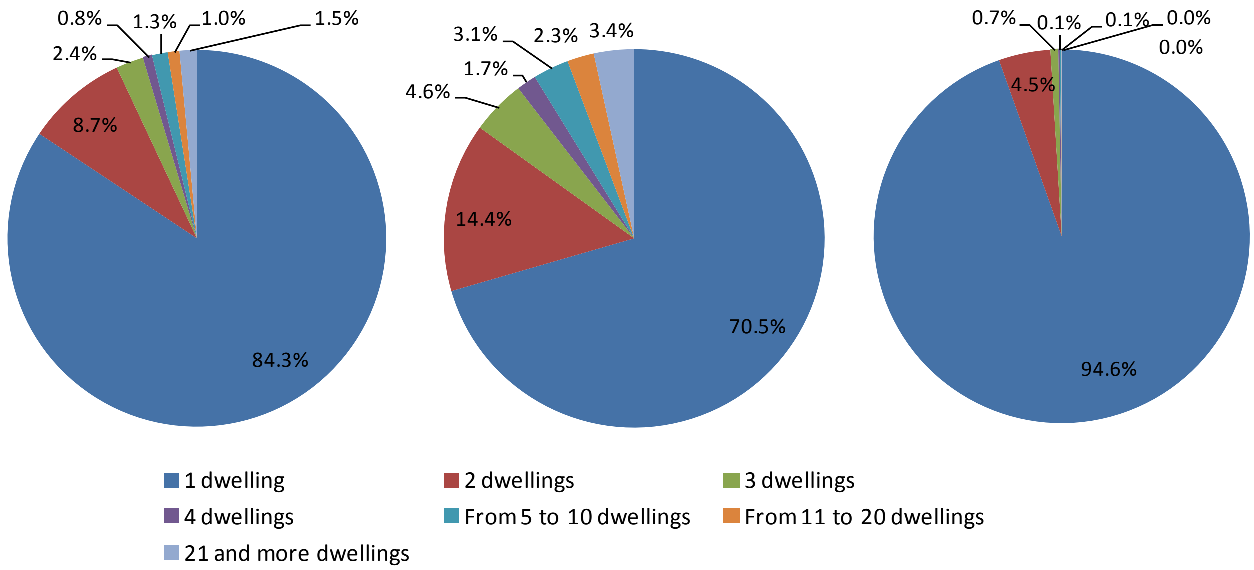
Residential buildings by number of dwellings

Over 84% of residential buildings in Bulgaria consist of one dwelling, over 84% of all are inhabited. In towns, 70.5% of residential buildings have one dwelling; 14.4% have two dwellings, and 15.1% have more than two dwellings. Buildings with 21 or more dwellings make up 3.4% of the stock in urban areas, and 1.5% countrywide. Within the 1st category, those with 41 or more dwellings make up 1.8% of the stock in towns, and 0.8% nationwide. In villages, residential buildings with one dwelling reach 94.6%, the buildings with two dwellings make up for 4.5% and all other only about 1%. The data is presented in Figures 5a, 5b and 5c.

Figure 5a - Shares by number of dwellings of residential buildings across the country

Figure 5b - Shares by number of dwellings of residential buildings in towns

Figure 5c - Shares by number of dwellings of residential buildings in villages



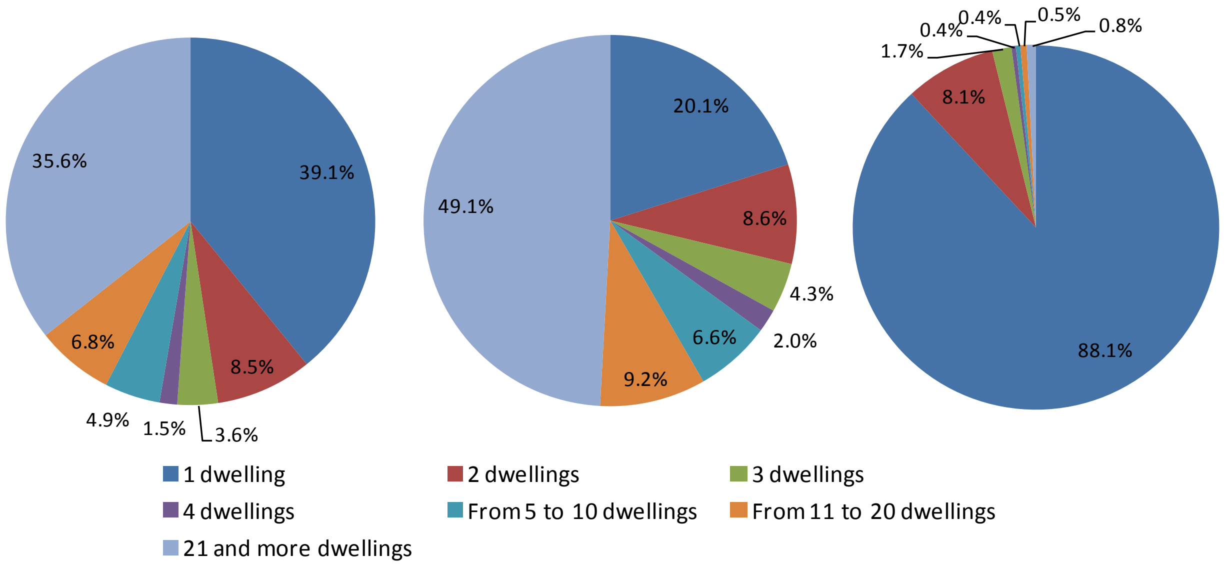
In terms of the total useful floor area of dwellings, the distribution is different. The buildings with one dwelling make up 39.1% of the total useful floor area, while the share in buildings with 21 or more is 35.6%. In towns, the share of buildings with more than 21 dwellings reaches 49.1%. Data on the distribution of the total useful floor area of the

dwellings is estimated as a share of the useful area of residential buildings devided by the number of dewllings in the building. The results are presented in Figures 6a, 6b and 6c.

Figure 6a - Shares of the useful area of residential buildings in the country

Figure 6b - Shares of the useful area of residential buildings in towns

Figure 6c - Shares of the useful area of residential buildings in villages



The total number of buildings with one dwelling is about 1.27 million, of which 452 000 are in towns and around 818 000 are in villages. According to the definitions of the types of buildings, buildings with one dwelling cannot be part of the group of multi-family buildings. The possibility of a building of mixed type, a dormitory or a building for collective housing to be counted with a single dwelling, is very small. According to the definition, a summer kitchen should also be excluded. If an assumption is made that all cottages have one dwelling, which, according to expert opinions, is an assertion approaching reality, then the number of houses with one dwelling could be calculated using the data from **Table 6** on the total number of buildings of any type.

The average total useful area of dwellings and the total living area of residential buildings with one, two or three dwellings are presented in **Table 7**. The average total useful floor area of dwellings in buildings with two or three dwellings is 179.3 m^2 (189.1 m^2 in towns and 152.5 m^2 in villages), and the average living area is 139.2 m^2 (147.2 m^2 in towns and 117.4 m^2 and in villages).

Table 7 - Average useful area and living area of buildings with one, two or three dwellings

Number of dwellings in buildings	Average useful area of all dwellings in buildings (m^2)			Average living area of all dwellings in buildings (m^2)		
	In total	In towns	In villages	In total	In towns	In villages
1 dwelling	76.5	79.6	74.8	58.2	61.0	56.7
2 dwellings	160.5	167.0	144.9	124.3	129.6	111.5
3 dwellings	248.8	257.8	203.0	194.3	201.9	156.1

The total useful and living areas for one-dwelling houses and for two or three-dwelling houses are estimated using the calculated values for the number of houses with one, two or three dwellings and the average areas for these groups of buildings are separately calculated. These results are summarised in **Table 8**.

Table 8 - Houses with one, two or three dwellings

Houses with:	Number	Number in towns	Number in villages	Useful area	Useful area in towns	Useful area in villages	Living area	Living area in towns	Living area in villages
	-	-	-	1000 m²	1000 m²	1000 m²	1000 m²	1000 m²	1000 m²
1 dwelling	1 129 901	373 816	756 085	86 453	29 757	56 559	65809	22795	42893
	87.5%	75.9%	94.6%	74.9%	57.0%	89.7%	74.5%	56.6%	89.5%
2 or 3 dwellings	161 648	118 851	42 797	28 990	22 476	6 528	22505	17495	5022
	12.5%	24.1%	5.4%	25.1%	43.0%	10.3%	25.5%	43.4%	10.5%
TOTAL	1 291 549	492 667	798 882	115 443	52 233	63 087	88 314	40 289	47 916

Residential buildings by age

The highest rate of residential buildings' construction was in the period from 1960 to 1969 - a total of 324 480 buildings, of which 179 718 units were in towns and 144 762 units in villages. The lowest construction rate was in the period 2000-2011 - a total of 83 013 units. The largest total useful area of these dwellings was built in the periods 1970-1979 and 1980-1989, about 551 million m² for each of these two decades. These dwellings are predominantly multifamily buildings concentrated in towns. The data for the year of construction is presented in Figures 7a and 7b.

Figure 7a - Number of residential buildings by year of construction and location

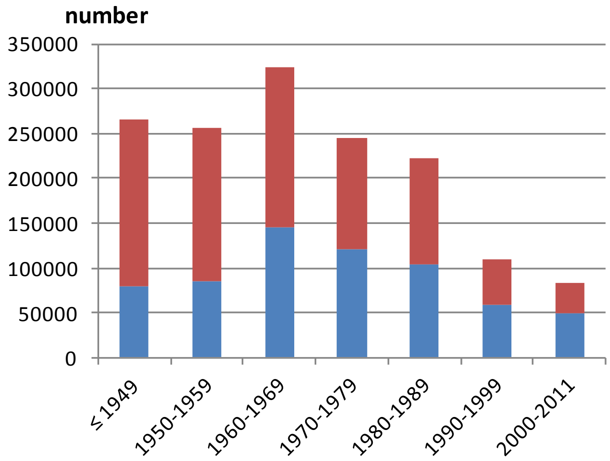
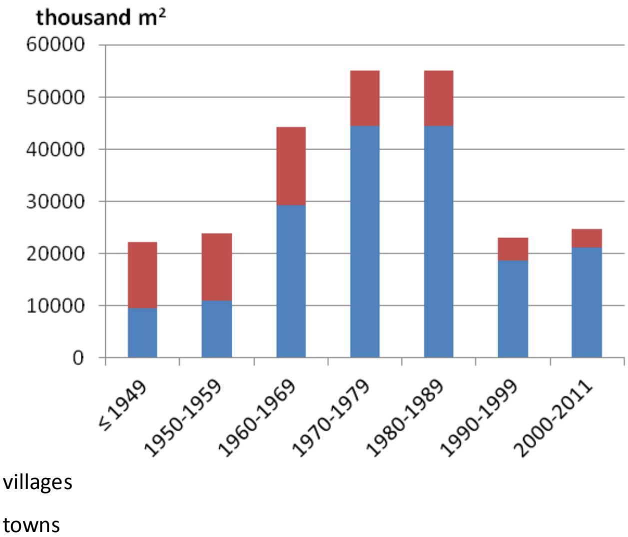


Figure 7b - Useful area of residential buildings by year of construction and location



Residential buildings by number of floors

Figures 8a and 8b present the distribution of the number of residential buildings and the total useful area depending on the number of floors.

Figure 8a - Distribution of residential buildings by number of floors

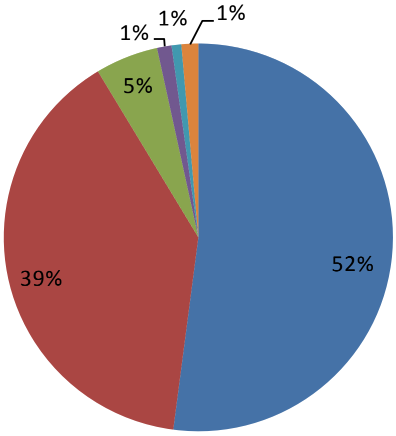
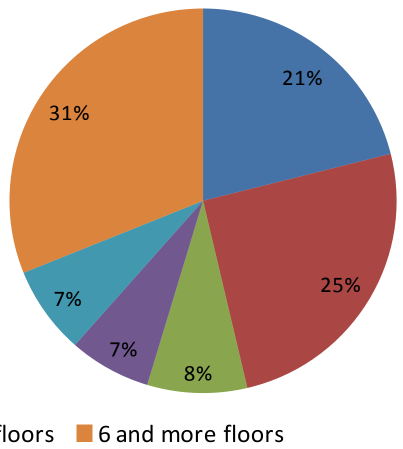


Figure 8b - Distribution of the useful area in residential buildings in relation to the number of floors



Most residential buildings have either one floor (52%) or two (39%). However, the largest useful area of dwellings is found mainly in buildings with six floors and more (31%). Buildings with two floors make up 25% of the total useful area and those with one floor, 21%. Buildings with three, four and five floors have approximately equal total living areas: 7%-8% for each category.

Residential buildings by construction material

About 44% of residential buildings are built with wooden beams and brick walls. Around 39% of the residential buildings are built with reinforced concrete slabs and brick walls. Buildings with prefabricated panels are only 1% of the total. The biggest total useful area of dwellings is concentrated in residential buildings with reinforced concrete slabs and brick walls – around 43%, while in those with a structure of wooden beams, although higher in number, the total useful floor area is only 21%. Residential buildings with prefabricated panels have 19% of the total useful floor area. The data for the residential buildings in terms of main construction material used is summarised in Figures 9a and 9b.

Figure 9a - Number of residential buildings by main construction material

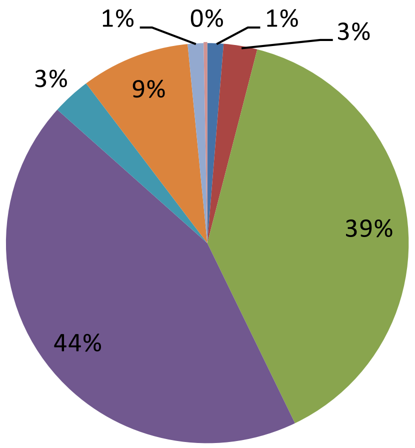
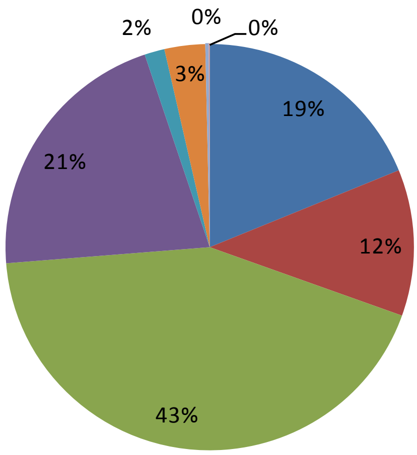


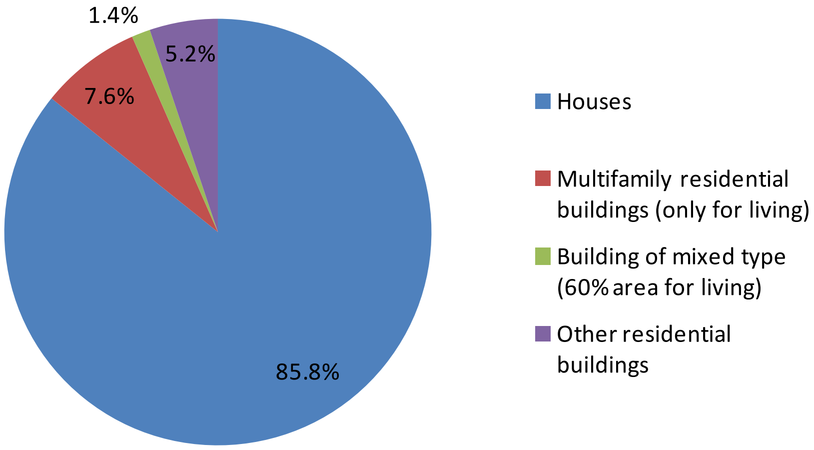
Figure 9b - Useful area of residential buildings by main construction material



Residential buildings by presence of solar collectors

By 2011, solar collectors were installed on a total of 27,291 (1.8%) buildings. The highest percentage of installed solar collectors are situated on houses - about 85.8%, while 7.6% are installed on multifamily buildings. The data is presented in Figure 10.

Figure 10 - Shares of different types of residential buildings according to the presence of solar collectors



Dwellings by energy efficiency measures applied

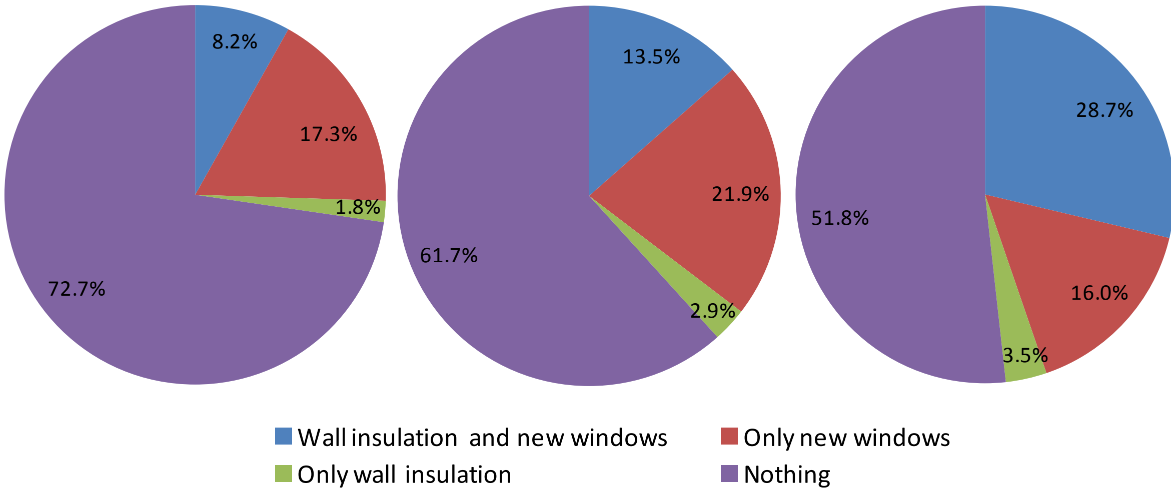
96.9% of the dwellings in Bulgaria are owned by private individuals, about 2.6% are State or municipal property and only about 0.5% are owned by private legal entities. 3.4% of State or municipal dwellings are located in towns and 0.7% in rural areas.

In terms of applied energy efficiency measures in the dwellings - defined by the presence of thermal insulation on external walls and the presence of new windows - information is presented in Figures 11a, 11b and 11c according to different types of ownership. The highest percentage of implemented measures are in dwellings owned by private legal entities. Within this class, 48.2% of buildings have thermal insulation or new windows, whereas both measures (insulation and windows) are present in 28.7% of dwellings. In 61.7%, of dwellings owned by private individuals, energy efficiency measures are not implemented, but when they are, the most common measure is new windows. 72.7% of dwellings owned by the State or municipalities do not have thermal insulation or new windows.

Figure 11a - Shares of applied energy efficiency measures in dwellings owned by the state or municipalities

Figure 11b - Shares of applied energy efficiency measures in dwellings owned by private individuals

Figure 11c - Shares of applied energy efficiency measures in dwellings owned by private legal entities



Dwellings by heating source

Statistics about the heating sources in dwellings show that wood, electricity, coal and district heating together are used in 99% of dwellings.

The largest share of dwellings are heated with wood (34.1%), while district heating is used in 16% of the cases. In towns, the dwellings in which the main source of heating is electricity account for 38.5% and those that heat with wood for 22.8%. District heating is used in 22.5% of dwellings. In rural areas, wood dominates as the primary heating source (62.8%), while coal is used in 32.5% of the cases and electricity in 4.1% of the building stock. All other heating sources are present in only 0.6% of dwellings. Data on the main heating sources is summarised in Figures 12a, 12b and 12c.

Figure 12a - Shares by main heating source of dwellings in the country

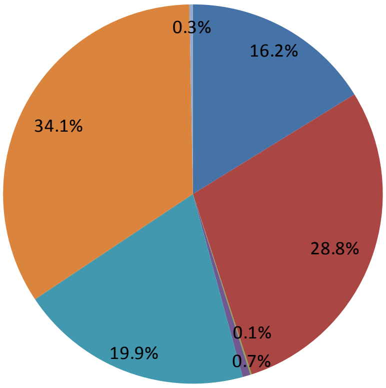


Figure 12b - Shares by main heating source of dwellings in towns

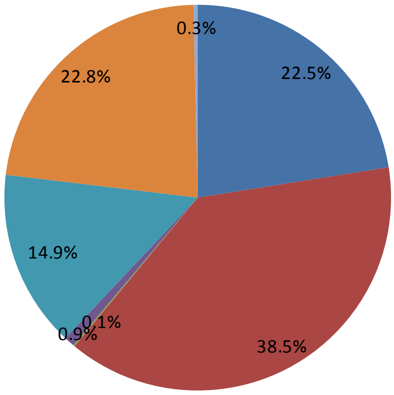
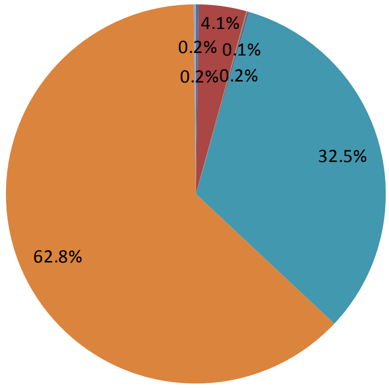


Figure 12c - Shares by main heating source of dwellings in villages



National building characteristics

Norms related to energy efficiency in buildings were introduced for the first time in the Bulgarian legislation in 1964 and set mandatory U-values for exterior walls, roofs and floors. Until 1999, these values differed depending on the outside design temperature, while for external walls different values also applied depending on the construction of the building - massive, light or very light.

In 1999, for the first time, mandatory U-values were introduced for windows and doors. Since 2005 the normative U-values are recommended, but not mandatory. The current U-values are in force since 2015. The information about the normative U-values is summarised in **Table 9**. For the period 1964 – 1999, U-values are presented for outdoor design temperature (-16°C) typical for Sofia.

Table 9 - U-values according to Bulgarian norms, W/m²K

Year	Wall			Flat roof	Venti-lated roof	Floor	Windows	Notes:
	massive	light	very light					
1964	1.56	1.43	1.3	1.09	1.2	1.3	-	U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C.
1977	1.56	1.43	1.2	1.09	-	1.2	-	U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C.
1980	1.2	0.869	-	0.966	-	0.483	-	Residential, hospitals, kindergartens, hotels, hostels. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for every building type.
1980	1.34	0.968	-	1.087	-	0.604	-	Schools, policlinics. U-values vary in correlation with design winter outside calculating temperature. There for -16˚C. Also Um (max) is determined for every building type.
1987	0.988	0.49	0.434	0.54	-	0.268	-	Residential, hospitals, kindergartens, hotels, hostels. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for every building type.
1987	1.099	0.55	0.48	0.6	-	0.604	-	Schools, policlinics. U-values vary in correlation with design winter outside calculating temperature. Here for -16˚C. Also Um (max) is determined for for every building type.
1999	0.55			0.3	-	0.5	2.65	For all buildings. Also Um (max) is determined in relation with A/V ratio.
2005	0.45			0.25	0.3	0.5	2	Insulated inside or in the middle of the wall/floor. Udoors ≤2.2.
2005	0.35			0.25	0.3	0.4	2	Insulated outside. For external door: U≤2.2.
2009	0.35			0.28	0.3	0.28	1.7	For PVC framed windows only. For wood framed windows U≤1,8. For aluminium framed U≤2. For curtain wall U≤1.9-2.2.
2015	0.28			0.25	0.3	0.25	1.4	For PVC framed windows only. For wood framed windows U≤1.6-1.8. For aluminium framed U≤1.7. For curtain wall U≤1.75-1.9.

The assessment of energy efficiency in buildings is determined by the value of the integrated energy performance characteristic of the building expressed in annual specific energy consumption (kWh/m²). In 2005-2009, the integrated energy performance characteristic was determined by final energy, but since 2009 it has been determined by primary energy. **Table 10** presents the latest national coefficients for conversion of final into primary energy for different types of energy and fuels as well as the CO_2 emission factors in accordance with the final energy consumed.

Table 10 - Actual values of the final to primary energy ratios and CO_2 emission factors

Fuel/ energy type	Final to Primary energy ratio	CO_2 emission factors, gCO2/kWh (final)
Electricity	3.0	819
District heating	1.3	290
Natural gas	1.1	202
Light Fuel Oil	1.1	267
Heavy Fuel Oil	1.1	279
LPG	1.1	227
Black Coal	1.2	341
Lignite/Brown coal	1.2	364
Antracite Coal	1.2	354
Briquettes from coal	1.25	351
Briquettes and pellets from wood	1.25	43
Firewood *	1.05	6

Source: Ordinannce No.7 for Energy Efficiency in Buildings (SG 27/28.04.2015)

** Source: Ordinannce № PO-16-1058 form 10 December 2009 for the indicators for energy consumption and energy performance characteristics of buildings*

National definitions for nZEB:

nZEB is a building that meets the following conditions:

1. The energy consumption of the building, defined as primary energy, corresponds to class "A" on the scale of classes for the respective type of building;
2. Not less than 55% of the final (delivered) energy for heating, cooling, ventilation, domestic hot water and lighting is energy from renewable sources, located in the building or near the building.

Compliance with the energy efficiency requirements

Compliance with the energy efficiency requirements is met when the annual specific primary energy consumption in kWh/m^2 corresponds to the following energy class:

1. "B" – for new buildings and existing buildings in operation since 1 February 2010;
2. "C" – for existing buildings in operation prior to 1 February 2010;
3. "A" – for nZEB;
4. "A+" – for buildings above the national requirements for nZEB.

Energy classes

The energy efficiency of buildings is evaluated according to the value of their integrated energy performance, which represents the calculated consumption of primary energy per square metre. The conditions for the level of comfort in the building must comply with the normative requirements at standard outdoor climate conditions. The scale of energy classes for residential buildings is presented in Figure 13.

Figure 13 - Scale of energy classes for residential buildings

Energy class	EPmin, kWh/m^2	EPmax, kWh/m^3	RESIDENTIAL BUILDINGS
A+	<	48	A+
A	48	95	A
B	96	190	B
C	191	240	C
D	241	290	D
E	291	363	E
F	364	435	F
G	>	435	G

Energy consumption

In the period 2000-2013 there was a slight trend of increased final energy consumption in households. In this period, the most noticeable was the increase of electricity and firewood consumption, and the reduction of district heat and coal consumption. There was a minimal growth in consumption of natural gas, but this is mainly due to the fact that the development of the gasification of households in Bulgaria began in 2003-2005. The increase of electricity consumption can be explained by the growth in the variety of household appliances and by the heating with electricity. The growth of the use of firewood can be explained by the substitution of other fuels and by the lower efficiency of the technologies used to burn wood. Data on the final energy consumption of households is summarised in Figures 14a and 14b.

Figure 14a - Final energy consumption of households in the period 2000-2013

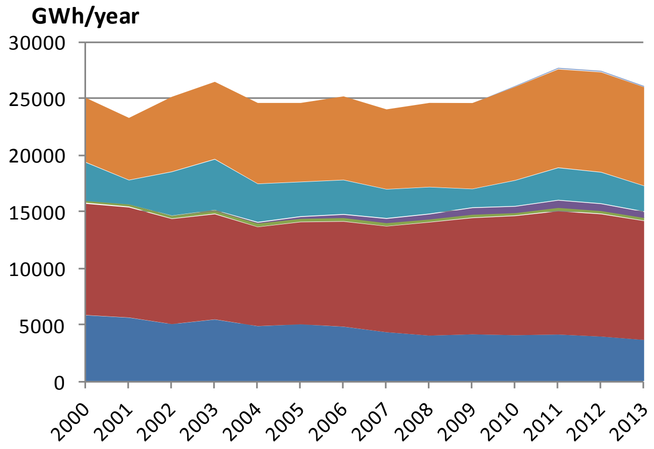
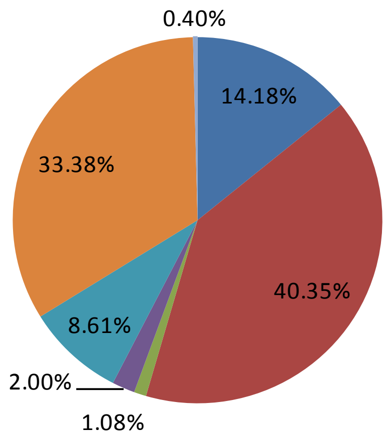


Figure 14b - Final energy consumption for 2013 by type of fuel



Heat Electricity Gas oil Natural gas Coal Wood Solar thermal

Source: Eurostat

If the coefficients in **Table 10** are applied to the primary energy consumption, then the final energy consumption of households and corresponding CO_2 emissions can be calculated. The calculated values are shown in Figures 15a and 15b. The increasing trend of primary energy consumption is mainly due to the increasing share of electricity consumption, which accounts for more than half of the primary energy consumption of households. For the same reason, in recent years, there was an increase in CO_2 emissions.

Figure 15a - Primary energy consumption of households in the period 2000-2013

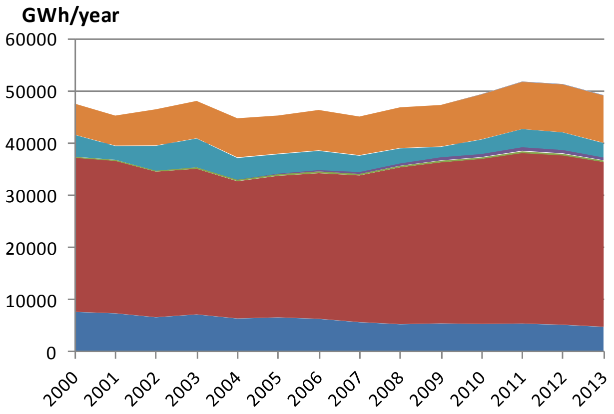
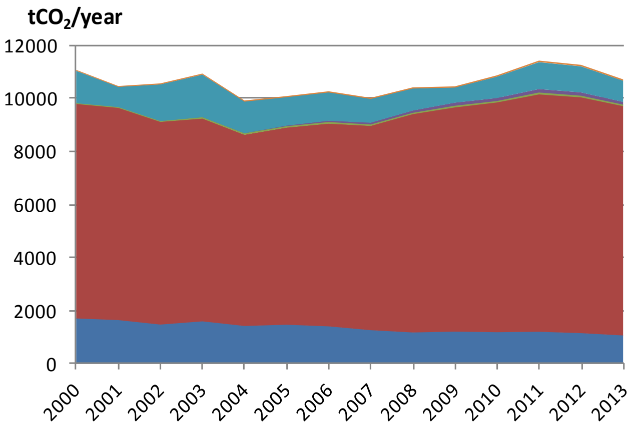


Figure 15b - CO_2 emissions for the period 2000-2013 due to energy use in households, thousands



The Sustainable Energy Development Agency (SEDA) has information in its database collected from energy audits prepared within the framework of the National Programme for Energy Efficiency of Multifamily Residential Buildings (NPEEMFRB). At the end of October 2015 the database hosted information from 445 energy audits, in which 125 buildings were connected to district heating and 320 buildings not connected to district heating. Data on the final specific energy consumption of buildings is summarised in **Table 11**.

Table 11 - Specific final energy consumption of multifamily residential buildings

Energy demand	Without District heating		With District heating	
	Actual	Normalized	Actual	Normalized
	kWh/m^2a	kWh/m^2a	kWh/m^2a	kWh/m^2a
Heating	65.3	139.8	58.7	128.2
Ventilation	0.8	29.1	0.3	19.4
DHW	11.1	20.5	28.4	33.5
Pumps and fans	0.4	0.4	0.8	0.8
Lighting	3.6	3.6	5.1	5.1
Others (appliances)	11.6	11.6	15.9	15.9
Cooling	0.6	12.7	0.3	8.2
TOTAL	**93.3**	**217.6**	**109.6**	**211.2**

Source: Sustainable Energy Development Agency database of energy audits of multifamily residential buildings. Data from 445 energy audits on 31 October 2015.

It can be observed that the actual energy consumption is less than half the expected "normalised" consumption according to the norms for the indoor microclimate in residential buildings. This is mainly due to the low incomes of households and the voluntary lower level of comfort, in order to reduce their energy expenditure.

The specific primary energy consumption is calculated using:

- the final to primary energy ratio in **Table 10**;
- the shares of dwellings in towns by main heating source in Figure 12b (as the multifamily residential buildings are concentrated in towns, according to the data in Figures 3b and 3c), and;
- the acceptance of the following condition, that the main source of heating used for heating, ventilation and DHW as well as electricity is used for pumps and fans, lighting, others (appliances) and cooling. The results are presented in **Table 12**.

Table 12 - Specific primary energy consumption of multifamily residential buildings

Energy demand	Without District heating		With District heating	
	Actual	Normalised	Actual	Normalised
	kWh/m²a	kWh/m²a	kWh/m²a	kWh/m²a
Heating	133.8	286.4	76.4	166.6
Ventilation	1.7	59.7	0.4	25.2
DHW	22.7	41.9	37.0	43.6
Pumps and fans	1.1	1.1	2.5	2.5
Lighting	10.7	10.7	15.2	15.2
Others (appliances)	34.8	34.8	47.8	47.8
Cooling	1.8	38.1	0.8	24.7
TOTAL	**206.6**	**472.8**	**180.1**	**325.7**
Conformity with the energy class:	**C**	**G**	**B**	**E**

The results of the above calculation, with the difference that electricity is used for ventilation and DHW, are presented in **Table 13**.

Table 13 - Specific primary energy consumption of multifamily residential buildings

Energy demand	Without District heating		With District heating	
	Actual	Normalised	Actual	Normalised
	kWh/m²a	kWh/m²a	kWh/m²a	kWh/m²a
Heating	133.8	286.4	76.4	166.6
Ventilation	2.5	87.3	1.0	58.2
DHW	33.2	61.4	85.3	100.6
Pumps and fans	1.1	1.1	2.5	2.5
Lighting	10.7	10.7	15.2	15.2
Others (appliances)	34.8	34.8	47.8	47.8
Cooling	1.8	38.1	0.8	24.7
TOTAL	**217.9**	**519.9**	**229.1**	**415.6**
Conformity with the energy class	**C**	**G**	**C**	**E**

The results clearly show that the actual energy consumption in multifamily residential buildings corresponds to energy class "C", which should be determined under a "normalised" level of comfort. In the particular case of multifamily residential buildings connected to district heating, where the main source of heating is used to cover the demand for ventilation and DHW, the actual energy consumption even matches the energy class "B".

Under the terms of the NPEEMFRB, buildings should be renovated to an energy class "C", which practically means to the same level of energy consumption as it is at the moment, but probably with a better average indoor temperature. Two basic conclusions can be drawn:

1. To achieve energy savings, which make a significant contribution to reaching the national energy saving targets, in the next stage of the NPEEMFRB the condition for the renovation of buildings to energy class "C" should be changed at least to class "B". Taking into account the envisioned pilot investment programmes for residential buildings presented in the draft of the National Plan for nZEB, it would be appropriate for the next phase of the Programme to include a number of renovations of residential buildings to the level of nZEB.

2. The necessary conditions for compliance with the energy efficiency requirements in case of renovation are described in the *Ordinance No.7 for Energy Efficiency in Buildings (SG 27/28.04.2015)*. The condition, namely to achieve energy class "C", at least with regard to the residential buildings, is not contributing sufficiently to the national targets for energy savings. It is necessary to adopt a requirement to achieve a higher energy class or to adjust the values in the scale of the energy classes for residential buildings.

Energy prices

The prices of the main types of fuel used by households are presented in **Table 14** for the period from 2008 to 2015.

Table 14 - Prices of electricity and fuels for households

Fuel/energy	Dim.	2008	2009	2010	2011	2012	2013	2014	2015	Source:
Electricity	BGN/ MWh	161.0	161.0	164.6	187.2	187.2	172.2	166.0	190.0	www.nsi.bg
Heating gas oil	BGN/ 1000 l	1484.4	1707.6	2128.8	2128.8	2485.2	1768.8	1609.2	1186.8	www.ec.europa.eu
Natural gas	BGN/ GJ	22.7	18.4	22.9	25.0	30.1	30.0	28.1	26.7	www.nsi.bg
District heating (Sofia)	BGN/ MWh	77.89	83.12	79.00	92.98	107.70	95.87	101.57	84.96	www.dker.bg
Brown coal	BGN/t	215.24	170	211	230	270	244.69	249.82	243*	www.ec.europa.eu
Wood (40% wet content)	BGN/ m^3	52.02	53.64	52.72	53.87	60.51	57.94	56.99	55**	www.ec.europa.eu

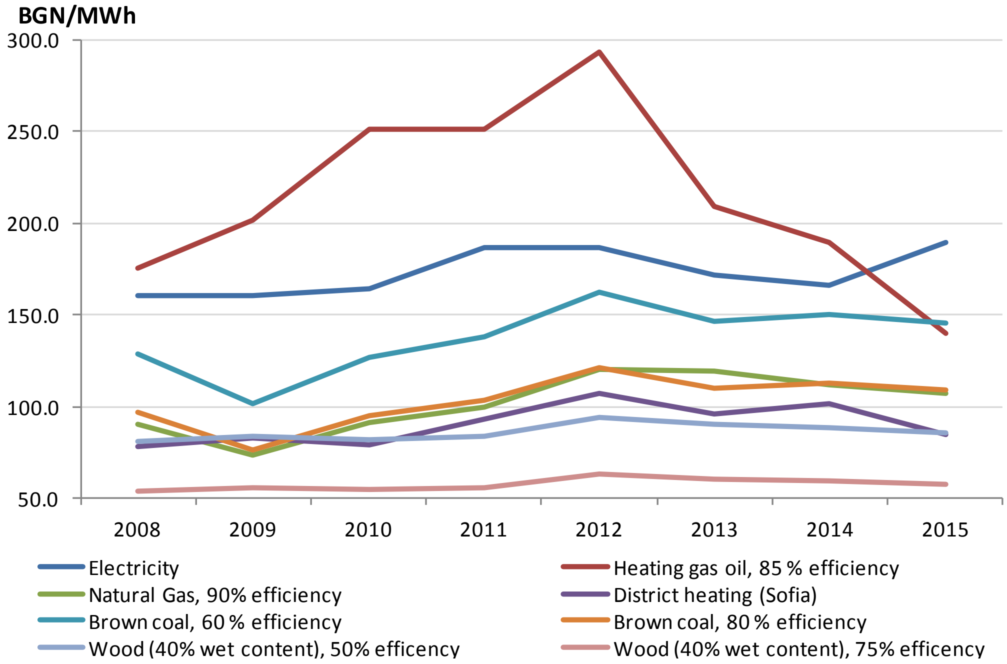
*   *source: www.darva.info*

*** source: www.grad.bg*

To make a comparison between the prices of the different energy resources, the price per MWh of final energy consumption for each fuel type is calculated. The following efficiencies in heat production are used: natural gas 90% , gas 85%, coal burned in boilers 80%, coal burned in stoves 60%, wood burned in boilers 75%, wood burned in stoves 50%. The results are presented in Figure 16.

For all types of energy there are large annual variations in prices, both upwards and downwards, which in some cases exceed 25% compared to the previous year. For the period under review, an overall upward trend of prices is observed for all types of energy, with the exception of gas oil. There is a decreasing trend in the price of gas oil for heating, but it remains one of the most expensive options. The highest growth rate is recorded for the price of energy from natural gas and coal. Moderate growth rates are observed in the price of electricity and heat, while the least increase is in the prices of energy from wood, which is used in most households.

Figure 16 - Energy prices in the period 2008-2015



Investment in energy efficiency measures

The SEDA database of energy audits of multifamily residential buildings for the NPEEMFRB contains information, estimated by energy auditors, on the investment needs for the implementation of recommended energy saving measures. Summarised data from a sample of 320 audits of multifamily buildings that are not connected to district heating, is presented in **Table 15**. The presented prices are not suitable for use in individual building assessments of other building types as the ratios of the areas of walls, roof, floors, windows and doors are different, and for the buildings included in the database it is not known whether or not the measures cover the whole area of the respective surfaces. For assessments at a macroeconomic level, the data can be considered sufficiently representative.

It should be kept in mind, however, that, within the NPEEMFRB, all buildings are updated to the energy class C. Assuming that the lower limit of the class – ER_{min} = 191 kWh/m^2 is achieved after the project, then the average energy savings will be about 50% of the "normalised" consumption, taking into account the data in **Table 12**.

Table 15 - Specific investment in energy efficiency measures in multifamily residential buildings

Energy Saving Measures	Investment, BGN/m^2 (total floor area)
Wall insulation	34.27
Floor insulation	4.38
Roof insulation	11.12
Window replacement	23.78
Lighting measures	0.10
Distribution substation	0.84
Boiler	1.80
Measuring systems	0.14
System adjustmensts	2.21
HVAC system measures	0.28
RES	1.78
Others	0.06

Source: Sustainable Energy Development Agency database of energy audits of multifamily residential buildings. Data from 320 energy audits on 31 October 2015.

The database of the Energy Efficiency and Renewable Sources Fund (EERSF) has data for about 100 real energy efficiency projects in buildings financed by the Fund. The buildings are mainly schools, hospitals, administrative buildings, kindergartens, university buildings and dormitories. Although the projects are not in residential buildings, similar average levels of investment as in multifamily residential buildings can be expected because the total floor areas are similar.

The average specific investment without VAT for an energy efficiency project, financed by EERSF, is 93 BGN/m^2 of the total floor area. The average specific investments without VAT for the three most commonly used energy-saving measures on the building envelope are presented in **Table 16**. With these investments, an average energy saving of 59.8% is achieved.

Table 16 - Specific investment in main energy efficiency measures in public buildings

Energy Saving Measures	Investment excl VAT
	BGN/m^2 (total floor area)
Wall insulation	28.4
Roof insulation	17.6
Window replacement	20.0

Source: Energy Efficiency and Renewable Sources Fund database for financed energy efficiency projects in buildings. 31 October 2015.

Reliable databases for energy renovations of houses were not found in the present study. This sort of information can't be found in the SEDA or EERSF archives. The specific price of the individual measures in single family houses should be higher, mainly because of the smaller areas of the building envelope surfaces and the smaller capacity of the installations.

The Ministry of Regional Development and Public Works published a list of maximum reference prices for the implementation of different activities for the energy renovation of multifamily buildings, which are presented in **Table 17**.

A direct comparison of the prices in the databases of SEDA and EERSF cannot be carried out as the maximum price for the execution of construction works includes the envisioned investments (except for the energy saving

measures), the structural reinforcement of the buildings, the improvement of the appearance of the facades, etc. However, it can be concluded that the price will be sufficient for the execution of the projects and it's even realistic to expect the implementation of projects with less than the envisioned investment funds.

Table 17 - Maximum reference prices for the implementation of activities in the National Programme for Energy Efficiency in Multifamily Residential Buildings

Activity		Max. value	
		BGN, without VAT	BGN, with VAT
Expenditures for technical audit and building passport issue and for energy audits	m^2	12.5	15
Expenditures for technical project design and for the designer's supervision	m^2	15	18
Expenditures for conformity assessment of the investment project	m^2	2	2.4
Expenditures for construction supervision	m^2	7	8.4
Expenditures for construction and installation works	m^2	250	300
Expenditures for Investor's supervision	m^2	4	4.8

Source: http://mrrb.government.bg/

Incomes and expenditures of households

According to the NSI, in 2014 the average annual income of households was 11,489 BGN. The average annual expenditures of households is 11,642 BGN, of which the cost of energy, water and maintenance of the dwellings is 1468 BGN (12.6% of the total). The data for the average annual incomes and expenditures of the households for the period 1999-2014 is presented in Figure 17a, and the deviation in percentage points of the difference between incomes and expenditures in relation to incomes is presented in Figure 17b. The tendency shows a reduction of the gap between incomes and expenditures, while in 2010 and 2011 higher incomes than expenditures were registered.

Figure 17a - Annual household incomes and expenditures in the period 1999-2014

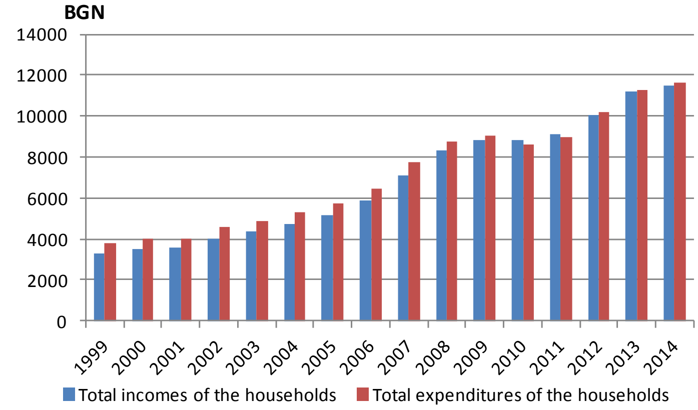
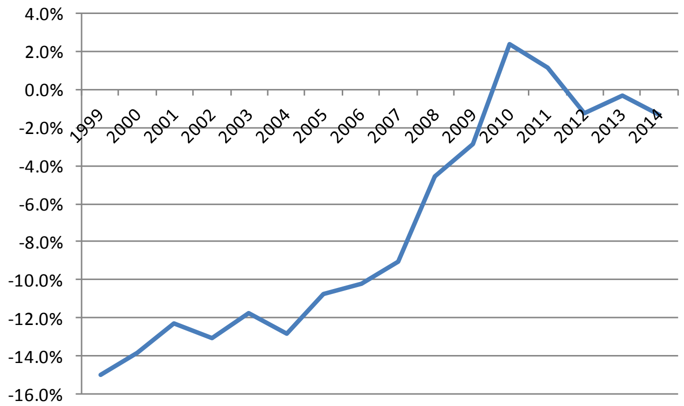


Figure 17b - Difference between annual incomes and expenditures, 1999-2014



Source: www.nsi.bg.

Figure 18a presents the annual expenditures of households for the period 1999-2014, and the share that is used for energy, water and maintenance of dwellings. The trend presented in Figure 18b shows that the percentage of energy costs compared to all expenditures increased until 2008, but has remained at approximately the same level of around 13% since then.

Figure 18a - Annual expenditures of households in the period 1999-2014

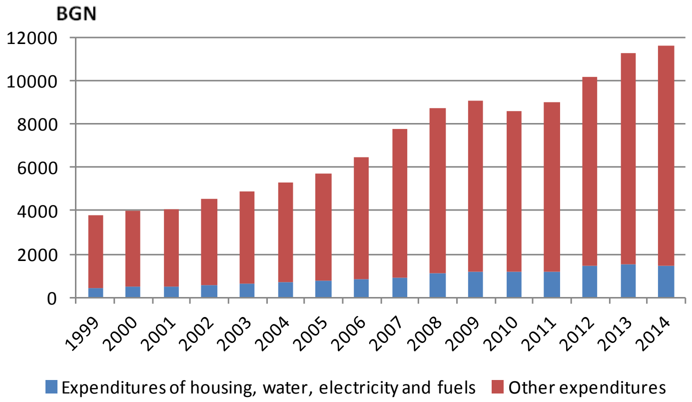
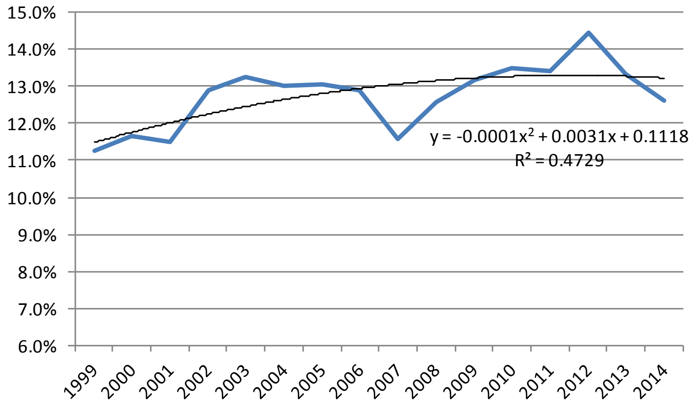


Figure 18b - Trend of the share of expenditures of housing, water, electricity and fuels of households



Source: www.nsi.bg.

It is normal at this low level of incomes and at this unfavourable ratio between incomes and expenses to observe a shrinking of the energy costs following a voluntary decrease of the level of comfort in the buildings, which was confirmed by data from energy audits in multifamily buildings (**Table 12**). There is no reason to believe that the situation of family houses will be very different in this respect compared to multifamily buildings.

The low level of energy use due to a voluntary lower level of comfort may be misinterpreted as higher energy efficiency depending on the methodology used to estimate the energy performance of a building. In reality, the lower energy use is achieved through lower indoor temperatures or selective heating of areas. Investment in deep renovations that further decrease energy demand allows occupants to increase the thermal comfort while maintaining stable operating costs. However, it is clear that it is not realistic to expect many households to allocate funds for the energy renovation of their homes.

ANNEX 2 - DESCRIPTION OF MODELLING

In order to explore different options for the evolution of the residential renovation programme, the team gathered relevant data and ran model simulations across a range of assumptions. Key elements of the exercise are:

- Collation of data on the Bulgarian building stock and its energy performance. This work was led by EnEffect, and has been summarised in the main report "Accelerating the renovation of the Bulgarian building stock".
- Identification of key economic drivers and other factors influencing the cost effectiveness of building renovation, from the perspective of the building owner/investor (undertaken jointly by BPIE and EnEffect). These include:
  - Assumptions about **future energy prices**. Two options are appraised:
    - 2.8% p.a. increase (as recommended by the European Commission in their cost-optimality guidelines);
    - Convergence with neighbouring countries – Hungary, Romania and Croatia.
  - Determination of **three different levels of renovation**, named R1, R2 and R3, equivalent to achieving an energy label class C, B and A respectively. For a given set of economic conditions, the model chooses which of the three options is the most cost-effective. Hence, the scenarios results exhibit variation in investments, energy savings, cost savings and overall cost effectiveness.
  - **Cost of renovations** for the three renovation levels.
  - **Learning curve,** i.e. the reduction in price of renovations over time, reflecting factors such as increased sales volumes, more efficient installation procedures, improved productivity or R&D resulting in new and better ways of saving energy.
  - **Subsidies** (which could be in the form of a grant, preferential loan, or other means).
  - **Transaction costs.** These are the additional costs incurred by applicants in undertaking a renovation, over and above the actual cost of the installed measures. This might include professional fees, setting up a Homeowners Association, costs of hosting meetings, application fees, costs of borrowing, any preparatory work not covered by the grant, etc. Such costs may be explicit in costs, or implicit in people's time.
  - **Discount rate**. This reflects the cost of borrowing to finance the energy saving investment (including financing of transaction costs).
  - **Co-benefits**. Whilst there is a wide range of benefits (whether monetised or not) associated with improving the energy performance of buildings (see for example IEA), in our modelling we only consider the value of increased comfort. The financial value of increased comfort is calculated as being equivalent to the amount of energy expenditure required to generate the increase in temperature witnessed by building occupants.
  - **Internal temperatures.** The information in the database of the Sustainable Energy Development Agency, containing energy audits of multifamily residential buildings, proves that the actual energy consumption is less than half of the expected consumption according to the norms for the indoor temperatures in residential buildings. In practice, this means that the current potential for energy saving is much reduced. However, extensive experience in other EU countries shows that, as citizens increase their wealth, they increase expectations of comfort, resulting in higher internal temperatures over time. While building renovation may not achieve the full expected energy

savings, this will be realised in the longer term as internal temperature expectations (and reality) increase over time, whether or not the building has been renovated.

- Development of scenarios (BPIE, EnEffect, TU Wien).
- Running of scenarios, using the Invert-EE/Lab model developed and operated by TU Wien.
- Plotting of Energy Saving Cost Curves and tabular outputs of scenario results with BPIE's ESCC Tool.

Model Description

The **Invert/EE-Lab** model is a dynamic bottom-up simulation tool that evaluates the effects of different promotion schemes (in particular different settings of economic and regulatory incentives) based on the energy carrier use, CO_2 reductions and costs for renewable heat and renovation support policies. Furthermore, Invert/EE-Lab is designed to simulate different scenarios and their impact on future trends of renewables as well as conventional energy use at the national and regional level.

The basic idea of the model is to describe the building stock, heating, cooling and hot water systems on a very detailed level, calculate related energy needs and delivered energy, determine reinvestment cycles and new investment in building components and technologies and simulate the decisions of various agents (i.e. owner types) in case that an investment decision is due for a specific building segment.

The energy needs and demand calculation module implemented in the Invert/EE-Lab model uses a monthly energy balance, quasi-steady-state approach enhanced by explicitly distinguishing between using and non-using days. Plus in the case of ventilation it distingueshes between average day (16 hours) and night (8 hours) outside air temperatures. Buildings are implemented as single zone building. Behavioural aspects, such as the dependency of energy needs for heating on the thermal quality of the building envelope or the heated area of dwellings are implemented.

The Energy Saving Cost Curves Tool (**ESCC Tool**) makes use of the results derived from the model Invert/EE-Lab. The ESCC plot tool has been developed by BPIE as an add-on to the Invert/EE-Lab with the purpose of displaying the results in the form of ESCCs. The tool uses the standardised format of delivered Invert/EE-Lab's model outputs that are used as inputs to the BPIE ESCC tool. In order for these inputs to be interpreted and presented graphically, the tool aggregates input by building category and vintage in order to display the weighted average renovation costs and energy savings for each building category.

The aggregated values for each building category are plotted according to the Energy Saving Cost Curve format with energy costs or savings on the vertical axis and energy savings on the horizontal axis. In addition to the ESCC output, which allows for a quick visualisation of the scenario results, the ESCC generator provides tabular outputs, in an aggregated format and by building category, of:

- Weighted average costs of renovation;
- Weighted average shares of renovation depths;
- Energy savings;
- Cost savings;
- Total investment requirements;
- Total value of subsidies.

HOW TO INTERPRET THE ENERGY-SAVING COST CURVE (ESCC) PLOT: The ESCC is a visual representation of the cost effectiveness of building renovation across a spectrum of building categories. The horizontal axis (x-axis) displays projected annual energy savings (GWh/a). The vertical axis (y-axis) shows the net costs or savings, discounted over the measures' lifetime, divided by the total lifetime energy savings (cents/kWh). The width of each bar represents the energy savings, while the height represents the specific costs (or savings) per unit of energy saved. If the bar is **above** the horizontal axis, there is a **net cost** for investors in that building category, meaning that lifetime cost savings are less than the initial investment. Conversely, if the bar is **below** the axis, there are **net savings**. Each bar represents a large number of different buildings, each with its own cost-effectiveness result. This means that, for example, a building category that is above the axis (i.e. overall not cost-effective) could include individual buildings that produce net savings.

Scenarios

An initial run of 10 scenarios was undertaken, all running to 2030. Subsequently, 3 scenarios (Numbered 11-13) were run to 2020 to see the potential impact over the current Bulgarian NEEAP period. In order to gain an understanding of the underlying economics of renovation for different building categories, one further scenario (Numbered 14 (11ns)), to 2030, was run using the existing economic conditions, but excluding subsidies.

Progressive increase of favourable parameters

In designing scenario parameters, the approach is to, firstly group them according to the subsidy level and then, within each group, to progressively add increasingly favourable parameters (

Table **19**). Finally there is a group of scenarios running to 2020. Thus there are:

a) Scenarios based on Business As Usual Economic Conditions;
b) Scenarios applying 75% subsidy;
c) Scenarios applying 50% subsidy;
d) Scenario applying 25% subsidy;
e) Scenarios to 2020.

This is best illustrated in the case of scenarios 5-9 belonging to group C. Each applies a 50% subsidy, while the other parameters are progressively becoming more economically attractive:

- Scenario 5 – Business As Usual parameters: standard energy price rise (2.8% p.a.; high transaction costs 20%; high discount rate 8%; low learning curve 5%); no co-benefits;
- Scenario 6 – ADD accelerated energy price rise – converging with neighbouring countries;
- Scenario 7 – ADD soft measures: medium discount rate (6%); lower transaction costs (10%); higher learning curve (15%); co-benefits (15%);
- Scenario 8 – ADD low discount rate (4%);
- Scenario 9 – ADD normal internal temperature.

The scenarios are summarised below.

Table 18 - Modelling parameters

No.	Short name	Subsidy	Description	Renovation level	Energy price increase	Transaction costs	Discount rate	Learning curve	Co-benefits	Internal Temperature	Time frame
1	100% - BAU	100%	Business As Usual (BAU)	C	2.8% real increase p.a.	20%	8%	5%	nil	low (17C)	to 2030
1ns	**BAU no subsidy**	0%	Business As Usual (BAU), no subsidy	C	2.8% real increase p.a.	20%	8%	5%	nil	low (17C)	to 2030
2	75% - BAU	**75%**	as per BAU	determined by model	2.8% real increase p.a.	20%	8%	5%	nil	low (17C)	to 2030
3	75% - price converge	**75%**	converging energy prices	determined by model	Convergence with neighbours	20%	8%	5%	nil	low (17C)	to 2030
4	75% - soft+comfort	**75%**	converging energy prices, soft measures and co-benefit	determined by model	Convergence with neighbours	10%	6%	15%	15%	low (17C)	to 2030
5	50% - BAU	**50%**	as per BAU	determined by model	2.8% real increase p.a.	20%	8%	5%	nil	low (17C)	to 2030
6	50% - price converge	**50%**	converging energy prices	determined by model	Convergence with neighbours	20%	8%	5%	nil	low (17C)	to 2030
7	50% - soft+comfort	**50%**	converging energy prices, co-benefit, soft measures	determined by model	Convergence with neighbours	10%	6%	15%	15%	low (17C)	to 2030
8	50% - low discount	**50%**	converging energy prices, soft measures, co-benefit, low discount rate	determined by model	Convergence with neighbours	10%	4%	15%	15%	low (17C)	to 2030
9	50% - normal temp	**50%**	converging energy prices, soft measures, co-benefit, low discount rate, normal temperature	determined by model	Convergence with neighbours	10%	4%	15%	15%	normal (21C)	to 2030
10	25% - normal temp	**25%**	converging energy prices, soft measures, low discount rate, high co-benefits, normal temperatures	determined by model	Convergence with neighbours	10%	4%	15%	15%	normal (21C)	to 2030
11	0% - BAU R1 (2020)	0%	Business As Usual (BAU), no subsidy	C	2.8% real increase p.a.	20%	8%	5%	nil	low (17C)	**to 2020**
12	75% - R3 (2020)	**75%**	R3, converging energy prices, soft measures, co-benefits, normal temp,	A	Convergence with neighbours	10%	4%	5%	15%	normal (21C)	**to 2020**
13	50% - R2 (2020)	**50%**	R2, converging energy prices, soft measures, co-benefits, normal temp	**B**	Convergence with neighbours	10%	4%	5%	15%	normal (21C)	**to 2020**

Overview of results

- For scenarios 1-10 with subsidies running to 2030, in all cases, there are savings for consumers (net present value, over the lifetime of the measures), and these range from €300M to €1.2bn. Energy savings range from 11TWh per year to 17TWh per year following the completion of renovations.
- For scenarios 11-13 which run only to 2020, total savings, as expected, are much lower, in the range of 2.2-5.7 TWh/a. Scenario 11 (no subsidy) is marginally not cost-effective overall, whereas scenarios 12 and 13, requiring renovation to class A and B respectively produce similar results – energy savings around 5.5 TWh/a, with net benefits of around €250M.
- Scenario 14 (1ns), based on BAU but with no subsidy, generates only half of the savings of BAU (which has 100% subsidy), and is marginally not cost-effective overall.

Table 19– Summary of scenarios results

No.	Description	Modelling period	Energy Savings (TWh/y)	Cost Savings (Billion EUR)
1	The BAU scenario represents the current situation. While subsidies are at the maximum (100%), the other economic conditions are not favourably geared towards building renovation	to 2030	12.8	0.96
2	Subsidy reduced to 75%, but otherwise as per BAU (no change in the economic conditions)	to 2030	12.8	0.64
3	75% subsidy, with a policy to converge BG energy prices to neighbouring EU country levels (H, RO, HR)	to 2030	13.0	0.81
4	75% subsidy, converging energy prices, and action on soft measures - reducing transaction costs, improved lending criteria (lower discount rate), accelerated price reductions, plus co-benefit	to 2030	16.0	0.82
5	Subsidy reduced to 50%, but otherwise as per BAU (no change in the economic conditions)	to 2030	10.6	0.30
6	50% subsidy, with a policy to converge BG energy prices to neighbouring EU country levels (H, RO, HR)	to 2030	11.3	0.45
7	50% subsidy, converging energy prices, and action on soft measures - reducing transaction costs, improved lending criteria (lower discount rate) and accelerated price reductions	to 2030	11.6	0.72
8	As above (no. 7), with valuation of comfort co-benefit	to 2030	11.5	0.77
9	As above (no. 8) , assuming design internal temperatures	to 2030	16.8	1.23
10	25% subsidy, low discount rates, with higher valuation of co-benefits and design internal temperatures	to 2030	16.3	1.22
11	No subsidy, BAU conditions, renovation levels fixed at R1 level	to 2020	1.3	0.00
12	75% subsidy, favourable economic conditions, renovation levels fixed at R3 level (class A)	to 2020	5.7	0.28
13	50% subsidy, favourable economic conditions, renovation levels fixed at R2 level (class B)	to 2020	5.3	0.26
14 (1ns)	As BAU scenario 1, but with no subsidy	to 2030	6.1	0.05

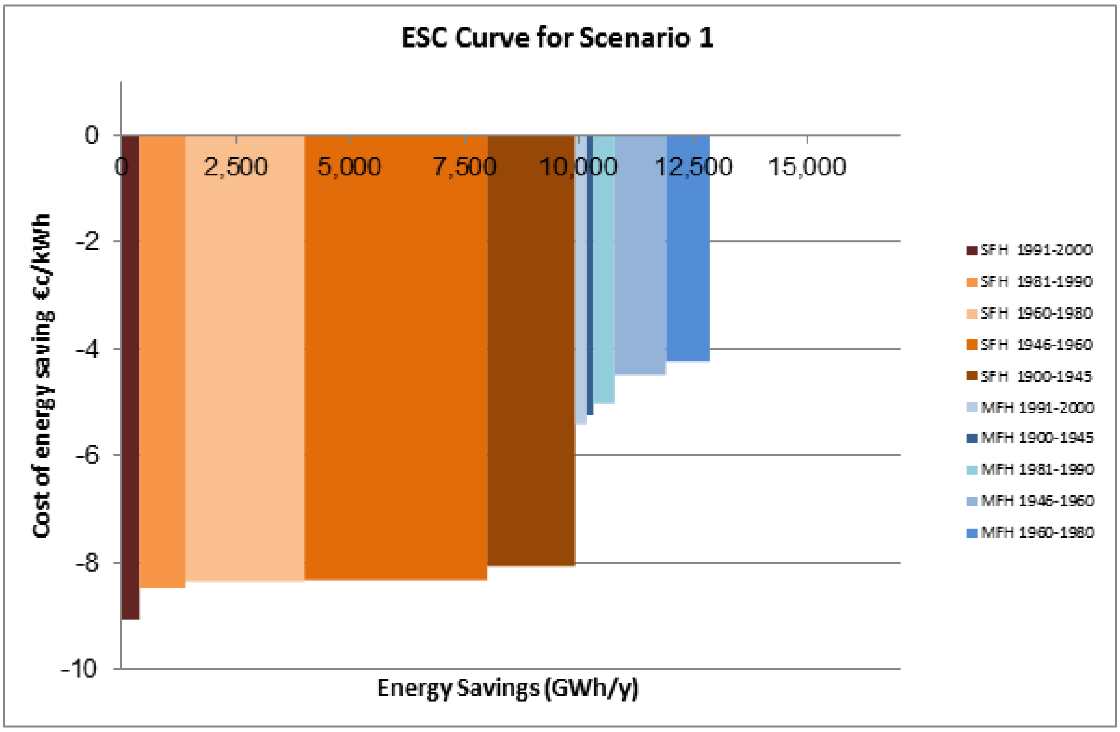
Results - Energy Savings Cost Curves

The results derived from the Invert/EE-Lab model are fed to the ESCC Tool, which produces the following ESCC graphs. Every bar represents a building category. If the bar is located below the axis, the renovation is profitable to the owner. The bar's length signifies the cost (or saving if the figure is negative) of renovation measures, and its width indicates the annual energy savings from the energy demand reduction through renovations.

Scenarios to 2030

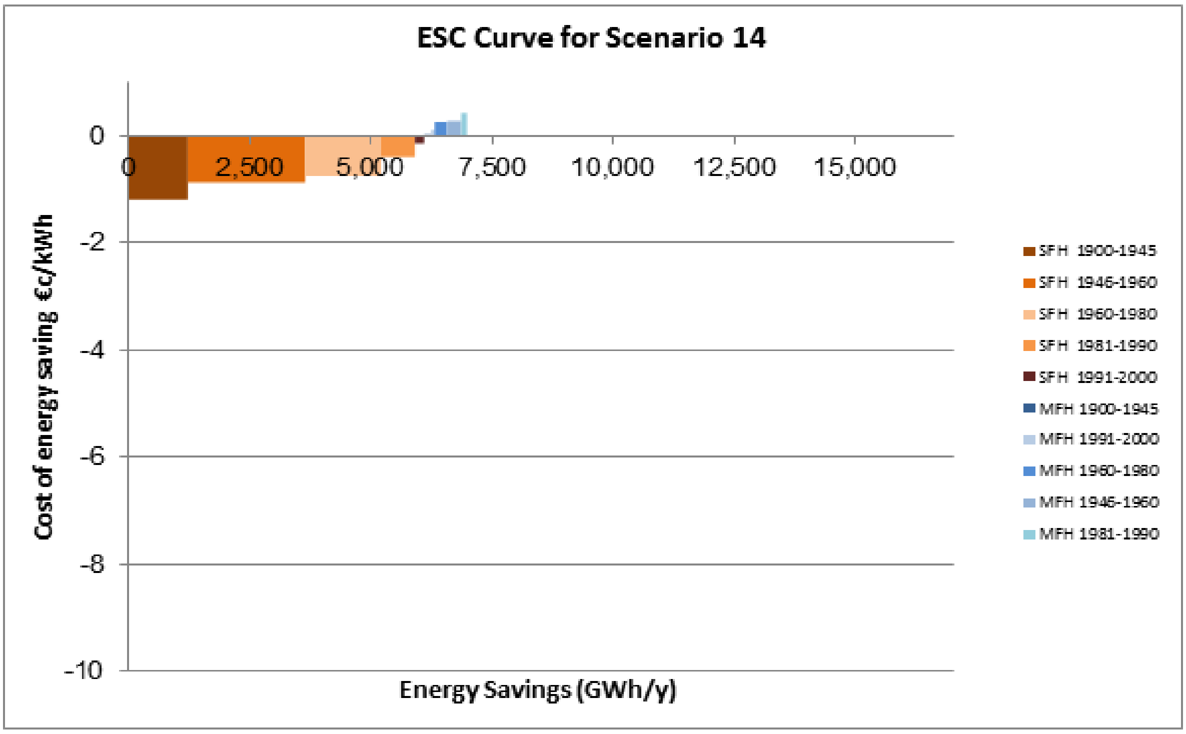
First, a set of 11 scenarios on the impact of renovations on the Bulgarian residential building stock up to 2030 is presented. It is noticeable that with the current economic support, all residential building categories can be renovated and provide a profit to their owners. Single Family Houses (SFH) are more profitable to renovate and provide more energy savings compared to Multi Family Houses (MFH).

a) Scenarios based on Business As Usual Economic Conditions



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
1	100% - BAU	12.8	0.96

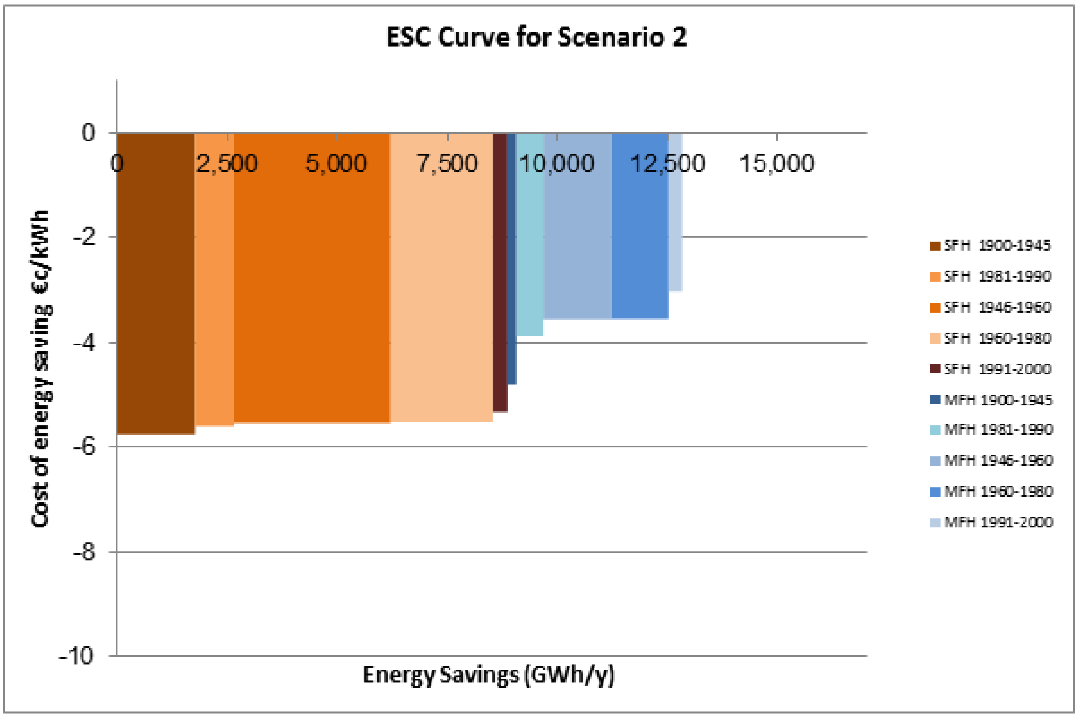
Scenario 1 follows the current policy design principle of a renovation programme that provides a 100% subsidy. The government therefore pays for the renovations and the building owners reap the benefits of reduced energy prices without having to partake in the investment. It is obvious that all building categories have negative costs, meaning that they produce economic returns to their inhabitants.



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
14 (1ns)	BAU no subsidy	6.1	0.05

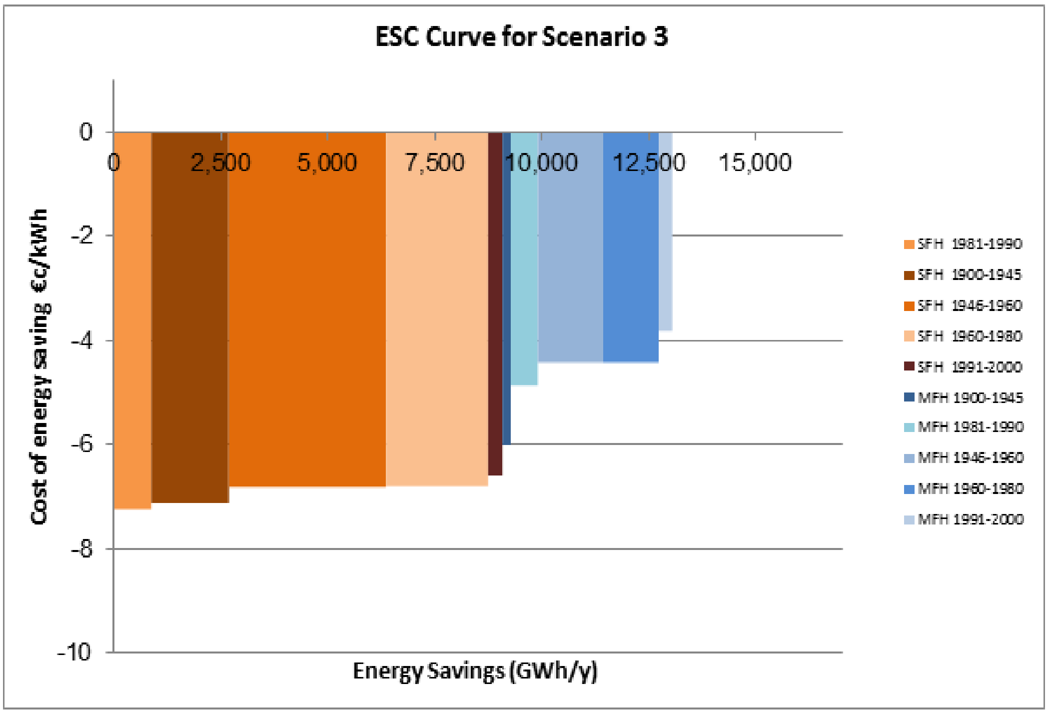
In order to assess the cost effectiveness of renovation in Bulgarian residential buildings, the subsidy was removed altogether in Scenario 14 (1ns). That resulted in almost half the energy savings and the overall economic result being marginally cost-effective.

b) Scenarios applying 75% subsidy



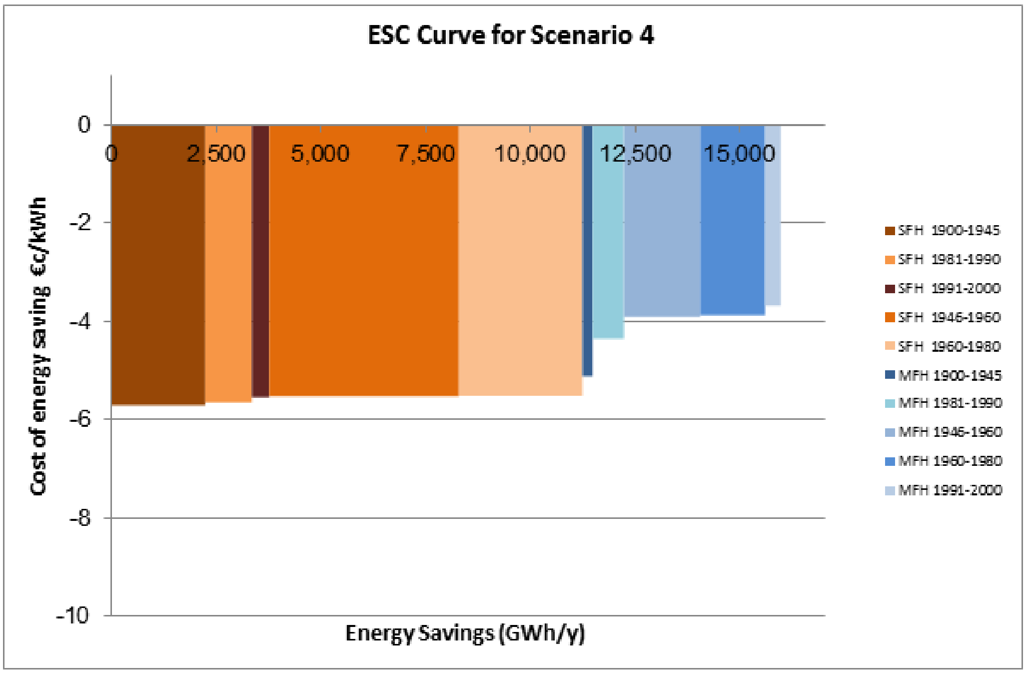
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
2	75% - BAU	12.8	0.64

Scenario 2 uses the prevailing economic conditions, but with a reduction in grant to 75%. The energy savings are almost the same and the measures in all building categories remain cost-effective. The government grant can therefore be reduced without negatively affecting the cost effectiveness of renovations.



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
3	75% - price converge	13.0	0.81

Scenario 3 shows a result similar to scenario 2 since all parameters are the same, except for the converging energy prices. Renovations therefore avoid extra costs that building owners would have had to pay for increased energy prices in the future. Thus, renovation makes properties future-proof and safeguards against the potential increase of energy prices in the future.

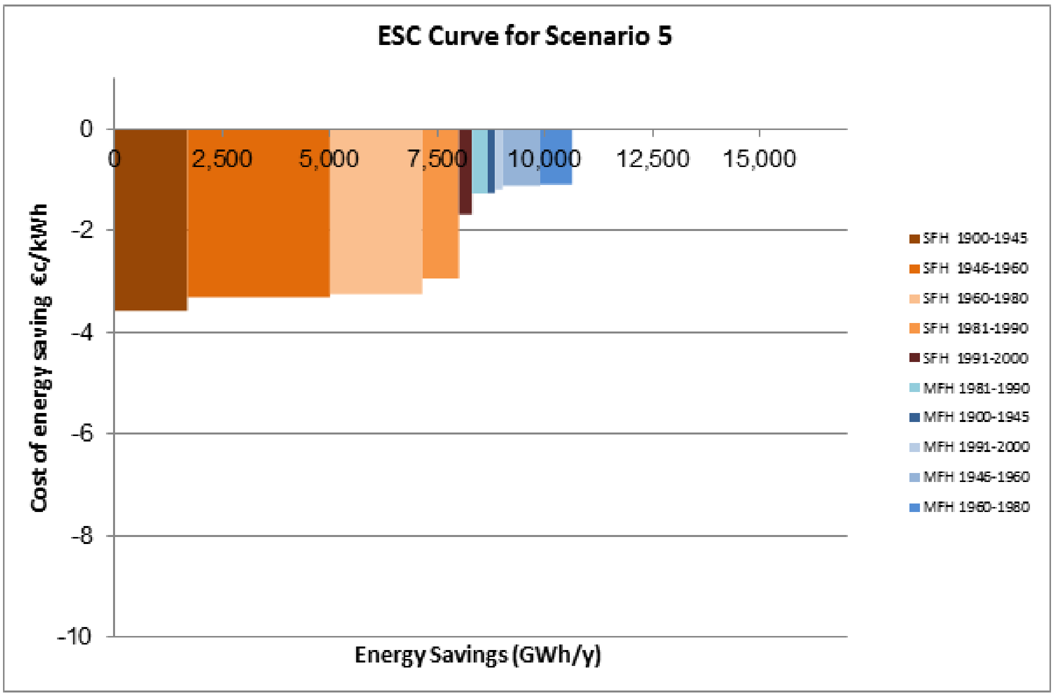


No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
4	75% - soft + comfort	16.0	0.82

Scenario 4 is the next in line for progressively increasing favourable economic situations. Here, the effect of soft measures is visible in the overall economic attractiveness of investments. These soft measures include reduced transaction costs and discount rates and an increased learning curve that leads to faster cost reduction of renovation costs. The value of comfort is also added, estimated through an increase in thermal comfort, translated into the cost of additional energy that would be used to reach that level if renovations had not been undertaken. Energy savings stand at 16,000 GWh/a and are greater than for Scenario 1.

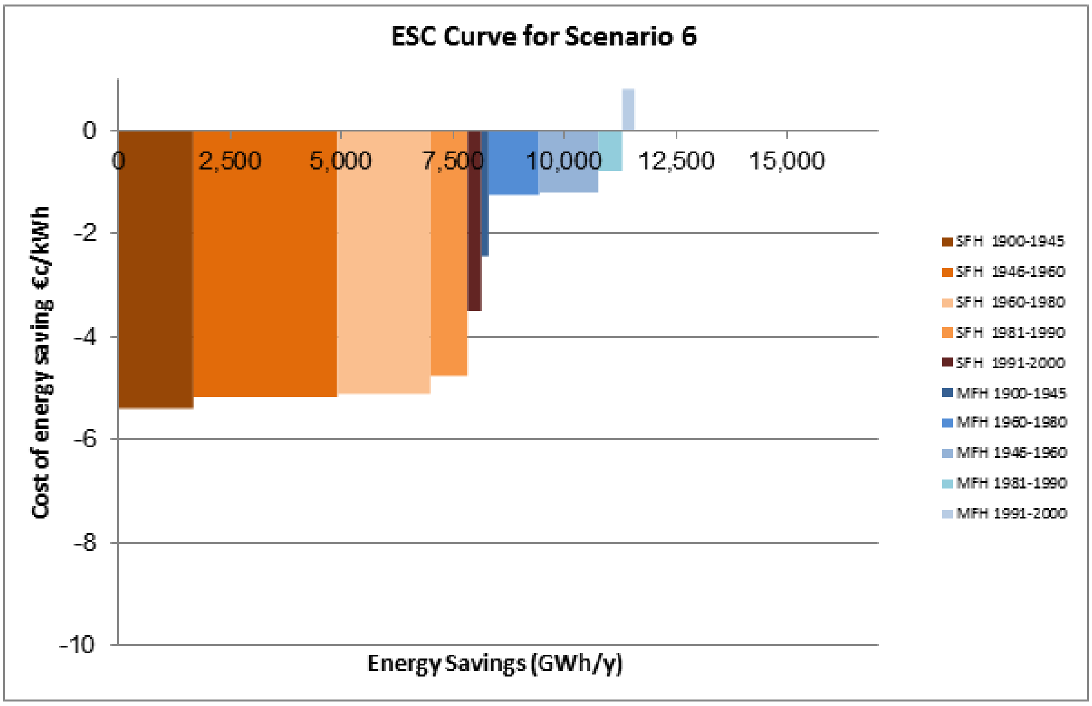
c) Scenarios applying 50% subsidy

For scenarios 5-9, grants are reduced to 50%. That showcases the effect of reduced government intervention on energy savings and costs. Public budgets are not always available for renovation activities and it is important to examine the level that subsidies can cost-optimally leverage.



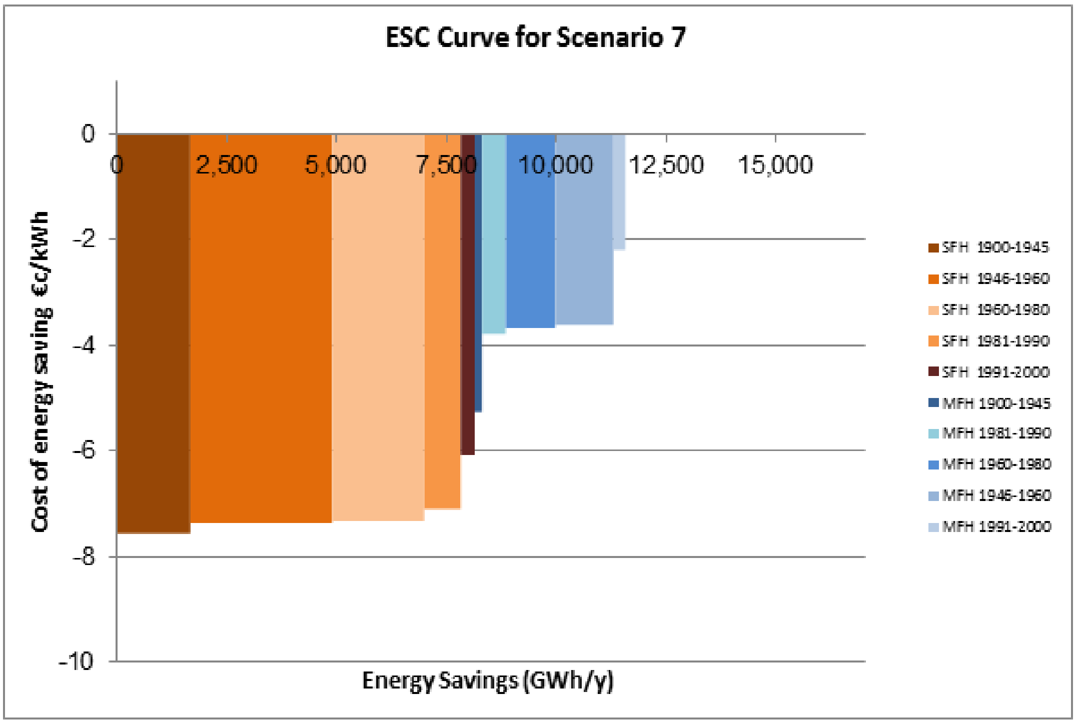
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
5	50% - BAU	10.6	0.30

Scenario 5 shows the case with current economic conditions, with only the subsidy level being reduced. As it can be seen, the cost effective energy savings are much reduced to under 10TWh. This occurs because, whereas in previous scenarios with higher subsidies, the option of deep renovation is the most cost-effective to investors, in scenario 5, some buildings are not renovated at all.



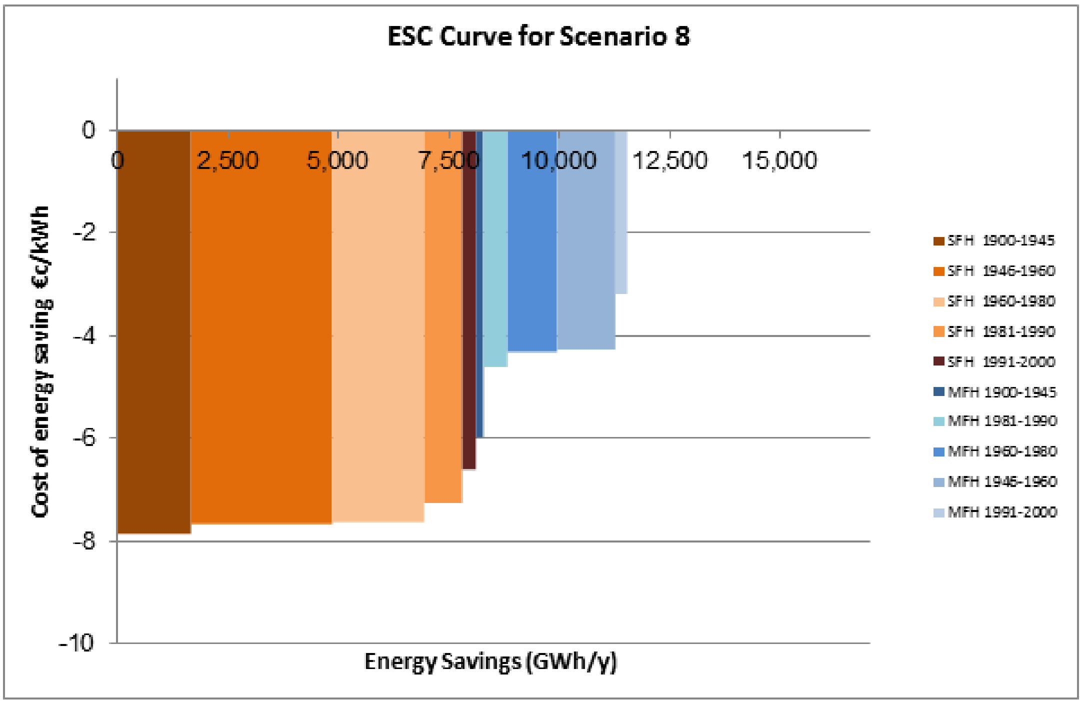
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
6	50% - price converge	11.3	0.45

Scenario 6 has similar parameters to scenario 5, but with converging energy prices. Overall results are similar, with a few more buildings being renovated to deep levels because higher future energy prices are more favourable for renovations. However, one building category – the newest multi-family housing constructed after 1991, is no longer cost-effective.



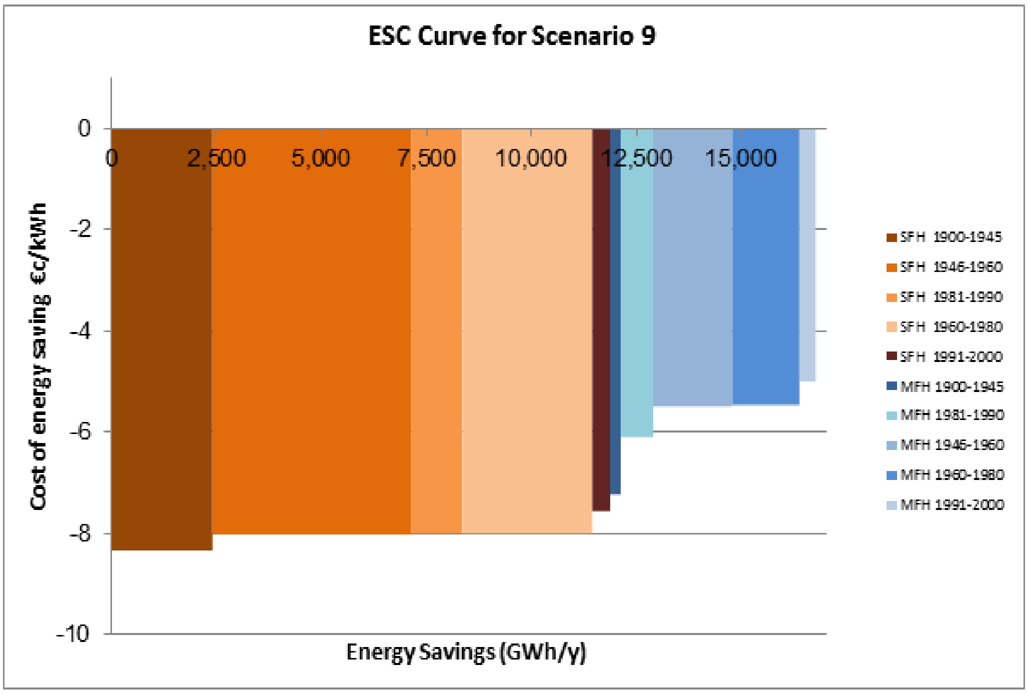
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
7	50% - soft + comfort	11.6	0.72

In scenario 7, we see the impact of applying soft measures (reduced transaction costs and discount rates and a steeper cost-reducing learning curve) and comfort. Compared to scenario 6, the energy savings are not changed, but increases are realised for cost savings to over to 0.7 billion euro for residential energy consumers.



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
8	50% - low discount	11.5	0.77

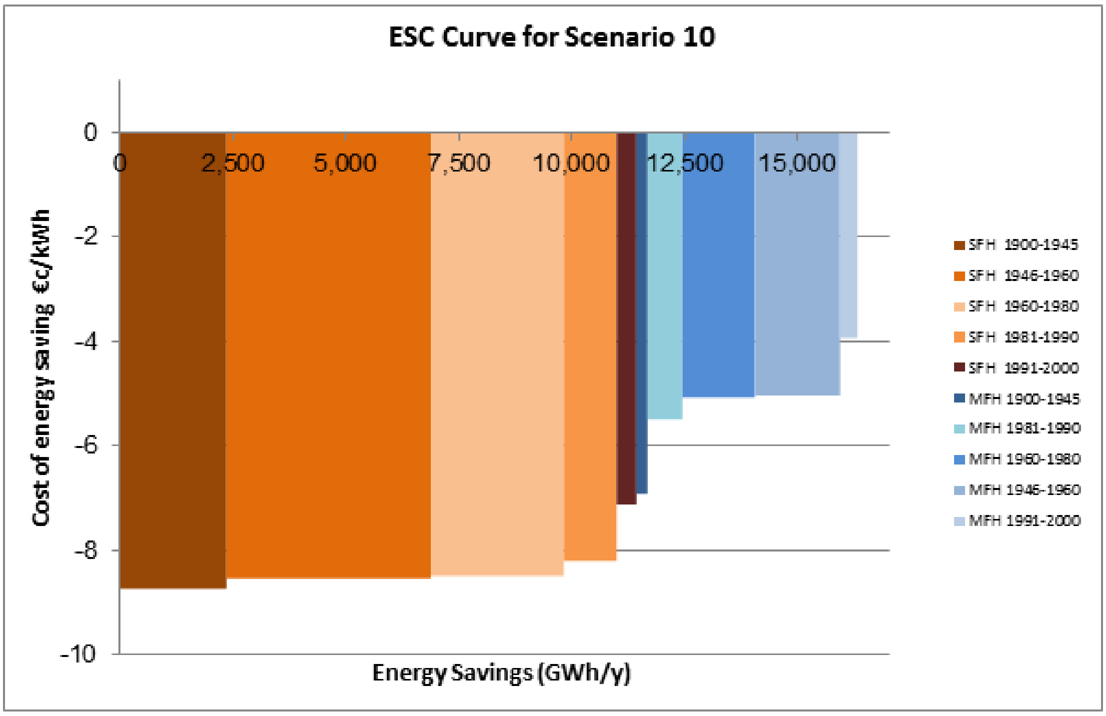
Scenario 8 is similar to scenario 7. The only change is a reduction in discount rate, from 6% to 4%. This has no impact on energy savings, and only a slight increase in energy cost savings.



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
9	50% - normal temp	16.8	1.23

Scenario 9 builds on the increased attractiveness observed in scenarios 5-9 by estimating the economic effect of avoided energy costs, if residents were used to higher indoor temperatures of 21° C (compared to 17° C in all previous scenarios). The only change is the application of normal internal temperatures (all previous scenarios 1-8 had low internal temperatures). The results are the highest energy and cost savings registered compared to all other scenarios. Individual preferences for comfort are one of the most important parameters determining the economic attractiveness of renovations from an economically rational perspective.

d) Scenario applying 25% subsidy



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
10	25% - normal temp	16.3	1.22

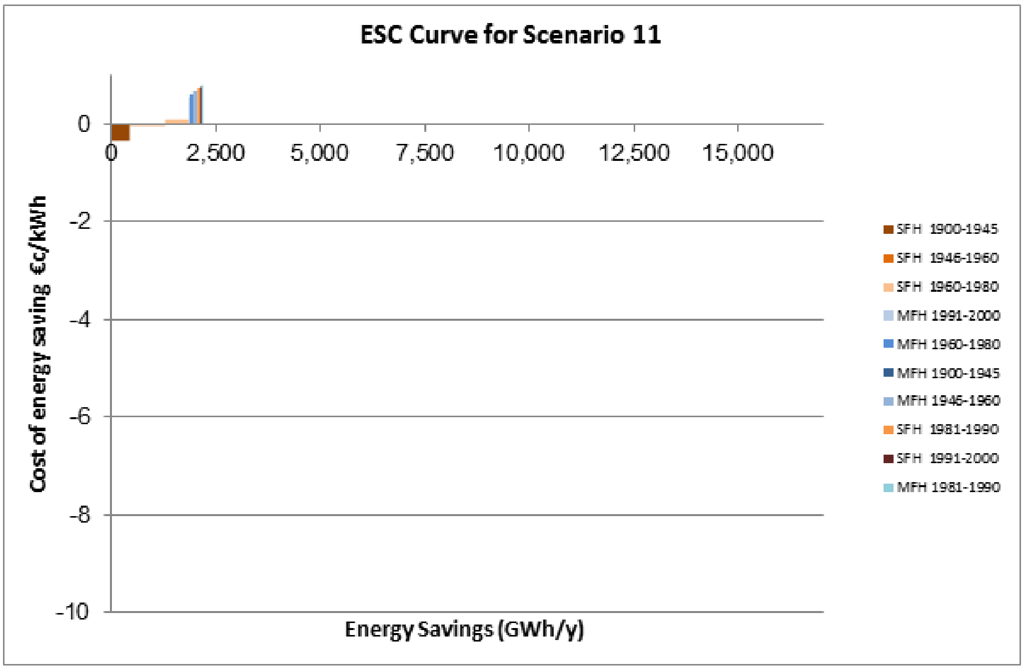
Scenario 10 explores the impact of applying a 25% grant level, alongside the most favourable economic conditions. Grant funding of 25% might be considered a more typical level seen in other EU countries. Despite requiring building owners to contribute 75% towards the cost of renovations, they remain cost-effective in all building categories. Energy and cost savings are only slightly less than the most favourable scenario 9.

e) Scenarios to 2020

Three scenarios, 11 to 13, were run to 2020, to explore the savings potential over the life of the Bulgarian NEEAP. In each case, the renovation level is fixed:

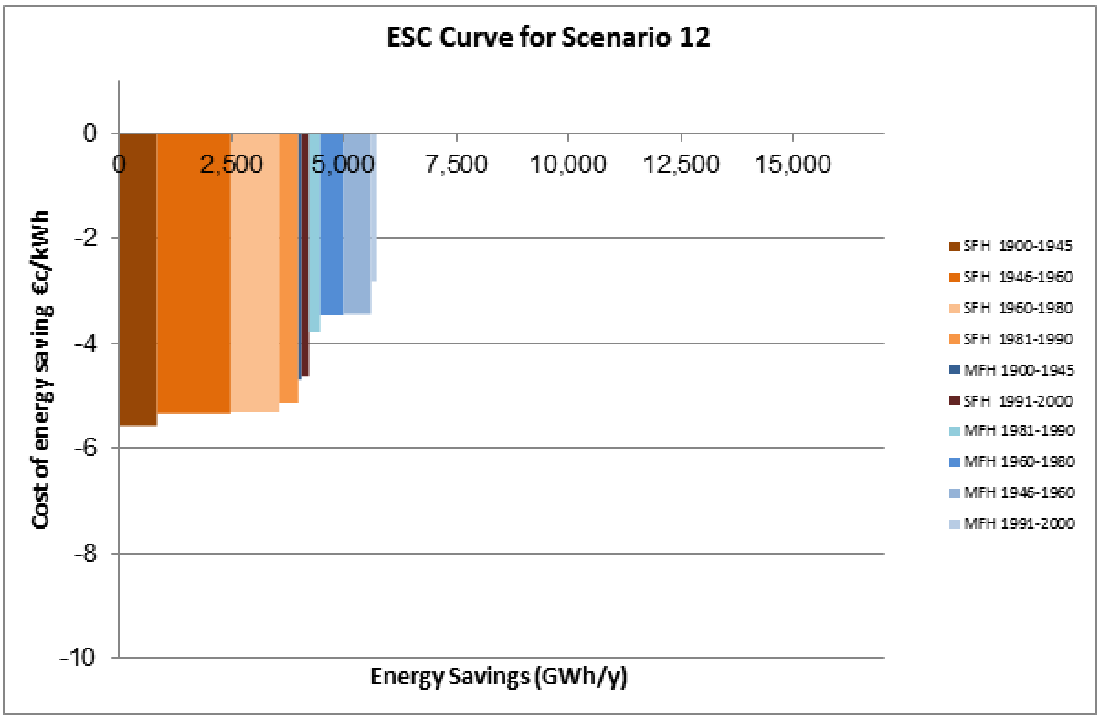
- Scenario 11 – renovation level to class C, no subsidy, BAU economic conditions and low internal temperatures;

- Scenario 12 – renovation level to class A, with 75% subsidy, favourable economic conditions and normal temperatures;
- Scenario 11 – renovation level to class C, no subsidy, favourable economic conditions and normal temperatures.



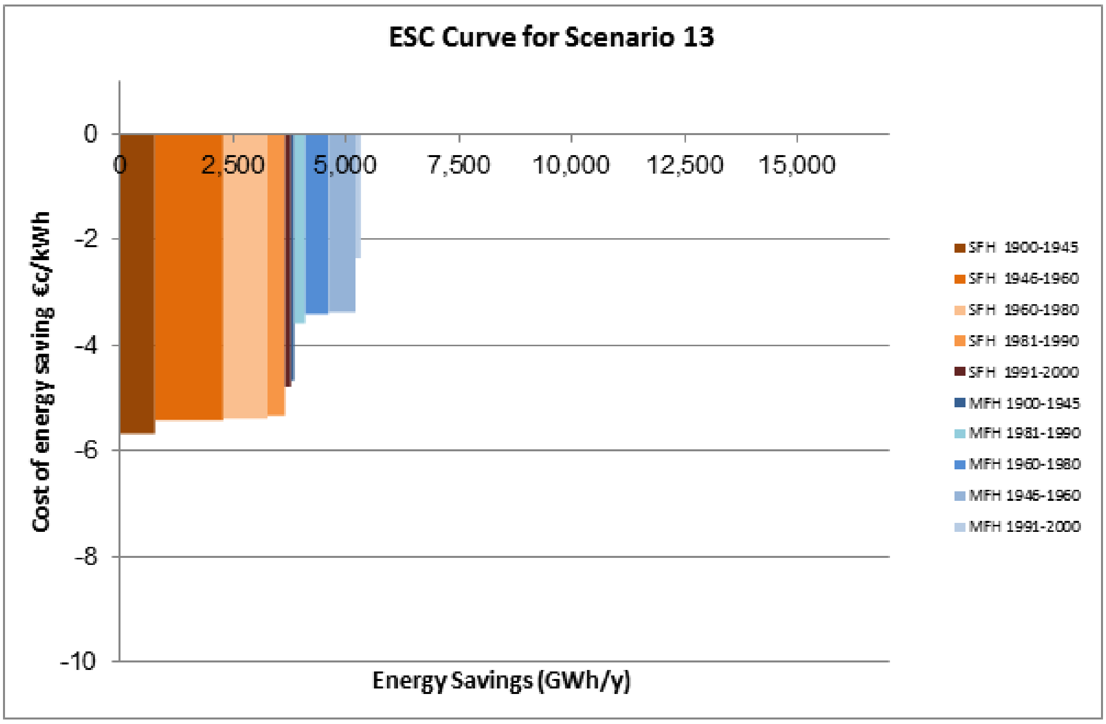
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
11	0% - BAU R1 (2020)	1.3	0.00

In scenario 11, the renovation level is fixed to R1 (Class C), and there is no subsidy applied. Under the applied existing economic parameters, none of the individual building categories are cost-effective.



No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
12	75% - R3 (2020)	5.7	0.28

Renovation level is fixed to the most ambitious R3 (Class A) in scenario 12. Alongside a 75% subsidy, favourable economic parameters and an assumption of normal internal temperatures are applied. All building categories are cost-effective.



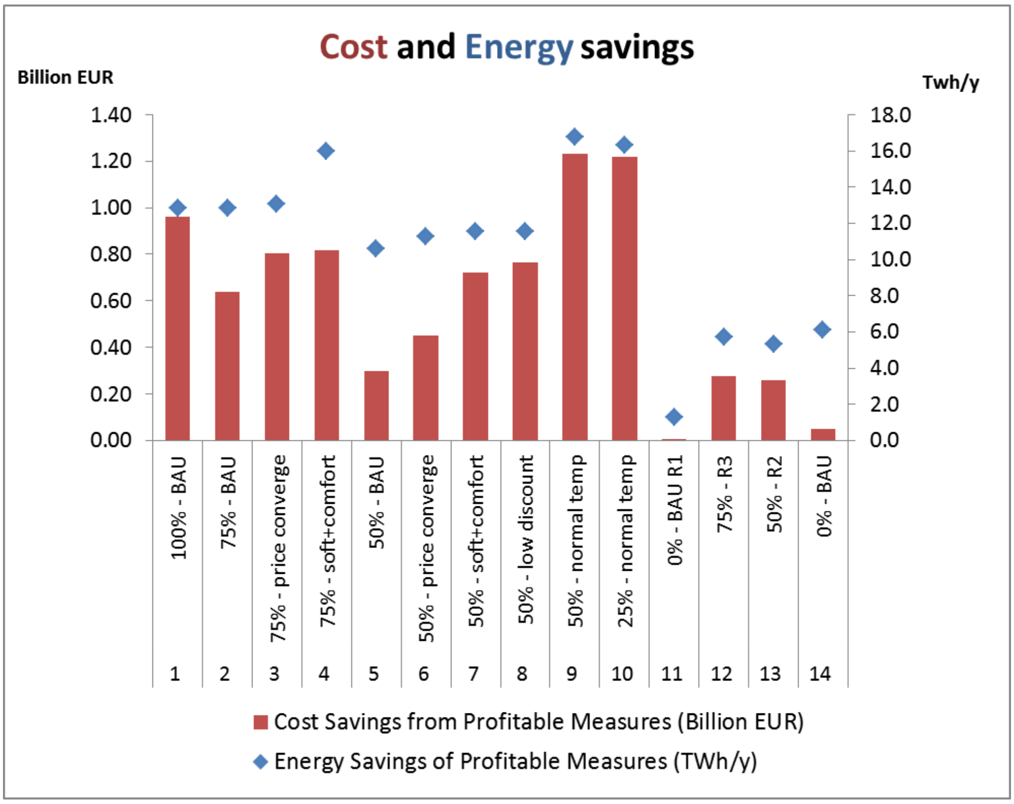
No.	Scenario (short name)	Total Energy Savings (TWh/y)	Lifetime Cost Savings (Present Value €bn)
13	50% - R2 (2020)	5.3	0.26

In scenario 13, renovation level is fixed to R2 (class A), and a 50% subsidy is applied. The same economic conditions are set as for scenario 12, generating similar results.

Comparison of Scenarios

Cost Savings

While scenarios 9 and 10 only offer 50% and 25% grants respectively, they deliver higher lifetime cost savings to building owners than all the other scenarios, including the 100% subsidy BAU case in scenario 1. This demonstrates the difference between the low internal temperatures in all scenarios except 9 and 10, where indoor temperature is set at normal levels.



Following scenarios 10 and 9, the next most economically profitable for building owners, is the scenario 1, which describes the Business As Usual approach to building renovations. Unfortunately, this scenario puts increasing strain on public budgets and while it is beneficial for building owners, it is detrimental to public finances, if it were to be scaled up further.

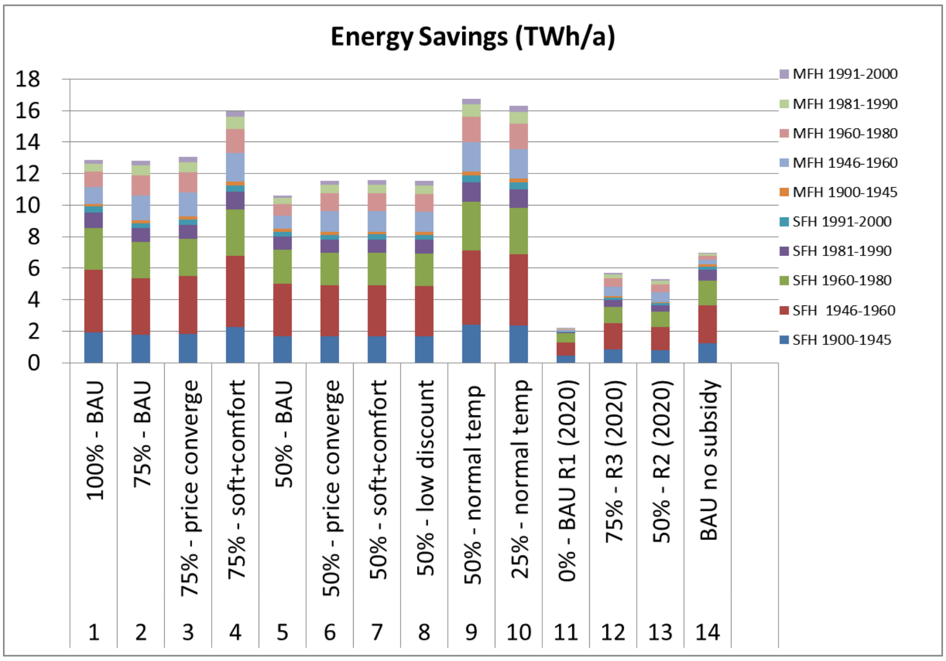
As subsidies decrease, so do the costs savings for building owners, as it is seen from scenarios 3-8. However, the increase of internal temperature (as shown in scenarios 9 and 10) and the more favourable parameters when it comes to discount rates, transaction costs and learning curves are able to compensate for these reduced cost savings.

Scenarios 11-13, which run to 2020, show that there are benefits to be achieved in the short term, and that a 50% and a 75% subsidy, offer very similar results. Lower subsidies could therefore be explored in this period.

Energy Savings

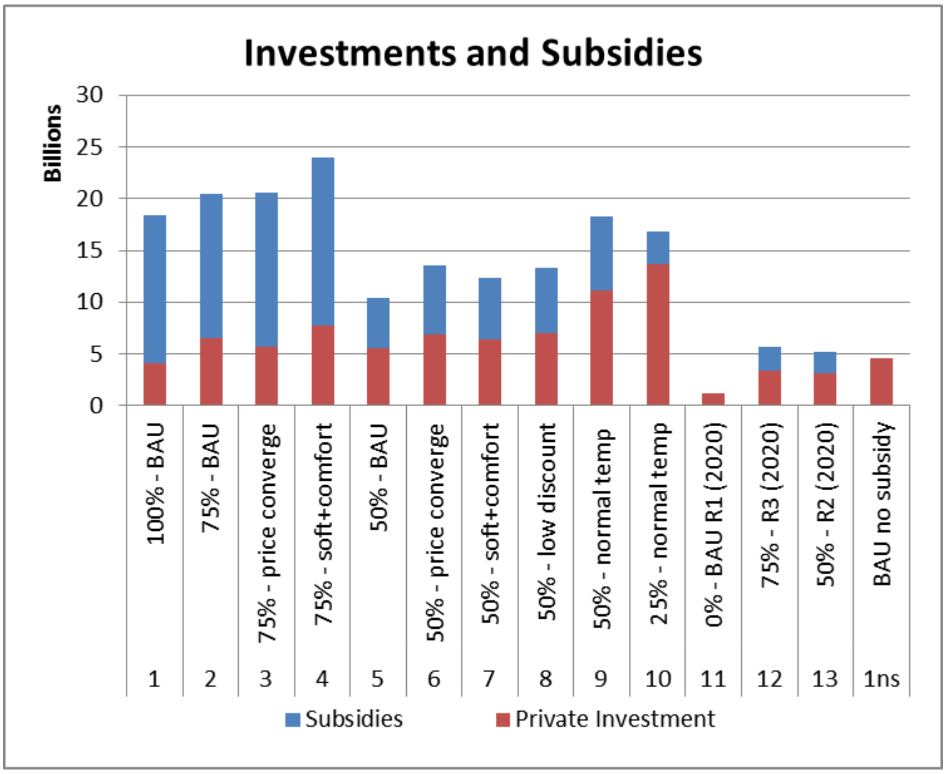
A more detailed focus on energy savings shows that there is not much fluctuation in terms of the shares of each building categories' contribution. Single family houses dominate the energy savings that can be achieved, since detached houses have lower energy performance, and therefore, more opportunities for savings. The overall savings however do not vary much and can be split into four groups:

1. Scenarios 4, 9 and 10, exhibiting high savings;
2. Scenarios 12 and 13, with low savings due to the short timeframe to 2020;
3. Scenarios 1-3 and 5-8, realising between 10,5 and 12,5 TWh of energy savings annually; and
4. Scenarios 11 and 14, which are not able to mobilise significant investments due to the lack of subsidies.



Investments and subsidies

The graph on required investments and their subsidies, provides insight into the most cost effective policies that can be implemented. The most successful scenarios are those that achieve high energy savings, produce a significant return on building owners and put a low strain on public budgets.

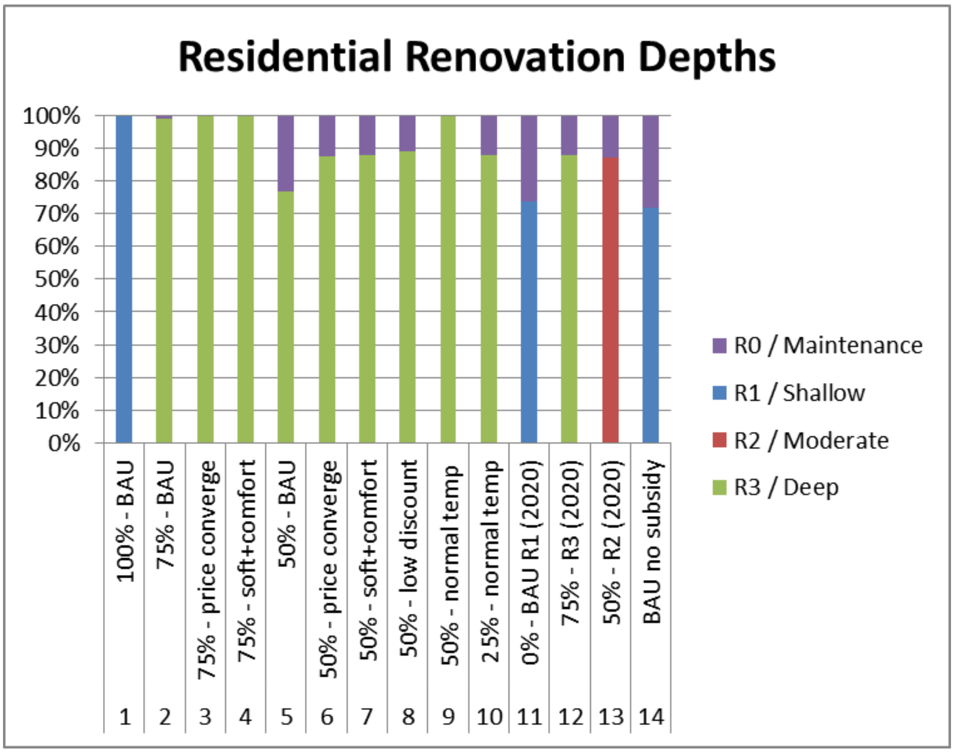


Considering the above, scenario 10 stands out as the most successful option, followed by scenarios 9 and 4.

Scenarios 5-8 achieve comparable energy savings to scenarios 1-3 by using less subsidies and overall reduced need for investments. Their economic attractiveness for building owners, however, is not optimal, since the high subsidies of scenarios 1-3 offer more financial returns to building owners.

Renovation depths

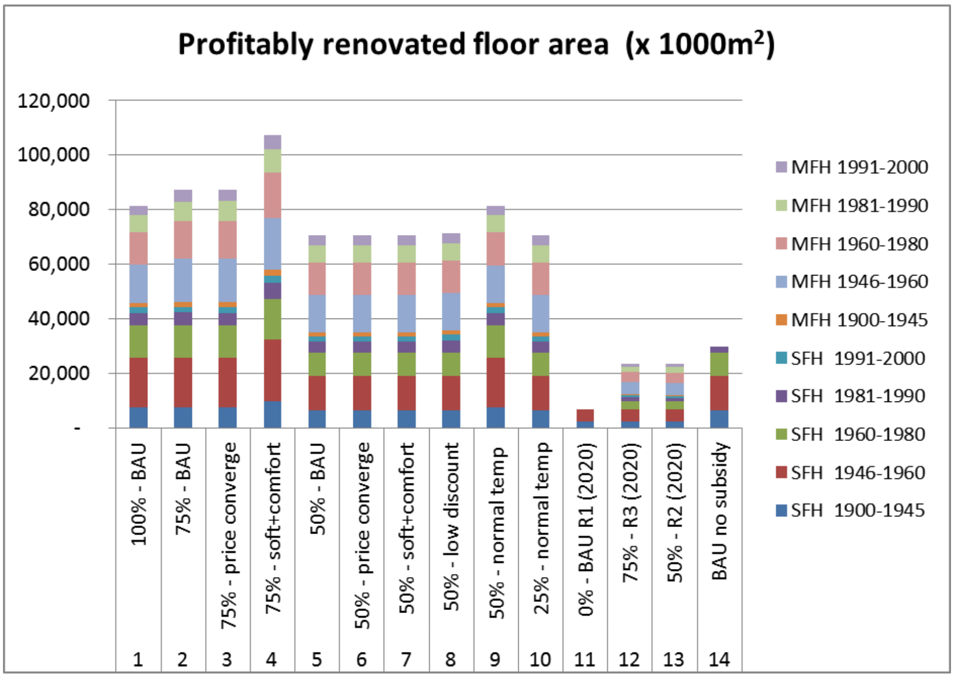
The significant subsidies offered by the Bulgarian renovation programme are at the moment spent on measures that achieve only a class C rating on the Energy Performance Certificate scale. This level is represented by the shallow renovation depth R1 in the following graph.



In our modelling, we removed this parameter and examined what is the depth of renovation that the offered subsidies can achieve. The results show that under current financial support, with subsidies ranging from 50% to 100%, it is possible to have all building categories renovated to very high energy performance levels, from an economic point of view. The reality on the ground of course may vary, but it becomes obvious that if subsidies are well exploited, then they could achieve deep renovations and significant energy savings as well as a high indoor thermal quality, for decades to come.

Renovated floor area

The figure below shows the renovated floor area done under each scenario. It can be seen that scenario 4, offering a 75% grant, with converging energy prices, soft measures and co-benefit, provides the greatest amount of renovation. However, looking at the energy saving graph above, the savings in scenarios 9 and 10 are broadly equivalent with those in scenario 4. This demonstrates that the last two scenarios entail a higher proportion of deeper renovation. The same effect can be seen when comparing scenarios 8 and 9. The renovated floor area is the same, but the deeper renovation triggered in scenario 9 translates into much higher energy savings.



Energy and Cost Savings														
Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	100% - BAU	75% - BAU	75% - price converge	75% - soft+ comfort	50% - BAU	50% - price converge	50% - soft+ comfort	50% - low discount	50% - normal temp	25% - normal temp	0% - BAU R1 (2020)	75% - R3 (2020)	50% - R2 (2020)	BAU no subsidy
Energy Savings of Profitable Measures (TWh/y)	12.8	12.8	13.0	16.0	10.6	11.3	11.6	11.5	16.8	16.3	1.3	5.7	5.3	6.1
Cost Savings from Profitable Measures (billion EUR)	0.96	0.64	0.81	0.82	0.30	0.45	0.72	0.77	1.23	1.22	0.00	0.28	0.26	0.05

Renovation costs (NPV in Euro cents / KWh)														
Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	100% - BAU	75% - BAU	75% - price converge	75% - soft+ comfort	50% - BAU	50% - price converge	50% - soft+ comfort	50% - low discount	50% - normal temp	25% - normal temp	0% - BAU R1 (2020)	75% - R3 (2020)	50% - R2 (2020)	BAU no subsidy
SFH 1900-1945	-8.07	-5.76	-7.12	-5.72	-3.58	-5.40	-7.56	-7.86	-8.34	-8.74	-0.35	-5.57	-5.67	-1.20
SFH 1946-1960	-8.33	-5.54	-6.82	-5.53	-3.31	-5.18	-7.37	-7.67	-8.02	-8.54	-0.04	-5.34	-5.42	-0.88
SFH 1960-1980	-8.36	-5.52	-6.80	-5.52	-3.25	-5.12	-7.33	-7.63	-8.00	-8.49	0.09	-5.31	-5.39	-0.75
SFH 1981-1990	-8.48	-5.60	-7.24	-5.65	-2.95	-4.76	-7.10	-7.26	-8.00	-8.21	0.74	-5.14	-5.34	-0.40
SFH 1991-2000	-9.07	-5.33	-6.60	-5.55	-1.68	-3.51	-6.08	-6.60	-7.56	-7.12	0.75	-4.63	-4.79	-0.15
MFH 1900-1945	-5.24	-4.81	-6.01	-5.12	-1.27	-2.45	-5.27	-5.98	-7.23	-6.92	0.66	-4.70	-4.68	0.02
MFH 1946-1960	-4.50	-3.57	-4.43	-3.91	-1.12	-1.20	-3.62	-4.27	-5.49	-5.04	0.67	-3.45	-3.38	0.27
MFH 1960-1980	-4.25	-3.55	-4.43	-3.88	-1.10	-1.26	-3.68	-4.32	-5.46	-5.08	0.60	-3.47	-3.42	0.25
MFH 1981-1990	-5.02	-3.89	-4.87	-4.35	-1.28	-0.79	-3.79	-4.62	-6.11	-5.49	0.79	-3.78	-3.59	0.42
MFH 1991-2000	-5.41	-3.03	-3.83	-3.68	-1.20	0.80	-2.20	-3.19	-5.00	-3.94	0.53	-2.82	-2.36	0.10

Total Investment (in million EUR)														
Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	100% - BAU	75% - BAU	75% - price converge	75% - soft+ comfort	50% - BAU	50% - price converge	50% - soft+ comfort	50% - low discount	50% - normal temp	25% - normal temp	0% - BAU R1 (2020)	75% - R3 (2020)	50% - R2 (2020)	BAU no subsidy
SFH 1900-1945	2,528	2,436	2,423	2,930	1,703	1,471	1,315	1,393	2,372	2,140	242	733	673	863
SFH 1946-1960	5,995	5,743	5,728	7,021	3,529	3,027	2,732	2,920	5,302	4,359	501	1,524	1,407	1,756
SFH 1960-1980	3,956	3,817	3,786	4,636	2,333	2,005	1,808	1,932	3,504	2,879	332	1,004	927	1,162
SFH 1981-1990	1,496	1,455	1,214	1,735	1,007	878	882	1,048	1,114	1,273	41	441	384	388
SFH 1991-2000	706	686	672	807	491	479	463	495	515	616	19	184	156	103
MFH 1900-1945	191	307	312	323	222	264	235	245	244	238	4	81	74	47
MFH 1946-1960	1,411	2,250	2,484	2,531	426	2,092	1,869	2,024	2,040	2,069	33	676	599	105
MFH 1960-1980	1,135	1,935	2,024	2,055	358	1,804	1,611	1,683	1,697	1,734	29	563	515	91
MFH 1981-1990	664	1,132	1,183	1,187	187	1,018	914	954	951	942	14	317	290	45

Subsidies (in million EUR)														
Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	100% - BAU	75% - BAU	75% - price converge	75% - soft+ comfort	50% - BAU	50% - price converge	50% - soft+ comfort	50% - low discount	50% - normal temp	25% - normal temp	0% - BAU R1 (2020)	75% - R3 (2020)	50% - R2 (2020)	BAU no subsidy
SFH 1900-1945	1,887	1,632	1,805	1,924	802	790	710	735	838	369	-	275	245	-
SFH 1946-1960	4,495	3,877	4,292	4,659	1,652	1,596	1,442	1,502	1,989	755	-	576	518	-
SFH 1960-1980	2,972	2,568	2,841	3,084	1,095	1,059	956	996	1,319	500	-	381	343	-
SFH 1981-1990	1,126	975	852	1,150	480	473	425	501	501	221	-	177	146	-
SFH 1991-2000	531	459	508	531	236	233	229	235	236	118	-	86	71	-
MFH 1900-1945	167	225	226	236	93	130	114	115	115	57	-	38	35	-
MFH 1946-1960	1,232	1,536	1,691	1,768	150	881	773	849	861	392	-	284	244	-
MFH 1960-1980	983	1,326	1,343	1,405	122	764	670	674	684	337	-	226	210	-
MFH 1981-1990	591	821	826	857	71	473	416	419	422	210	-	140	130	-
MFH 1991-2000	342	497	496	519	37	190	252	254	254	127	-	85	79	-

NPV of Investments														
Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	100% - BAU	75% - BAU	75% - price converge	75% - soft+ comfort	50% - BAU	50% - price converge	50% - soft+ comfort	50% - low discount	50% - normal temp	25% - normal temp	0% - BAU R1 (2020)	75% - R3 (2020)	50% - R2 (2020)	BAU no subsidy
SFH 1900-1945	152.9	100.2	126.8	125.7	59.5	88.7	124.2	128.3	196.2	202.0	1.5	46.1	42.9	14.4
SFH 1946-1960	325.7	193.7	245.5	246.1	107.5	163.7	233.0	240.5	373.9	378.9	0.3	86.1	80.2	20.9
SFH 1960-1980	213.4	125.6	159.3	159.9	68.6	105.1	150.5	155.5	242.3	244.7	-0.5	55.6	51.8	11.6
SFH 1981-1990	83.1	48.4	61.8	61.7	24.5	39.0	58.1	61.0	94.5	94.3	-0.5	21.6	20.2	2.7
SFH 1991-2000	34.1	16.6	21.3	21.8	4.9	10.1	18.2	19.7	31.7	29.9	-0.2	6.9	6.2	0.2
MFH 1900-1945	7.4	9.3	11.6	11.7	2.4	4.4	8.9	10.0	17.1	16.5	-0.1	3.6	3.5	0.1
MFH 1946-1960	56.2	65.2	81.3	84.6	11.2	20.7	58.7	68.7	123.4	115.1	-0.7	25.5	24.7	-1.0
MFH 1960-1980	48.4	55.3	68.8	71.8	9.6	17.1	49.5	58.1	104.6	97.3	-0.6	21.6	20.9	-0.8
MFH 1981-1990	23.8	24.7	30.9	32.9	4.6	4.4	20.8	25.3	47.8	43.0	-0.3	9.6	8.8	-0.5
MFH 1991-2000	14.0	10.4	13.1	14.8	2.3	-2.0	7.1	9.8	21.0	17.0	-0.1	3.9	3.2	-0.1

ANNEX 3 – POLICY RECOMMENDATIONS

For the optimisation and further development of the main features of the National Programme for Energy Efficiency of the Multi-family Residential Buildings with a view to ensuring the long-term sustainability of its instruments and effects.

"Can we afford to spend 46% of our energy bill on heating and cooling our buildings? Is that not a little too expensive when we are spending almost EUR 400 billion a year on energy imports? How much can we save? What enormous potential we have in this area if we really increase the efficiency of our buildings. (…)

Maybe we should think more about incentives. (…) Therefore I think if we could consider the schemes and learn from each other in Europe – because we have good schemes in our member states – how to motivate households, how to motivate municipalities and local authorities to actually work better on the energy efficiency of buildings, this may be one of the arguments which could help us to convince the member states to be more serious and positive about these policies."

Hearing of Maroš Šefčovič, Commissioner for Energy Union, October 20, 2014, Strasbourg

The current recommendations for the development of the National Programme for Energy Efficiency of the Multi-family Residential Buildings stem from its current parameters. They aim,

> **without limiting the scope and impact of the Programme and without slowing the pace of its implementation, to ensure the start of a smooth transition to deep energy renovation, carried out in stages ("step-by-step"),**

as recommended in the European Energy Efficiency Directive (par. 16 of the Preamble and Art. 4, item. "c") and preconditioned in the new Bulgarian standards for energy efficiency. At the same time, the proposals aim to set clear and realistic energy, environmental and economic objectives and to preserve and develop the social dimension of the Programme, while at the same time ensuring economic stability and showing a constructive portrait to the main stakeholders - end users and beneficiaries, Bulgarian local authorities, international and national financing sources, EU institutions.

The proposals take into account the objective fact that significant parts of the building stock is not heated to satisfactory comfort levels. Therefore, their average energy consumption corresponds to energy classes C or B under the Bulgarian classification, but, in respect to their physical characteristics, these buildings fall into classes D or E. This means that the renovation of these buildings to class C (as required by the current Programme) will create the conditions for increased comfort, but not for significant energy savings and, in some cases, the energy consumption could even increase.

Scope of the programme

Over the next several years, the focus of the Programme should be maintained on the multi-family apartment buildings (see the exemplary roadmap). Along with energy efficiency measures, renovation should continue to include measures for the examination and strengthening of the building structures (where necessary).

New:

In the coming years, the Programme can gradually

> **expand its scope in accordance with a coherent and publicly recognised long-term roadmap, covering more and more building types,**

congruent with the fact that the share of direct state support (in the form of subsidies) will gradually decrease.

It is appropriate, together with the structural reinforcement of the buildings, to install new district heating systems or modernise the existing ones, where necessary, feasible and economically justifiable. Thus, the projects will result in horizontal links to individual apartments (with individual metering of energy costs) and in conditions for the inclusion of local systems for renewable energy (solar, wood biomass, geothermal energy). The implementation of these measures will create the conditions to achieve energy class A/nZEB in a medium-term perspective. Measures to strengthen the construction and building installations must be accounted for separately from the energy efficiency measures so as to ensure a proper evaluation of the energy savings and reduced CO_2 emissions in accordance with the established international protocols for verification.

The adoption of higher goals and the realistic approaches for their achievement can contribute to the formation of a typical Bulgarian renovation model, which can take a worthy place among the best European practices. This model can be built around several basic requirements for the renovation projects, as follows:

a) higher energy performance and lower energy consumption achieved through a gradual upgrade of the energy class in each step of the retrofit process;
b) the possibility to use renewable energy sources for the production of electricity and for the supply of heating and hot water;
c) high comfort of habitation (thermal, optical, sanitary, acoustic), reached by easily applicable and accessible measures carried out in stages.

BEST PRACTICES

Brussels-Capital Region , Belgium

Starting around 10 years ago from a very modest level of energy efficiency, the Brussels-capital region reached now a leading position in both Belgium and the European Union. The main force in this rapid development was the "Exemplary Buildings" Programme, which provided financial support to the residential, public and commercial buildings constructed under the Passive House standard. By 2014, the region built or renovated more than 1 million m^2 of building area under this

standard, including single-family and multi-family residential buildings, offices, kindergartens and schools. Gradually, this standard was established as a common practice in the region.

Federal province Tyrol, Austria

Since 2002, the Austrian province of Tyrol has conducted a consistent policy to achieve energy independence by limiting the use of fossil fuels, especially of oil derivatives. For this purpose, all types of buildings are constructed and renovated according to the Passive House standard (corresponding to energy class A/A+). The higher the objectives achieved, the more that additional incentives are provided to building owners. This policy is implemented through joint efforts of the widest possible range of stakeholders, from end energy users to political decision-makers.

Frankfurt am Main, Germany

Since 2007, Frankfurt Municipality is committed to an ambitious and coherent policy plan to promote energy-efficient buildings. A special local law stipulates that all buildings constructed by the city or for the city, including municipal housing associations, must meet the Passive House standard, and at the same time create conditions for a more widespread use of renewable energy in non-residential buildings. For this purpose, the municipal development strategy states that, by 2050, energy demand should be entirely satisfied by renewable energy. So far, over 100,000 m^2 of residential floor area meeting the Passive House standard have been constructed.

Features of the Programme and expected results

By 2020, the Programme could keep its main social characteristics - a broad public character and significant (though declining over the years) government funding.

New:

It is highly desirable that, by the end of 2016, clear and measurable medium- (until 2020) and long-term (up to 2030/2050) objectives are defined and communicated,

as follows:

a) energy goals - long-term energy savings in MWh, production of energy from renewable sources;
b) environmental goals - long-term reduction of CO_2 emissions and improvement of air quality in Bulgarian cities, including reduction of the pollution by fine particles (PM);
c) social goals - reducing energy bills, improving living comfort, improving the aesthetic characteristics of buildings, residential complexes and surrounding areas;
d) economic benefits – positive impact on the energy balance of the country, the GDP and the creation of new jobs.

On the basis of such measurable goals, priority should be given to different types of projects over the years, respecting at the same time their economic viability.

Necessary additional actions:

a) To develop and adopt a long-term strategy for housing renovation to 2020-2030-2050, with clear and measurable social, energy, environmental and economic goals.

b) To develop and publish a roadmap to 2020-2030 (an indicative roadmap is proposed in this report).
c) To develop and adopt a short term action plan for deep renovation for the period 2017-2018, including ambitious pilot projects in several municipalities (pilot sites to be selected on a competitive basis).

BEST PRACTICES

The Czech Republic

The National Programme for building renovation in Czech Republic requires refurbishment to energy class B and the achievement of a reduction of at least 40% in the total energy consumption in renovated buildings where the necessary measures are economically viable. Upon achievement of the class C, that reduction should be of at least 30%.

Antwerp, Belgium

After joining the Covenant of Mayors in 2009, the Antwerp Municipality is planning intensive energy efficiency actions as part of a broader programme to reduce the CO_2 emissions by 20% throughout the municipality and by 30% in the city itself.

Frankfurt am Main, Germany

Frankfurt is one of 19 German municipalities that participate in the programme "Master Plan for 100% climate protection", initiated by the German Ministry of Environment, Buildings and Nuclear Safety. Each participating municipality has to develop a master plan for reducing the greenhouse gas emissions by 95% in 2050 and for a social development that has no impact on climate.

Federal province Tyrol, Austria

By 2050, the energy consumption in the Austrian province of Tyrol will be halved, and the share of renewable energy in buildings will increase by 30%. This will allow the province to produce and supply the necessary energy by itself. At the same time, this policy will strengthen the local economy, create new jobs, reduce the costs and preserve the environment.

Level (depth) of renovation

The currently renovation of existing buildings to energy class C can be maintained for a short period, though this should be in the context of eventually achieving a higher energy class. However, from 2020 at the latest, the minimum energy class to which renovations need to be carried out should be gradually increased according to an established roadmap, subject to a wide expert and public debate and presented well in advance to the general audience.

New:

The renovation of buildings to Class A should be adopted as a mandatory long-term goal of the Programme. In order to achieve this, the opportunity to employ the step-by-step

renovation approach, based on the gradual upgrade to higher energy classes at each phase of the renovation, should be established.

The analysis of about 20 different scenarios[9], run to optimise the Programme, shows that, by 2030, the most economically feasible strategy is to carry out the renovations to energy class A. In this case, the optimal ratio between the investment and the resulting effects (energy savings and reduced CO_2 emissions) would be achieved. This also corresponds to the requirements of the European Energy Performance of Buildings Directive (2010/31/EU), according to which all buildings must be designed to meet the national criteria of "nearly Zero-Energy Building (nZEB)" – or to energy class A following the national classification.

It is appropriate to consider the possibility to further stimulate renovation through a tax relief for the owners of buildings that achieve an upgrade to or above Class A before the terms set out in the national legislation.

Necessary additional actions:

a) To further improve the existing legal framework for energy efficiency in buildings, in order to entirely comply with the requirements and the spirit of the Energy Performance of Buildings Directive (2010/31/EC).
b) To introduce special incentives for the owners willing to renovate their buildings to a higher energy class (as compared to the minimum requirements for the respective period), following the example set by many European countries.

BEST PRACTICES

Directive 2012/27/EC

"... in order to capture the growth and employment opportunities in the skilled trades and construction sectors, as well as in the production of construction products and in professional activities such as architecture, consultancy and engineering, Member States should establish a long-term strategy beyond 2020 for mobilising investment in the renovation of residential and commercial buildings with a view to improving the energy performance of the building stock. That strategy should address cost-effective deep renovations which lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance. Such deep renovations could also be carried out in stages."

(§16 of the Preamble to Directive 2012/27 / EC on energy efficiency).

Federal province Tyrol, Austria

By 2050, the maximum specific annual consumption of energy for heating in all buildings categories of the Austrian province of Tyrol must not exceed 25 kWh/m^2.

Antwerp, Belgium

In accordance with the European Directive on the Energy Performance of Buildings, the municipality of Antwerp has adopted a clear orientation towards the implementation of the regional standard

[9] The modelling of the scenarios is done by the Buildings Performance Institute Europe (BPIE) based in Brussels and Technical University - Vienna with the participation of EnEffect – Bulgaria.

for "nearly Zero-Energy Building" (nZEB). Special attention is paid to the renovation of the existing building stock, as the ambitious goals can only be achieved by significantly reducing current energy consumption. To this end, a new specialised municipal fund was established in 2015 in order to encourage the construction of nZEB buildings. From 2014, all renovated buildings should additionally utilise a certain minimum amount of renewable energy.

Brussels-Capital Region, Belgium

Brussels-Capital region has adopted a new regulation according to which, from January 2015, all new buildings and building renovations in the region must be designed and constructed following the Passive House standard. This inspires more and more regions in Europe to adopt high energy standards when designing and constructing a building.

Courcelles-Lès-Lens, France

Currently, two multi-family residential and social housing buildings built in 1978 are being refurbished using the step-by-step approach. They both have 16 apartments (of 57 or 70 m^2), with outdoor terraces and a central staircase in the heated volume. The buildings are constructed with panels produced locally with built-in 8 cm mineral wool insulation. The concrete roof is partially insulated with 8 cm mineral wool. The windows have double glazing and PVC frames, being installed in 1995. Heating and DHW rely on individual gas boilers. The apartments are equipped with mechanical ventilation without heat recovery. The main objective of the project is to achieve the financial benefits of the "step by step" renovation.

The first step includes two measures, which will be executed in 2016:

a) Airtightness n50 = 1 h-1 and Mechanical Ventilation with 80% effective heat recovery ratio,
b) Replacement of all windows and doors to passive house component quality. Average U-value of installed components of 0,85 W/(m^2.K) with an overall positive energy balance in winter, feasible with passive house components.

These measures will be mostly executed while keeping tenants in situ.

The following steps will occur after 2016:

c) External insulation of walls and roof with an average U-value of < 0,15 W/(m^2.K).
d) All difficult thermal bridges will have their impact on the envelope U-values reduced by at least 50% while avoiding condensation.
e) Renewable energy integration: 1 m^2/person free-standing solar thermal could cover 35% of the domestic hot water demand.

After the completion of all the steps, the specific energy consumption for heating is expected to reach 11 kWh/m^2 per year from a starting level of 113 kWh/m^2 (i.e. a reduction of more than 10 times).

Step-by-step renovation approach

In order to set the high energy class A/nZEB as a realistic long-term goal of the Programme, while maintaining its output in terms of the renovated living spaces without an increase in the initial

investment, the Programme must

introduce the stage-based (step-by-step) renovation approach. Within this approach, the prescribed energy efficiency measures are implemented in several steps (stages), and each of them achieves a higher energy class (from C to A/nZEB).

The measures must be designed and implemented so that each next step builds on the achievements of the previous ones without harming or affecting its impact. For this purpose, energy audits and projects should be prepared according to the requirements of the energy class "A", defined by the recently adopted new standards for energy efficiency. The current reports from the energy audits must be supplemented by staging plans for upgrades using the "step-by-step" approach, in which the optimal sequence for the implementation of the prescribed measures should be determined.

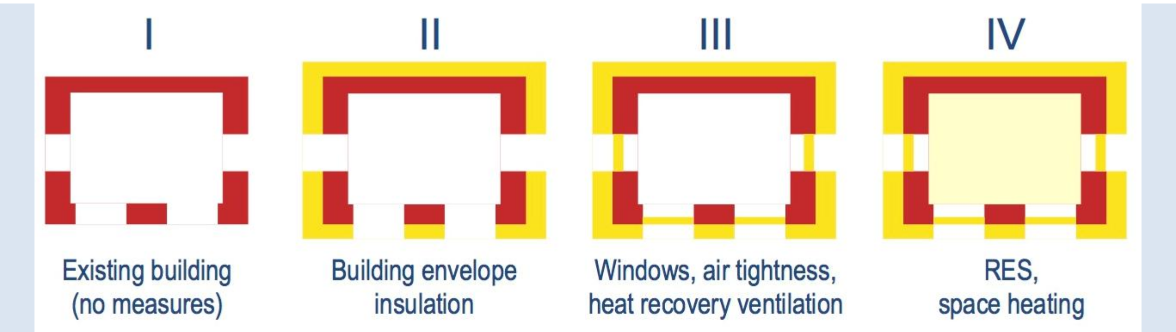
To facilitate the implementation of the step-by-step renovation, it is appropriate that the National Programme for Energy Efficiency of the Multi-family Residential Buildings focuses on the insulation of the building envelope (roof, walls and foundations). Thus, class C would be universally achieved, and the total volume of investments and the anticipated energy savings preserved. At the same time, the possibility for further energy improvements in the next stages would be kept intact, avoiding the lock-in effects of “shallow” retrofitting.

For the owners of individual apartments, insulation is the most difficult energy efficiency measure to organise and implement, as it requires a comprehensive and simultaneous implementation. This makes it the most suitable for centralised funding by the Programme. An additional advantage of this approach is the possibility to achieve relatively quick and visible results that can radically change the appearance of the buildings and therefore attract new candidates for participating to the Programme.

Pilot Project in Gabrovo

The "step-by-step" renovation is a practice that is strongly encouraged and is increasingly spreading in the EU. The European project EuroPHit examines in detail the possibilities of applying this approach in different countries and supports a number of pilot projects. Their results convincingly demonstrate the advantages of the step-by-step renovation and its applicability to different economic conditions. A pilot project implementation, starting in 2016, was also initiated in the Bulgarian city of Gabrovo (step-by-step renovation of the school "St. Cyril and Methodius").

Figure 17 - Possible distribution (example) of the energy efficiency measures for step-by-step implementation in three packages



Reference multi-family residential building in Gabrovo

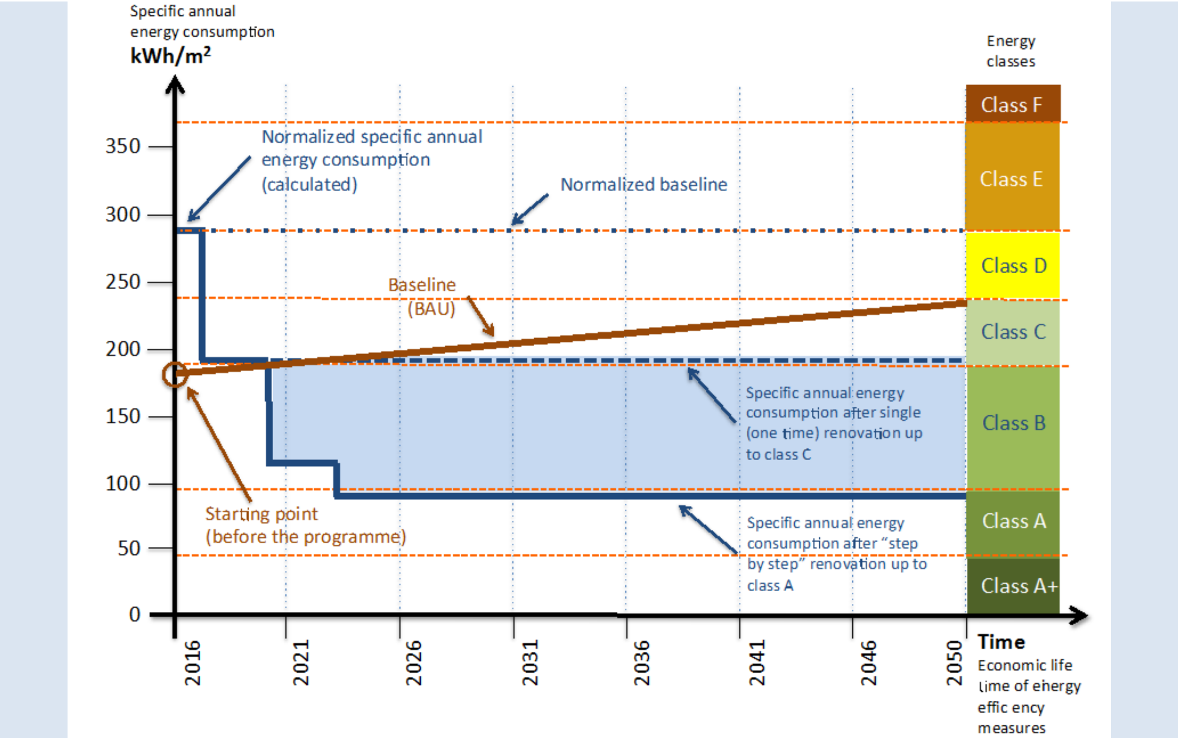
Here's what the analysis of a reference building in Gabrovo, Bulgaria shows in terms of the impacts of renovation to be carried out under the current conditions of the National Programme for Energy Efficiency of the Multi-family Residential Buildings. The energy audit performed by EnEffect found that, while the integrated energy performance of the building corresponds to the limit between classes D and E, the actual energy consumption is in the lower end of class C. (This result is quite similar to the results of the first 425 energy audits of multi-family residential buildings under the National Programme, summarised in the database of the Sustainable Energy Development Agency. According to SEDA, the average integrated energy performance of the buildings corresponds to class E and the actual energy consumption is in the lower end of class C). The reason for this discrepancy lies in the fact that many of the heaters in the apartments are turned off and that the premises are not heated according to the established norms.

This phenomenon is typical in most residential buildings in Bulgaria. If retrofitting is performed to class C through the implementation of a set of compromise measures, the physical characteristics of the building will be improved, but the energy consumption is unlikely to change substantially. It may even increase if residents decide to improve the comfort of their homes. On the other hand, if the same class C is achieved through the implementation of one of the measures - insulation of walls, roof and basement, but dimensioned (calculated) according to the requirements for reaching class A (e.g. with greater thickness according to specific calculations), the building will achieve approximately the same energy savings with almost the same volume of investment.

The main benefit of this approach is that the building will remain open for the (step-by-step) implementation of other measures that will also be designed at the level of class A – replacement of windows, improvement of air tightness, installation of ventilation with heat recovery, and, finally, installation of facilities for the utilisation of RES. Thus, after several stages of gradual improvements, the building will reach Class A, providing much greater energy savings and incomparable better indoor climate.

The area on the chart coloured in light blue indicates the energy savings we would miss if we renovated the building to class C with a set of compromise measures, "sealing" it to this low level of energy efficiency at least until 2050 (the economic lifetime of the implemented measures). If the results of this example are extrapolated to the entire building stock, the sheer volume of the possible savings we could miss becomes clearly visible.

Figure 18 - Long-term effects on the perception of energy classes C and A of the renovated residential buildings



Necessary additional actions:

a) To urgently introduce the necessary changes to the current regulations for energy audits and design, in order to regulate and facilitate the "step-by-step" building renovation approach.

b) To legally regulate the preparation of "step-by-step" renovation plans and to develop appropriate guidelines for energy auditors and designers.

Financing of the Programme

New:

In 2017, the programme should be amended in two ways. Firstly, overall subsidy rates should be reduced to 75%, and the focus should shift towards insulation measures that are consistent with achieving higher energy classes. However, while the overall subsidy should not exceed 75% in future, funding for qualifying insulation measures could be maintained at 100%. At the same time, additional financial instruments should be identified and widely disclosed, through which the measures of the next renovation steps could be financed with the participation of individual building owners. In this phase, one guiding principle should be established: the state support (in the form of grant components to loans) should be proportional to the achieved results, or

the higher the energy classes achieved and the more energy savings are realised, the greater would be the state support for the building owners/investors.

This will create the conditions for a significant reduction in CO_2 emissions, and their sale could provide additional financial resources for a further implementation of the Programme.

Serious attention should be paid to the recently initiated discussions about the possibility of an involvement in the European Fund for Strategic Investments (EFSI)(better known as "the Juncker Plan"), to be used to promote the energy renovation of private residential buildings in European cities, representing one of the most fragmented markets. The coordination of the National Programme with the Juncker Plan may reserve a rightful place among the best European practices, and this in turn may attract the interest of international investors.

Necessary additional actions:

a) To establish a comprehensive and flexible financing scheme involving various financial sources and individual building owners, allowing for the "step-by-step" implementation approach and evolving over the years (an indicative scheme is presented in this report).

b) From 2017 on, to introduce incentives for individual building owners (by their own or through borrowed funds) to co-financing, on account of the reduction of state subsidies.

c) To develop and implement a scheme to finance the rehabilitation of the adjacent open spaces around the buildings, predominantly owned by the municipalities. In this respect, pilot projects for all neighbourhoods should be planned and implemented.

d) To conduct studies and consultations with national and international experts and representatives of the European Fund for Strategic Investments (EFSI), in order to identify the possibilities to link the National Programme for Energy Efficiency of the Multi-family Residential Buildings to this plan. Such actions will attract the interest of international investors and will thus provide additional financial resources to the Programme.

BEST PRACTICES

Federal province Tyrol, Austria

The volume of public subsidy in the Federal province of Tyrol is determined by the “ecological level” of the building (eco-3 levels), its area and the extent of heating demand reduction. Buildings with very high energy and environmental performance in project and construction works receive additional subsidies for achieving the highest eco-level (3) or complying with certain standards such as the "Passive House" or the "Klima: active house".

Hannover Municipality

“ProKlima”, the local fund for climate protection in the municipality of Hanover, operates on the basis of a public-private partnership in which the municipality of Hanover, five other neighbouring municipalities and the local energy supply company have a key role. Through this unique collaboration, they combine their interests and managerial capacity with the needs of the end users and overcome many market barriers to implement a number of projects for low-energy and passive buildings present in the municipality. Over the past 15 years, the fund has invested over € 53 million in energy efficiency measures, reducing greenhouse gas emissions by over 118,000 tonnes. Every euro invested by the Fund has mobilised € 12.70 additional private investments.

Latvian Environmental Investment Fund

The specialised Latvian Environmental Investment Fund (LEIF) is working closely with the local authorities. Within its recent programmes, the Fund financed 14 "nearly zero-energy" buildings that meet the standard "Passive House" and reach 15 kWh/m^2 annual consumption of energy for heating. Since 2010, the Fund monitors the implementation of the projects and the performance of buildings receiving financing. Through its operation, the LEIF has established a large network of private companies, utilities, local authorities, associations and research centers that supports its activities.

EBRD credit line in Bulgaria

The credit line for energy efficiency in households (REECL) opened in 2005 and completed its first phase in January 2010. By the end of 2009, 24,362 projects for energy efficiency in households were funded. The projects for energy saving windows (45.2% of total loans) and heat pump systems (27.5%) were predominant. The equivalent of electricity savings from completed projects amounted to around 182.7 GWh per year. The next phase of the credit line for energy efficiency in households started in mid-2011 and continued until 2015, when it absorbed the entire financial resource. In 2016, the third stage of the same credit line will start. Each household or association of owners that is approved for crediting under the REECL is entitled to a grant of 20% or 30% of the project value (for collective reconstruction of multi-family building), once it is successfully completed and meets all the requirements of the programme. Loans and grants are also awarded for energy efficient windows, boilers, heaters, stoves and biomass boilers, solar collectors for hot water, cooling and heating heat pump systems, and others. The rules of the credit line encourage the beneficiary to achieve even higher energy saving results.

European Fund for Strategic Investment

The European Fund for Strategic Investment aims to promote and enhance market efficiency by supporting private investments in sustainable projects and avoiding overlaps with other financial instruments. Recently, Stratos Paradias, President of the International Union of Property Owners (UIPI), said: "*We see the Juncker plan as a promising tool to support modernisation in the private housing stock*." In this area, property owners and small and medium-sized companies are the main actors and expect the Fund to be used in combination with the right mix of incentives for them. An exemplary project is currently implemented in France, where 40,000 homeowners have access to long-term loans to improve their insulation and, as a result, achieve significant energy savings. Through this fund, the establishment of investment platforms bringing together smaller projects, in conjunction with other financial instruments, is encouraged to achieve better visibility in front of the investors.

Technical assistance

The methodological guidance of the Programme will continue to be implemented by the Ministry of Regional Development and Public Works. The preparation (surveys and design) and

implementation (construction and installation) of the retrofitting works will continue to be coordinated by the municipalities.

New:

In order to ensure the effective implementation of the Programme, it is appropriate to introduce an additional "Technical Assistance" component, through which creating the conditions for

> **providing professional management and control over the preparation and implementation of the Programme by municipalities.**

Through this component, continuous capacity building for the main participants in the Programme - municipalities and participating companies (energy auditors, designers and construction companies) – will be provided, contributing this way to the good-quality preparation and implementation of projects and Programme activities.

Since most of the municipalities do not have the capacity to manage the Programme, it is necessary to provide resources for strengthening the position of the Municipal Energy Manager. This position was already introduced by the Energy Efficiency Act, but in practice it is not effectively used. In larger municipalities (e.g. in regional centres), expert teams supporting the energy manager should be formed and trained in order to provide professional management to the Programme.

Necessary additional actions:

a) To develop and enforce a medium-term technical assistance component (until 2020) for the main participants in the Programme, including a plan to increase the capacity of:
   - Municipal Energy Managers and their expert teams;
   - Energy auditors and designers;
   - Contractors / construction companies;
   - Specialists in the newly built municipal advisory offices.

b) To develop and validate:
   - Instructions to prepare energy audits and design plans for the "step-by-step" implementation of renovation projects;
   - Instructions for the "step-by-step" implementation of construction works and energy efficiency measures in housing renovation, including standard details and technological units;
   - A package of supporting materials for contractors - manuals, instructions and guidelines, including standardised technical solutions and details, minimum technical requirements, maximum prices - differentiated for energy efficiency and other technical measures.

BEST PRACTICES

Brussels-Capital Region, Belgium

In 2007, the Brussels-Capital region announced its ambitious programme "Exemplary Buildings" (BatEx), targeted to potential investors in new buildings or in building renovations in the region. The programme survived all the uncertainties and difficulties of the following years, becoming a major financial instrument for promoting very energy-efficient private and public buildings of all kinds, regardless of their size or ownership. The programme underwent five annual editions of € 5 million each, aiming at reaping maximum benefits by promoting the concept of "eco-development" and showing these benefits for the transformation of the city, building by building. All buildings

supported by the Programme had to be constructed in accordance with the "Passive House" standard. A special guide to facilitate the use of green building materials, the conservation of biodiversity and the design and construction of buildings without CO_2 emissions was prepared and disseminated. It was required that the buildings have high architectural qualities, organically fit into the urban environment, and have acceptable financial indicators.

Management, maintenance and monitoring

In its current form, the Programme does not provide any special measures for the management and maintenance of renovated residential buildings, as well as for the monitoring of buildings performance after renovation.

New:

To ensure the credibility and sustainability of the results of the multi-family residential buildings renovation and to draw valid conclusions for a further improvement of the Programme itself, it is necessary

to create conditions for the introduction of professional management and maintenance of the renovated buildings and for the conduct of long-term monitoring on their energy performance.

The first steps in the right direction have been made by recent amendments to the Law on Condominium Management. The efforts in this direction should continue and should be extended to other legislation acts, if deemed necessary.

Necessary additional actions:

a) To develop and implement incentives to accelerate the introduction of alternative forms of professional management and maintenance of the residential building stock.
b) During the period 2016-2017, to implement pilot projects in at least two Bulgarian municipalities, based on the principles described in this document. An indicative plan for monitoring and verifying the performance of renovated buildings should be prepared and tested in pilot projects.
c) Based on the pilot implementation of an indicative plan for the monitoring of pilot buildings, the following documents should be developed:
    - A medium-term monitoring programme for renovated buildings (for the periods up to 2020 and 2025), and
    - a standard for processing and storing information.

BEST PRACTICES

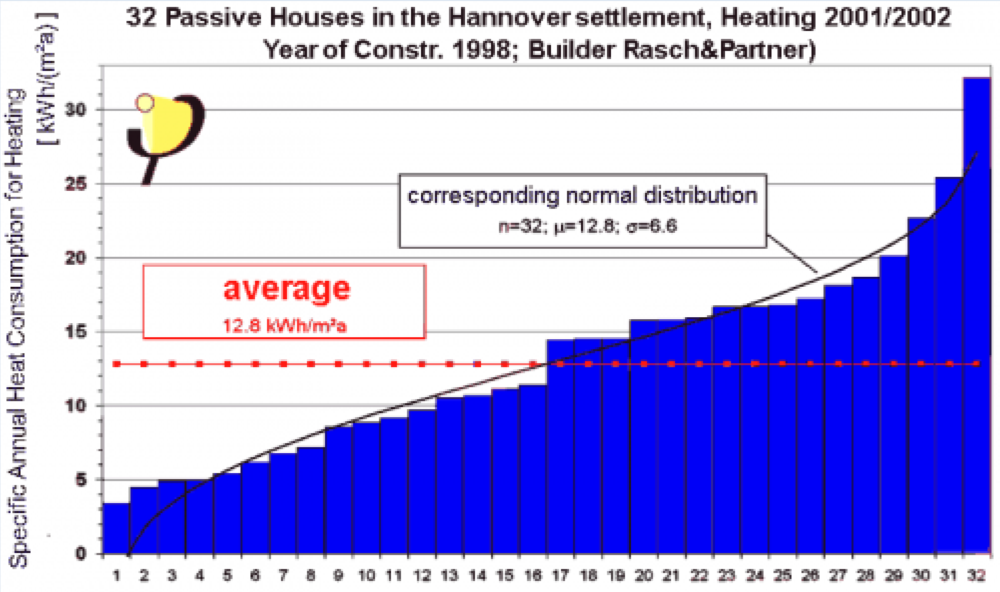
Kronsberg settlement, Hannover, Germany

The Passive House settlement in Hanover/Kronsberg consists of 32 essentially identical terraced houses built as mixed constructions, according to the Passive House Standard. The settlement was built in 1998/99 and all units were designed individually. The figure below documents the heat meter readings in the heating season of 2001/2002. The average value is 12.8 kWh/(m²a). The

consumption in this Passive House development is therefore about 81% less than that of the low-energy development in Niedernhausen.

As a result of the continuous monitoring, started in the complex since its construction, it was found that the relative average annual energy consumption for all the monitored passive houses decreased each year as follows: 14,9 kWh/m² (1999/2000), 13,3 kWh/m² (2000/2001), 12,8 kWh/m² (2001/2002). The expected consumption during the preliminary calculation of the energy balance in the design phase was 13,5 kWh/m²/a.

Figure 3 - Summarised results of the continuous monitoring of the first complex of 32 passive houses in Hannover (Source: Passive House Institute, Darmstadt, Germany)



Hannover Municipality

In order to ensure the achievement of the ambitious 2020 target for reducing CO_2 emissions by 40% compared to 1990 levels, the Hanover Municipality introduced a precise monitoring system. The most important instruments of the monitoring are periodic audits, differentiated to account for the emissions from energy and transport sectors. Through these audits, it was possible to identify and reduce the energy consumption for heating, to speed up the penetration of renewable energy sources, and to increase the number of decentralised units for Combined Heat and Power (CHP).

Limited Profit Housing Associations (LPHA)

The LPHA in Austria comprise altogether 190 housing co-operatives, private- and public-limited companies, accounting for a housing stock (rental dwellings and owner-occupied apartments) of 865,000 units, equal to 23% of the total housing stock. These associations offer affordable apartments for large groups of the population, as their main advantages are the security and predictability of costs, resulting from the professional building management and the continuous monitoring on energy consumption. Notwithstanding the relatively low limit profit margins (3-4%

per year), many of these companies have achieved strong financial positions and, with their significant turnover, contribute to the stability of construction and industry sectors. In turn, the housing subsidies in Austria offer possibilities for the application of innovative building concepts, such as the ambitious energy standards Passive House and klima:aktiv, actively used by these associations. They not only contribute to the achievement of climate and energy policy objectives, but they also became role models for the other participants in the housing market.

Lodenareal, Innsbruck, Austria

The Lodenareal residential complex in Innsbruck includes 354 apartments built according to the Passive House standard. The energy required for its operation is provided by solar thermal installation and wood pellet boiler. Continued monitoring of the complex has been performed since its commissioning, demonstrating in this way an almost perfect match between design and actual energy consumption.

Information dissemination and communication

Currently, the Programme is supported by a general advertising and information campaign that should continue in the next stages of the implementation. As a result of awareness raising and organisational efforts, more and more homeowners' associations should join the Programme.

New:

To ensure strong and sustainable public support for the Programme, especially from the most directly concerned actors in its implementation – the individual homeowners, the general advertising and information campaign has to be supplemented with

> **a targeted (clearly addressed), understandable and informative communication campaign involving all the key stakeholders of the Programme.**

The communication must be based on clear, concrete and properly addressed messages in order to explain scope, objectives and expected effects of the Programme, the time horizons of its implementation, and the roles of the various participants, including municipalities and individual homeowners. The communication campaign should be supported by the Programme and actively involve municipalities and local NGOs. For this purpose, it may use the capacity of newly established municipal offices and expert teams managing the Programme activities. The messages from national media should be reaffirmed at local level and explained in a direct communication between local experts and potential beneficiaries.

Necessary additional actions:

a) To develop and ensure the implementation of a medium-term communication programme (up to 2020) targeting the main beneficiaries of the National Programme and institutions and individuals directly influencing its decision-making process and public perception. On the one hand, these are the individual homeowners and their associations; on the other hand – the

national, regional and professional media, NGOs, industry and professional organisations and building professionals (energy auditors, designers, contractors).

b) To develop and begin the implementation of a short communication plan (for the period 2017-2018).

c) To actively publish and explain the results of the pilot projects using them as inspiring examples for the other occupants. The entire renovation process - from the decision at the owners' meeting until the completion of the construction activities and the dispatching of the first heating bills – should be objectively and reliably presented in the communication materials.

d) To develop supporting information, materials and guidelines for municipalities and owners of apartments, such as instructions to access the different sources of financial support.

e) To explain the newly introduced incentives for projects with higher energy and environmental objectives, emphasising the immediate benefits and the long-term effects for the end users.

BEST PRACTICES

The Ice Challenge, Belgium

The event "Ice Challenge" was organised in Brussels and Antwerp. It aimed to show the benefits of better building insulation. Two ice blocks weighing about 1300 kg were placed in two separate improvised bungalows - one insulated according to the Passive House standard and the other one without insulation. Both bungalows were located next to each other in the main streets of the cities in the summer months. The curious citizens were prompted to guess the time the two ice blocks would have taken to melt. After 40 days, more than 450 kg of ice remained in the well-insulated bungalow, while in the non-insulated one, the block of ice melted completely after only 11 days. Citizens who guessed the outcome right were offered useful free consultations on how to save energy in their homes.

Sustainability of the Programme

Currently, the first stage of the Programme is being conducted, while the next stages are not yet defined in detail or disclosed. This makes the Programme unpredictable to the potential participants and undermines its credibility.

New:

In order to achieve the sustainability of the Programme, thereby ensuring a long-term implementation of its objectives and results,

the predictability, reliability and verifiability of the achieved results must be secured, and the risks pertaining to the implementation of the Programme must be minimised.

The decisive condition for its success and sustainability is to build public confidence in it. For this purpose, it is necessary to create and widely disclose a long-term strategy with a roadmap for the renovation of the residential building stock, with clearly defined parameters and deadlines that will also be at the centre of an active public information campaign. Special emphasis should be placed

on the work with children and students, who, with the help of the Programme, could be educated on the efficient use of resources (in particular energy) and on the maintenance of buildings and adjacent areas.

Necessary additional actions:

a) To provide the conditions for a transparent and predictable medium- and long-term development of the Programme by widely promoting its main strategic objectives and related documents (long-term strategy, roadmap, etc.).
b) To create the conditions to reliably report and verify the results and the effects coming from the implementation of the Programme, with a view to a further deepening and exploitation.
c) To plan periodic updates of the legal basis for energy efficiency in buildings, in accordance with the European Energy Performance of Buildings Directive.
d) To refine the energy efficiency standards related to the renovation of existing buildings.
e) To prepare a medium-term (until 2020) plan for the mitigation of potential risks harming the Programme.
f) To prepare a programme for the structural reinforcement of buildings including:
   - A description of the eligible measures for strengthening the structures and the rules for their evaluation, planning and financing;
   - Measures to promote the construction and/or replacement of building heating systems with the introduction of renewable sources (solar and geothermal energy and biomass) and individual metering of energy consumption.
g) To prepare a programme for multiplying the environmental effects of the energy efficiency activities, including:
   - A comprehensive programme to limit air pollution from fine particles through an increase in the energy efficiency of residential buildings and introduction of environmentally friendly and highly efficient appliances for heating and DHW production with renewable energy, including advanced technologies for heating by wood biomass.
   - A plan to restrict the use of electricity for heating and replace it with other types of ecological heating sources.
   - National standards for highly efficient appliances and biomass installations with a view to an optimal utilisation of the existing ones and to minimum environmental impacts (in the form of CO_2 and particulate matter).

BEST PRACTICES

Cesena Municipality, Italy

In the municipality of Cesena (Italy), a series of events to educate and inform children, students, parents, and teachers were organised in the last few years. The main goal of these events is to provide information about the actions of the municipality to implement energy efficiency and renewable energy measures and solutions. Thus, along with the increased awareness, more trust in the municipality’s policies and practical activities is gradually established. Under this initiative, many workshops with students from primary schools and evening meetings in the neighbourhoods were conducted. Thanks to the organised entertaining games and competitions, the attention of all social groups was attracted.

Future orientation of the Programme

The refurbishment of residential buildings will significantly improve the appearance of urban areas, having this way a strong educational effect on the residents, especially on the younger generation. However, in some parts of the cities, the renovated buildings could be in conflict with the neglected open spaces around them. After providing an initial boost to the renovation of buildings,

> **central and local public authorities should focus on the adjacent urban areas, for whose maintenance they bear sole responsibility.**

With the reduction of public support for the refurbishment of private dwellings, the responsible authorities must increase their efforts to renovate the common open spaces around the buildings. Thus, an overall improvement of the conditions and comfort of habitation, both within the dwellings and in their surroundings, will be achieved. It is appropriate to introduce tools for linking the obligations of the municipalities for the renovation and maintenance of the open spaces around the buildings with the obligations of the residents to renovate and maintain their own buildings.

ANNEX 4 – FINANCIAL TOOLS

Tools applicable to finance the National Programme for Energy Efficiency in Multi-family Residential Buildings in Bulgaria

Introduction

The renovation of the existing residential stock requires significant State support in the form of direct or indirect subsidies and other incentives. Through the currently implemented "National Programme for Energy Efficiency in Multi-family Residential Buildings", a 100% State subsidy is provided and fully ensures the necessary funds for the renovation of qualifying condominiums.

This exceptional State support is intended to give initial impetus to the renovation process which, through the positive examples achieved, is expected to continue to accelerate and deepen in the future, with decreasing State participation.

From 2017 onwards, the State subsidy under the "National Programme for Energy Efficiency in Multi-family Residential Buildings" is envisaged, thereby requiring a financial contribution from participating building owners. To create the conditions for this without slowing down the pace and scope of the Programme and in order to gain access to financial resources with lower interest rates and favourable conditions, improved financing opportunities for building owners will have to be created. Currently, the financial markets offer instruments for small projects, including projects for energy efficiency. These, however, should undergo significant further development to match the needs of the "National Programme for Energy Efficiency of Multi-family Residential Buildings".

There is particular public interest in the renovation of buildings to ever higher energy classes - B, A and nZEB, for which the owners have to provide the necessary additional funding. The interest of the owners coincides with the public interest for maximum energy savings and positive impact on the environment. That is why there are reasons to accept the following guiding principle when considering the financial instruments intended for the renovation of the existing building stock: the State support should be proportional to the results achieved or **the higher energy class achieved and the bigger energy saving realised, the greater the degree of State support would be.**

Based on this principle to encourage deep renovation of residential buildings in line with the spirit and requirements of the Energy Performance of Buildings Directive (2010 recast), various incentives are introduced and widely applied in developed EU countries. Following this basic principle, the results of the analysis of the financing opportunities for the Programme for the renovation of residential buildings in Bulgaria are presented further below. The subject of the analysis is both the existing tools in the country, but also other instruments that are widely used in European countries and could be adapted to the specifics of the Bulgarian Programme.

Existing financial tools

National Trust EcoFund (NTEF)

The National Trust EcoFund was established in 1995 through the Environment Protection Act. It manages dedicated funds provided by the State budget, including the swaps "Debt for Environment" and "Debt for Nature".

The NTEF funds are also raised through international trade of GHG emissions with Assigned Amount Units (AAUs), sales of quotas of GHG emissions from aviation activities, as well as funds made available under different agreements for environment protection of the Republic of Bulgaria with international, foreign or Bulgarian financial sources. The basic revenue sources of NTEF are:

Sale of emissions from aviation activities. According to Art. 56, para. 2 of the Climate Change Mitigation Act (CCMA) "*The revenues from the sale of quotas for aviation activities are deposited in the budget of the Enterprise for Management of the Environmental Protection Activities (EMEPA) and can be spent by the National Trust EcoFund according to a procedure established by the Minister of the Environment and Waters*". In this case, Art. 22, para. 2 is applied. The practical realisation of this function depends on the timely adoption of the bylaw.

Sale of quotas from installation activities. This is just a theoretical option (non-guaranteed revenue source), which arises from Art. 58, para. 2 of CCMA: "*The procedure and spending of revenues under para. 1 and Art. 57 is determined by Government decree*". The practical realisation of this function depends on the timely adoption of the bylaw and the specific projections for NTEF that will be included in it.

Sale of annual quantities of emissions. The management of funds from the sale of annual assigned emissions shall be governed by Art 3, §. 2 of Decision No 406/2009/EO. According to Art. 67, para. 6. Revenues from this trade are deposited in the budget of EMEPA and are spent through NTEF in accordance with Art. 22 of CCMA.

Other funds. The management of other funds - obtained from governments and international financial institutions as well as other donors for environmental protection purposes in the Republic of Bulgaria - is a function of the fund, which derives from the Environment Protection Act (EPA). It gives NTEFT ample opportunities for financing projects in virtually each environmental sector in Bulgaria and turns it into the main funding mechanism out of foreign sources in the environmental field.

Practices of NTEF

Upon completion of the "Debt for Environment" swap, NTEF funded 100 investment projects and provided more than 26.5 million BGN. Thanks to this, the fund has become the decisive factor for the mobilisation of another 115 million BGN from other, mainly foreign, sources for the implementation of projects related to environmental protection in Bulgaria. At the end of 2011, two deals for the sale of Assigned Amount Units with the Republic of Austria were made, according to Art. 17 of the Kyoto protocol. By the end of 2014, under the two deals, 40 public projects amounting to 27.4 million BGN were implemented. The financial participation of NTEF in these projects amount to 23.3 million BGN.

Energy Efficiency and Renewable Sources Fund (EERSF)

The Energy Efficiency and Renewable Sources Fund (EERSF) was established with the Energy Efficiency Act in 2005 with the support and financial participation of the Global Environmental Facility (GEF), the World Bank and the Bulgarian Government. The initial capital was supplemented by donations from the Austrian Government and several private donors.

The main advantages of the fund, in comparison with other not specialised financial institutions, are:

a) The availability of its own high technical capacity for evaluation of energy efficiency projects;

b) Accumulated experience in quality assurance and monitoring of project implementation; and

c) Experience in organisation and conduct of monitoring of the project performance after the implementation of energy efficiency measures.

The current rules of the Fund allow funding for complete renovation of both single and Multi-family buildings at preferential interest rates. For Multi-family buildings, the Fund offers guarantee schemes for complete renovations. For complete renovations of buildings, EERSF also provides portfolio guarantees for individual bank loans by apartment owners. The scheme is welcomed by commercial banks and can be applied for lending to all apartment owners, including households that are not creditworthy by the standard criteria.

Practices of EERSF (2006-2015)

Single family residential buildings. So far, several projects have been discussed, but none has reached practical realisation. The main reason is the current parallel credit line of EBRD intended for private households which provides a 20% grant. However, opportunities in this respect still remain.

Multi-family residential buildings. EERSF offers financing and a guarantee scheme for complete renovation of multi-family residential buildings. So far, together with the United Nations Development Programme (UNDP), one project has been successfully funded. The loan is granted to ensure the 20% participation of dwelling owners. The loan has been repaid in full, which is why there is reason to believe that similar funding is possible in the future.

Residential Energy Efficiency Credit Line of EBRD (REECL)

The credit line was opened for the first time in 2005 and is expected to be reopened in April 2016 with a budget of 20 million euro and an additional subsidy of 3 to 4 million provided by the Kozloduy fund.

> **Residential Energy Efficiency Credit Line (REECL):** http://www.reecl.org
>
> The credit line for energy efficiency in households was opened in 2005 and ended its first stage in January 2010. 24,362 projects for energy efficiency in households were funded by the end of 2009. Among them, projects for energy saving windows (45.2% of the total volume of loans) and heat pumps (27.5%) prevailed. The equivalent of electricity savings from the projects' implementation was about 182.7 GWh per year. The continuation of the credit line for energy efficiency in households started in mid-2011 and ended in 2015, when the funds were fully depleted. The third stage of the same credit line starts in 2016.
>
> Each household or association of home owners that get loans under the REECL programme has the right to a 20% or 30% grant (when the renovation of the multi-family building is collective) of the cost of the energy saving project funding, but only after it is successfully completed and all the requirements of the programme are fulfilled.
>
> Loans and grants are awarded to fund: energy efficient windows, gas boilers, heaters, stoves and biomass boilers, solar panels for hot water, heat pumps for cooling and heating, etc.

In 2016, REECL is expected to give loans and subsidies up to 20% for mortgage loans for the construction of residential multi-family buildings and single family houses as well as for the renovation of buildings in order to achieve higher energy classes: B or A. The loans will be lent by commercial banks while subsidies will be provided by the updated REECL programme for energy efficiency through the Kozloduy fund. The construction of zero-energy buildings or buildings with a high energy performance (class A or A+) will be encouraged. Projects aiming to reach the highest levels of energy savings, A or A+, are expected to receive a higher percentage of subsidy. Upon completion of the basic construction works, the hiring of a specialised company to install better insulation, windows and doors, solar panels for hot water or photovoltaics on the roof will be possible. This could be done under contract between the building owners and specialised companies for energy services (ESCOs). Compared to the previous stages of the programme, the grant for general renovation of multi-family residential buildings is reduced from 30% to 20%.

New financial tools

Repayment together with other payments

Currently, the Bulgarian legislation does not permit other payments to be collected along with taxes and fees as well as with energy bills. Such practices are however widespread in other European countries. That's why they must be carefully investigated to allow the identification of opportunities for their implementation in Bulgaria and also the evaluation of possible consequences. For this

reason, it is necessary to initiate certain partial amendments to the current legislation. These changes will be additionally facilitated when the energy traders begin to offer energy services. To ensure the sustainability of implementing these financial tools, measures should be taken to accelerate the reconstruction of the building internal pipe distribution system. This will allow the introduction of individual (for each apartment) registration and billing of the energy consumption.

On-bill payment of energy consumption

The potential for investment repayment through this tool is considerable and can be easily applied to buildings connected to central heating systems (district heating or gas distribution systems) and particularly to cases when opportunities for individual (for each apartment) billing of energy consumption are provided. Under the Energy Efficiency Act, energy traders are obliged and must prove significant annual energy savings as a result of the energy services provided to end users. The Sustainable Energy Development Agency (SEDA) has calculated that about 551 million BGN should be invested through this requirement by 2020. This resource is obviously significant and its rational use is compulsory.

Repayment at local taxes payment (for buildings, litter)

This tool is relatively easy to apply in all types of buildings. However, its introduction can cause some public opposition. That is why it should be explained to home owners that after building renovation, although the repayment would be added to their taxes, the real household expenditures will not increase as they will have already achieved the savings from their energy expenditures. On the other hand, through the significant subsidy provided by the State for the renovation of the building, the market value of their property would actually increase. There is enough ground to believe that, this way, at least part of the investments in private properties may return to the State budget, generating sufficient resources to continue the Programme for the benefit of other Bulgarian households.

Repayment through energy service contracts

Agreement for energy services

To fulfil their obligations under the Energy Efficiency Act and the Energy Performance of Buildings Directive (2012/27/EC), energy traders must provide services achieving energy savings of 1.5% of the annual volume of their sales. Savings of such big volumes can be achieved mainly in residential buildings as many of the public buildings have already been renovated. This instrument is easily applicable to both single and multi-family buildings. If the energy traders do not invest directly, they are obliged to make a contribution to the Bulgarian EERSF or to other similar funds that in turn will carry out the investments. The contributions made by the energy traders to the EERSF could be used to provide subsidies for the achievement of higher energy classes of buildings. This scheme can be most easily applied by the suppliers of electricity and natural gas which have the technical capacity to cease deliveries if the end users do not pay their bills. With district heating enterprises, the application of this tool will be facilitated with the provision of reliable forms of individual metering of energy consumption.

Public energy service companies (super ESCOs)

It is possible to establish public (State or municipal) companies for energy services (ESCOs), that can fully or partially reimburse the funds invested on account of the savings achieved. This tool is applicable to all types of residential buildings, but it's more efficient in the case of multi-family residential buildings. The comparatively small value of projects in single family houses can increase the administrative costs and make monitoring more complicated. This impact can be mitigated with proper grouping and bundling of projects. The *energy relief* (State subsidies for low-income family) can be integrated into this scheme as well. Households that receive energy relief will pay only for the consumed energy and not for the investment. In this way, the energy relief would be transformed into an investment. *Energy traders* can work in a similar way when they offer energy services to their customers.

Private energy services companies (Energy Performance Contracts)

The private companies for energy services can work both with single and multi-family residential buildings. In this case, the small size of the projects for single family houses will also increase the administrative costs and will make monitoring more difficult. With proper bundling of the projects, however, these difficulties can be considerably mitigated. The administration of such projects can be significantly facilitated if the buildings (also the multi-family ones) are managed and maintained by specialised *companies for facility management*. These companies can be included in the energy services contracts while, at the same time, they maintain the buildings and their systems, collect the heating, electricity and gas bills and monitor the energy consumption. The fairness of the accounts can be guaranteed by the introduction of individual (for each apartment) metering for energy consumption.

Civil funding

(Mutual fund for energy efficiency measures)

As the basis for creation of the tool for civil financing, the "Repair and Renovation" funds, which each condominium is bound to create in undertaking the Condominium Act, can be used. These funds are inherent mostly for multi-family residential buildings and are expected to act as mutual funds for the corresponding condominiums. In some countries (Slovakia, Germany), the resources from such funds are used for the reconstruction and renovation of multi-family buildings. There are valid grounds to believe that in Bulgaria, after the accumulation of enough resources, these funds will be used to provide co-financing from dwelling owners in projects aiming for complete building renovations. The realisation of this scheme will require the concentration in selected depository banks of the separate "Repair and Renovation" funds for multi-family residential buildings. This way, a considerable amount of temporarily free funds may be accumulated on a national scale. These funds can provide low-interest loans at preferential terms and without requirements for collateral. This tool will remain outside the regulation of the bank financing, as the risks will be borne by the aggregated fund for repairs and renovations. In this form, the aggregated fund can be managed as an NGO.

National Guarantee Fund (NGF)

To attract the local commercial banks and other private partners to finance renovation of the residential building stock, it is appropriate that the State, with the help of the Development Bank, creates a National Guarantee Fund for the renovation of residential buildings, similar to the current one for small and medium size companies, which provides guarantees up to 1 million BGN or up to 50% of the loan amount. This fund should accumulate and cover (to some extent) the losses caused by the non-payment of instalments on loans for individual buildings (private property). It can be assumed that arrears and non-payment of the loans will not exceed 15% of the portfolio. The establishment of such a guarantee fund will correspond to the spirit and intent of the Juncker Plan for the creation of incentives for investments when the national development banks are involved. The following results are expected to be achieved:

a) Mobilisation of substantial financial resources from citizens, which currently mature passively in commercial banks at interest rates that do not even cover inflation;

b) Easier access to financing for the self-participation of building owners involved in the "National Programme for Energy Efficiency of the Multi-family Residential Buildings";

c) Incentives for building owners who choose higher energy efficiency classes (B, A, nZEB) for their projects and achieve significantly higher long-term savings;

(d) Savings in budget funds, which will allow the renovation of more buildings and larger residential areas;

e) Bigger energy savings and higher comfort of living.

The losses covered by the fund can be compensated by money from the sales of CO_2 emissions resulting from the implemented energy efficiency projects. For this purpose, it is necessary to seek the maximum effect of the projects, i.e. maximum energy savings and hence greater CO_2 emissions reductions.

European Fund for Strategic Investments (Juncker Plan)

Currently, the possibilities to provide investments for the renovation of the private residential building stock through the Fund for Strategic Investments of the European Union (widely known as the Juncker Plan) are actively discussed. On March 17, 2016 the European Builders Confederation (EBC) and in particular small and medium size construction companies together with the International Union of Property Owners (UIPI) initiated an international discussion to promote private investments in small scale energy efficiency renovations of residential buildings. The European Fund for Strategic Investments was created with the idea to overcome the market inefficiencies, at the same time avoiding overlapping with other financial tools.

In order to support private investments, the Fund needs good coordination and appropriate sustainable projects. The participants in the discussion perceived the Juncker Plan as a promising tool to support the modernisation of the private residential stock and expressed their readiness to start gathering projects for renovation. To motivate specific investment decisions accelerating the

renovations in the private residential sector, this new tool should be supplemented with an appropriate combination of incentives aimed at individual owners and landlords. In Europe, there are hundreds of thousands of building renovation projects that require appropriate funding. This is also the case where a niche for co-financing the Bulgarian "National Programme for Renovation of Multi-family Residential Buildings" can be found. If coordinated with the Juncker Plan, the National Programme may find its rightful place among the best European practices, which in turn may attract the interest of international investors.

Promotional tools (incentives)

A system of appropriate incentives to encourage both property owners and potential foreign investors must be developed and implemented to achieve sustainability in the growth of private investments for the renovation of the existing residential building stock. This is a long term task that should be started immediately. At the same time, the already created tools must undergo constant monitoring and evaluation with the aim to maintain and update the effectiveness of their impact.

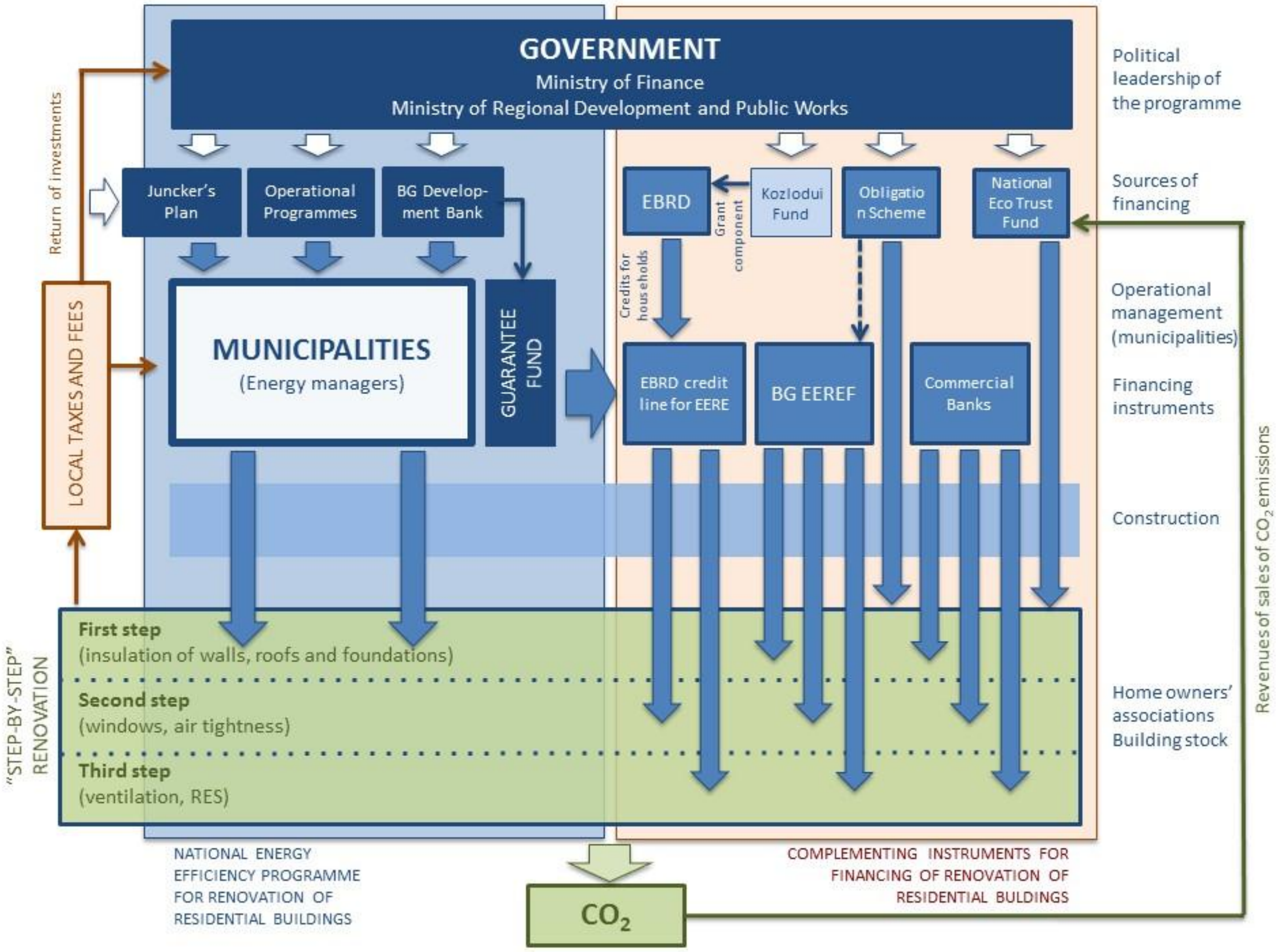
Sample financing scheme

The survey of financial tools and the possibilities for their combination with other means of funding gives reason to believe that the organisation of the management and use of public and private financial flows targeted to the "National Programme for Energy Efficiency of Multi-family Residential Buildings" can be immediately created. A model organisation of the two streams that can be enriched with new tools and mechanisms in the future is shown in the following scheme (Figure 19).

On the left part of the scheme, the financial streams that are directly controlled by the State are shown, and on the right side – those connected with private or public-private sources. The funds that are directly controlled by the State (to the left) are proposed to be used in coordination with the "National Programme for Energy Efficiency of Multi-family Residential Buildings" in the first stage of the renovation process, while the other sources can finance the individual steps (measures) that are implemented in the next stages.

Figure 19 -Sample financing scheme

The National Energy Efficiency Renovation Programme for Multi-family Residential Buildings with an increasing financial contribution from home owners.



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