ENERGY EFFICIENCY IN POLAND
2017 REVIEW

SINGLE-FAMILY HOUSES
SMOG

WHAT SHOULD THE NATIONAL PROGRAMME FOR THE MODERNISATION OF SINGLE-FAMILY BUILDINGS BE LIKE?

WHAT RENOVATION NEEDS DO POLES HAVE?

HOW MUCH CAN THE MODERNISATION OF POLISH HOUSES COST?

HOW CAN THE MODERNISATION OF POLISH HOUSES BE FINANCED FROM THE EU ETS FUNDS?

HOW DOES THE MODERNISATION OF SINGLE-FAMILY BUILDINGS IMPACT THE LABOUR MARKET?

Institute of Environmental Economics

Efficient Poland

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INTRODUCTION
WHY IT IS WORTH READING THE "REVIEW" FROM COVER TO COVER

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"Energy Efficiency in Poland. 2017 Review" focuses on the most important challenges relating to energy efficiency in Poland at the turn of the 20th and 21st centuries – the problem of smog and the modernisation of single-family buildings.

For the past few years we have been persuading successive governments to start dealing with the issue of single-family building modernisation and the problem of low quality coal burnt in obsolete "smokers" which is directly linked with the problem of smog. In 2015, we managed to persuade the National Fund for Environmental Protection and Water Management to launch two key programmes addressing the issues of energy efficiency: *NF15/NF40* and *Ryś* (Lynx).

NF15/NF40 set the technical standards for energy-efficient buildings and *Ryś* initiated a discussion about a programme for the modernisation of single-family buildings. An amendment to the Thermal Modernisation Act announced at the beginning of 2018 is to take into account the specificity of single-family building sector and prepare support for people affected by energy poverty.

If the situation is so good, why write about it then? Well, it is not as good as it might seem. The implementation of *NF15/NF40* and *Ryś* was suspended abruptly under a trivial pretext and the government has announced its plans (hopefully only temporary ones) to establish a support programme targeting 10% of the poorest owners of single-family buildings and leaving the remaining 90%

of them out of sight. So what kind of programme should be put in place for the remaining 90%? Whom should it be addressed to? What kind of support instruments should it provide for and which international examples should it be based on?

Our goal is to provide a sound knowledge base for the establishment of effective support mechanisms. We would also like to continue the discussion about challenges and possible lines for action in the changing political, economic and legal environment. We do not present ready-made solutions as these should be worked out by the relevant officials and politicians who will sign them and ensure that they are implemented with the active involvement of us all.

A brief overview of the issues discussed in the following chapters is provided below. We hope you find the Review interesting to read.

National Programme for the Modernisation of Single-Family Buildings – what elements should it contain and why should it place particular focus on the needs of rural populations? The arguments presented relate, among others, to the advantages of the proper use of biomass, and to the fact that while the income levels in rural areas are often high enough, it is in these areas where the problem of poverty is the most serious. This chapter also deals with support mechanisms aimed at the owners of single-family buildings indicating the appropriate target groups.

In 2017, Institute of Environmental Economics once again commissioned research to analyse the single-family building market situation in Poland. This type of research is necessary for the adequate understanding of thermal modernisation needs. Particular emphasis was put on issues related to the heating of single-family buildings, which is crucial for the quality of air in Poland. The research shows, among others, that obsolete coal-fired appliances continue to be the main source of heating in Poland and that the majority of single-family buildings do not have access to a gas network. A novel finding was that people living in rural areas rely in fact on a double-fuel system – a substantial amount of biomass is burnt in coal-fired boilers. Decision-makers

will soon have to find answers to questions on how to establish a programme which, on the one hand, provides for heat source replacement and, on the other hand, takes into account the limited access to gas networks and the widespread access to biomass in rural areas. It is worth pointing out that 40% of Polish buildings are not insulated at all. Our respondents were also asked if they were planning to have their heat source replaced – the answers show that quite a lot of them have such plans. Furthermore, it is notable that nearly 50% of the respondents would be likely to have their old heating systems replaced without any subsidies – so what prevents them from making the decision? This is a good question and the answer is worth PLN 100 billion, i.e. the amount necessary to finance the modernisation of single-family buildings... The research was prepared by IEE/CEM and conducted by CEM Market and Public Opinion Research Institute.

If someone asked us to name one source from which the buildings modernisation programme should be financed in Poland, we would definitely choose the ETS funds. These funds are available to the Polish government but they are practically "appropriated" by the power sector. Not only is it highly unfair, but also ineffective. If only some of these funds were used to finance buildings modernisation, the environmental effect would be much better than the one resulting from the currently planned measures. Aleksander Śniegocki from WiseEuropa writes about the fact that the ETS funds are more than sufficient for meeting the modernisation needs of Poles. In my opinion, very good solutions relating to buildings modernisation were adopted by France in 2012. Incidentally, France is used as an example to follow as regards the use of these funds to create comprehensive support programmes based on loans, tax exemptions and subsidies. But the success achieved by France relies on ETS*!

In the chapter on "The assessment of labour demand generated by single-family buildings modernisation projects implemented in the voivodships of małopolskie and śląskie", the IBS team headed by Piotr Lewandowski

* https://www.openexp.eu/posts/financing-energy-renovation-we-need-re-think-our-approach

discusses the effects of modernisation projects on the labour market. This problem may not seem so important in larger cities but it is still politically significant in poorer and less urbanised areas. The analysis focused on two voivodships in which regional anti-smog resolutions (local laws) were passed. It should be presumed that the shift from coal, waste and biomass to more expensive technologies and heat sources will contribute to an increased economic activity. The authors answer the question concerning the impact of modernisation projects on the labour market.

NATIONAL PROGRAMME FOR THE MODERNISATION OF SINGLE-FAMILY BUILDINGS

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BACKGROUND

The Institute of Environmental Economics (IEE) started undertaking efforts to have the single-family building sector taken into account in government documents and programmes back in 2014. Two major changes took place between 2014 and 2018 – so far reflected mainly in the public awareness but also in the attitudes adopted and statements made by politicians. Firstly, single-family buildings have been noticed and taken into account in government energy efficiency strategies. Secondly, energy efficiency has been linked with the issues relating to air quality.

The publication of *Buildings Modernisation Strategy: Roadmap 2050* and the meeting of the managing bodies of the National Fund for Environmental Protection and Water Management (NFEP&WM) and BGK (2014), during which it was clearly concluded that the National Thermal Modernisation Fund was not fit for the purpose of supporting single-family building sector, played a key role in drawing more attention to the problems concerning single-family buildings. After the meeting, NFEP&WM management decided to implement *Ryś* (Lynx), a subsidy programme addressing single-family buildings, which was

created in cooperation with Efficient Poland (an initiative started and moderated by IEE) on the basis of the *Buildings Modernisation Strategy: Roadmap 2050*.

The pilot phase of *Ryś* was launched in 2015 but the new management of NFEP&WM refrained from further implementation soon after the parliamentary elections that were held in the same year. The reason stated for making such a decision was limited interest from the banks that were to take an active part in distributing the programme (customer acquisition and service). This lack of interest from the banks (including even the Bank for Environmental Protection (BOŚ) run by NFEP&WM) was due to the fact that NFEP&WM failed to provide for any bonuses for programme distribution, incorrectly assuming that commercial institutions would in fact distribute the programme for free. The programme itself has raised significant interest from potential beneficiaries and has been noticed both by the market and the politicians, as proven by a large number of applications submitted with NFEP&WM in Kraków.

As far as single-family buildings modernisation and air pollution prevention are concerned, the period between 2016-2017 can be described as the time of discussions, political declarations and preparations for the implementation of a new nationwide programme (as part of the project run by the World Bank).

In 2017, Efficient Poland Initiative presented a proposal of the National Programme for Buildings Modernisation. Heading Towards Low-Carbon Economy* to the government. We were also actively involved in the evaluation of the functioning of the Thermal Modernisation Fund (it was still necessary to emphasize that this instrument failed to address the needs of the single-family building sector).

Although no specific solutions were introduced between 2015 (implementation of the pilot phase suspended) and the end of 2017, the government's work is underway and the programme is likely to be re-launched in 2018.

* http://efektywnapolska.pl/wp-content/uploads/2017/09/National-Program-for-Buildings-Modernisation-2017-IEE-EP.pdf

RENOVATION, THERMAL MODERNISATION? MODERNISATION!

A renovation involves restoring the building to its previous state of repair, modernisation involves changing or improving building's functionality (e.g. adding an extra storey), whereas thermal modernisation is in fact a combination of renovation and modernisation aimed at decreasing energy consumption. The scope of thermal modernisation is narrower than the scope of modernisation as the former does not involve, for instance, a flat roof renovation or customization, but only its insulation against heat loss. **In the context of single-family buildings, focusing on thermal modernisation only (heating system replacement/ modernisation and improvement of building envelope insulation) is often rather short-sighted and can lead to an unnecessary reduction in the scope of works.**

It is also possible to use another, operational definition of thermal modernisation: thermal modernisation involves activities specified in support programmes (Thermal Modernisation Fund, Operational Programmes)*. The problem with defining the scope of works is well illustrated by the roof renovation dilemma – attic owners often delay having their roof insulated until after attic customization the "side effect" of which is the improvement of building envelope insulation, sometimes even above standard. There are a number of other similar examples: delaying the façade renovation until after garage is sectioned off, delaying the heating system renovation until after the bathroom and/or kitchen is renovated etc.

When it comes to the promotion of activities aimed at reducing emissions, the concept of modernisation is much more accurate in reflecting the specificity of works as we do not usually talk about a simple repair of a heating appliance (an obsolete manually-fed boiler), but about a modernisation of the whole heating system including the improvement/installation of central heating, the supply of domestic hot water (which in turn involves bathroom renovation and modernisation etc.). This kind of modernisation

* Definition of a thermal modernisation undertaking, BGK, 2016. https://www.bgk.pl/files/public/Pliki/Fundusze_i_programy/FTiR/Regulamin_dla_inwestorow.pdf

plays an instrumental part in improving living conditions, reducing emissions, increasing the value of a building and enhancing its energy efficiency*.

It must be assumed that "a thorough renovation/modernisation" of buildings is carried out every 15-20 years, which is related to the technical lifetime of the materials and appliances used (windows, boilers, automatic devices, façade, solar collectors, heat pumps). The cost of such modernisation is quite high as it can reach up to several dozen thousand zlotys.

* The distinction between modernisation and renovation is important for entrepreneurs for tax reasons – modernisation increases the value of a fixed asset and should be amortised and renovation can be included in operating expenses. The distinction does not have a significant impact on private owners of single-family buildings, it should be pointed out though that modernisation is a broader concept.

CRITERIA OF EVALUATION AND TARGET GROUP SELECTION

While preparing a programme for the modernisation of single-family buildings, it is of key importance to properly select the target group, bearing in mind the initial assumption according to which the programme is to be addressed to the owners of single-family buildings. It must be pointed out, however, that the group of single-family building owners is not a homogenous one.

The main differentiating factors that may be useful for preparing support programmes are as follows:

- urbanisation – people living in rural areas have slightly different needs as compared with those living in urban areas,
- wealth/income – the difference refers to the ability to self-finance certain activities,
- concentration of combustion-related pollution – i.e. the extent of exposure to smog,
- modernisation needs – people planning to have their buildings renovated/modernised vs those who do not have such plans.

Legal and financial instruments as well as the institutional structure aimed at each target group should be different. The main instruments for wealthier people should include an attractive loan product, for example, a loan combined with a tax exemption. As for people on lower incomes, the focus should be placed most of all on poverty prevention

(so it is more of a social rather than technical financial or environmental issue). People living in rural areas do not have the same modernisation needs as those living in towns, cities or suburbs. The main differences include: income structure, building's function, source of heat (access to biomass), combustion control possibility (enforceability of regulations), local waste management, pollution levels, building quality (usually self-constructed), way of carrying out renovation works (owners often carry them out on their own without the necessary technical knowledge), sources of support (e.g. Agency for Restructuring and Modernisation of Agriculture). The relationship between pollution concentration and buildings is obvious – buildings heated locally with fossil fuels constitute emission sources, especially during the winter season. In areas where emission limits are exceeded, actions (legal, financial, promotional and educational ones) should be taken to reduce pollution levels.

URBANISATION – URBAN AND RURAL NEEDS

The distinction between urban and rural areas does not mean that one of the groups should be addressed first or ignored – a different approach should just be taken to dealing with each of them. Thinking about single-family buildings has until recently been focused on urban areas. This was due to the impact of these buildings on air quality both in large agglomerations (Kraków, Katowice) and in smaller towns (Rabka, Nowy Sącz). Thanks to the increased number of measurement stations it can be concluded, however, that the quality of air in large cities is strongly affected by the heating methods used on their outskirts. For example, pollution concentrations measured in the vicinity of Kraków are often higher than in the city itself. Therefore, if we are to effectively reduce high concentrations of air pollution in cities, it is necessary to modernise rural buildings.

The vast majority of single-family buildings are located in rural areas.

Number of people in inhabited buildings per type of building in 2011

	Number of people in inhabited buildings	Including: residential buildings	Including:	
			single-family	multi-family
Total	38 121.4	38 005.7	19 474.7	18 531.0
Urban areas	23 184.7	23 123.0	6352.3	16 770.7
Rural areas	14 936.6	14 882.6	13 122.4	1760.3

Source: Inhabited buildings. National Population and Housing Census 2011, Central Statistical Office of Poland 2013

* http://www.dofinansowaniedla-firm.pl/lubuskie/dotacje-na-za-%C5%82o%C5%BCenie-firmy

The Rural Development Programme (RDP)* to support the conversion of residential and non-residential buildings for commercial purposes is being successfully implemented in rural areas. In order for RDP or another similar programme to play a significant role in the National Programme for the Modernisation of Single-Family Buildings, it should contain elements relating to energy efficiency of residential buildings and air protection – which means that renovation works should be planned in such a way as to ensure the best possible effects in these two areas. This goal can be achieved by introducing a requirement for improving insulation and modernising the source of heat (which should preferably be replaced with a low-emission biomass source). Where emission intensive heat sources (a primitive coal-fired boiler in which municipal solid waste is often burnt) are installed in buildings with improved insulation, RDP support should be increased and made conditional upon the replacement of the problematic source.

One of the fundamental differences between urban and rural areas is the use of biomass. Currently, 30% of heat in rural single-family buildings is generated from biomass which may constitute the cheapest and the most environmental frendly source of heating. The programme should not only contribute to the replacement of heat sources but also to the increased use of biomass for heating purposes provided, however, that only low carbon heat sources are taken into consideration.

Heat source replacement should be accompanied by:

- modernisation of the heating system including the installation of a modern automatic central heating system,
- improvement of building envelope insulation.

As far as possible, activities should be carried out comprehensively because synchronising the improvement of building envelope insulation with installation of automatic appliances may lead to a reduction in energy consumption by up to 60-70% (the new source of heat should have much lower nominal power, which is particularly important in the case of biomass boilers due to a relatively low combustion temperature and a high content of water vapour in fumes).

Single-family building modernisation programme addressing the problems of rural areas should on the one hand be similar to programmes aimed at urban areas (e.g. special support should be provided to people affected by poverty) and, on the other hand, it should also contain solutions specifically targeting the needs of rural areas. Specific characteristics of rural areas include:

1. type of buildings – nearly 100% of the rural population live in single-family houses,
2. type of fuel used for heating – around 30% of energy used for heating is generated from biomass, which on the one hand is an example of sustainable use of energy raw materials, but on the other hand, usually leads to increased emissions of air pollutants (due to technical aspects of biomass combustion),
3. building infrastructure – the infrastructure of rural buildings is slightly worse than that of urban buildings (e.g. the difference is notable when taking into account the access to central heating systems),
4. saleability – rural buildings are more difficult to sell, which is why an elderly person living in such a building alone is often forced to live there till the end of his/her life.

Bearing in mind the above-mentioned differences, rural areas require dedicated support provided through the RDP distribution network and relying on its experience, with particular focus on the promotion of low carbon biomass heat sources.

WEALTH

It is the owner of a building who decides whether to invest in its modernisation or not. In Poland, however, owners are faced with a number of obstacles that make the decision-making process more difficult. The decision is often taken on an ad hoc basis, because the "roof is leaking" or the "boiler has broken down" (the owner contacts a repairman and has some minor temporary repairs done).

The main problems relating to the level of wealth of single-family building owners include:

- lack of spare funds for the modernisation,
- poor access to attractive credit,
- insufficient knowledge about the benefits of comprehensive modernisation (possibility to achieve significant savings on energy bills and often a dramatic improvement of living conditions),
- high initial/investment costs – the cost of a comprehensive modernisation may vary from PLN 40 to 80 thousand.

Lack of spare funds, or in fact savings, is a typical problem of the "emerging markets" which still include Poland. Salaries are relatively low and Polish middle class is not very large and poor as compared with the countries of the "old Europe". According to the 2014 report of the Central Statistical Office on the Structure of Wages and Salaries by Occupations, 90% of Poles earn less than PLN 6 917 gross (4 886 net)* (the report assumed that people earning more than that can be classified as wealthy).

* https://stat.gov.pl/obszary-tematyczne/rynek-pracy/pracujacy-zatrudnieni-wynagrodzenia-koszty-pracy/struktura-wynagrodzen-wedlug-zawodow-w-pazdzierniku-2014-r-,5,4.html

Average monthly income per person, average monthly expenditure per person, the share of expenditure in available income in 2004-2015

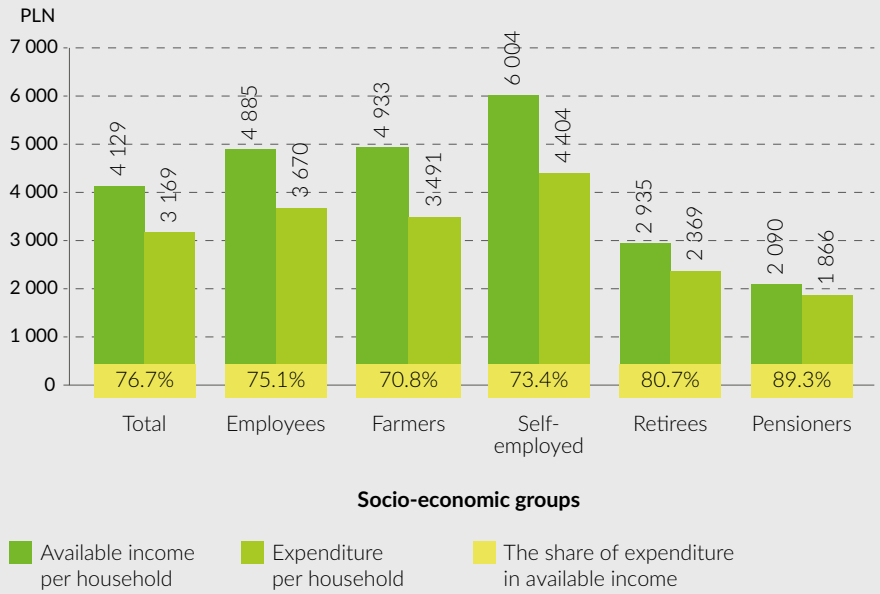
Year	Average monthly income (in PLN)	Average monthly expenditure (in PLN)	The share of expenditure in income (in %)
2004	735	695	94.5
2005	761	690	90.7
2006	835	745	89.2
2007	929	810	87.2
2008	1 046	904	86.5
2009	1 114	957	85.8
2010	1 201	998	83.1
2011	1 235	1 021	82.7
2012	1 278	1 051	82.2
2013	1 299	1 062	81.7
2014	1 340	1 079	80.5
2015	1 386	1 091	78.7

Source: Household budgets in 2014, Central Statistical Office of Poland 2017

The table above shows that the average available income per person in 2015 was PLN 1 386 a month and the average monthly expenditure amounted to PLN 1 091. Low available income means that Poles have difficulty in saving money, which translates into a need for financing unexpected/sudden investments from credit. The majority of loans in Poland are taken for flat/house renovation purposes and the situation has been the same for many years. According to an IPSOS survey commissioned by Wonga, 34% of respondents borrowed money for renovation in 2015, 39% in 2016 and 37% in 2017*.

* Respondents in the Ipsos survey commissioned by Wonga (a payday loan company) included people who had taken a loan of up to PLN 10 000 over the previous two years.

Average monthly available income and expenditure per household and the share of expenditure in available income by socio-ecomonic groups in 2016



Source: Household budgets in 2016, Central Statistical Office of Poland 2017

What follows from the above is the fact that appropriate support mechanisms should be created to address the needs of people who do not manage to save money (those on low incomes or not motivated enough). It is useful to draw attention to the levels of available income in particular socio-economic groups. Available income is the difference between the income and expenditure, e.g. farmers' available income is PLN 1 442. Surprisingly, there is a relatively small difference in available income between the self-employed and farmers, which means that a lot of farmers can afford to pay for modernisation works (but it does not mean, of course, that there are no poor people living in rural areas).

The support should be based on Individual Housing Accounts (IHA)* the aim of which will be to award bonuses for saving up for housing purposes. IHAs should also make it possible to save up for modernisation purposes. Modernisation loans should be made available to people who cannot or do not want to wait until they have saved enough.

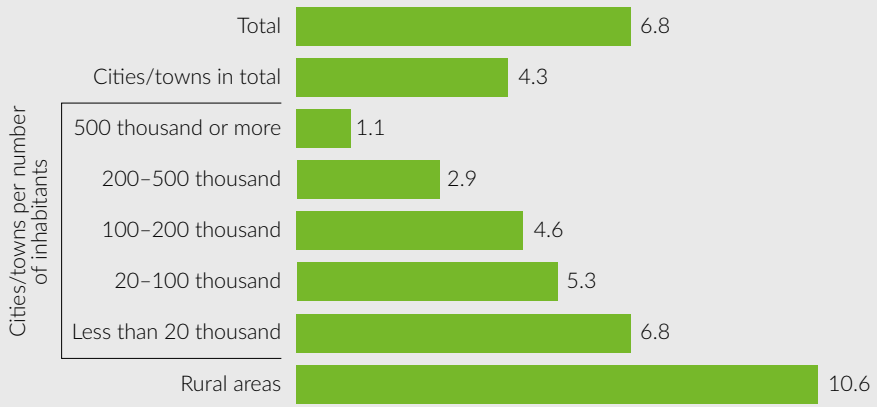
* http://ikm.org.pl/

Both mechanisms should apply to investments which meet basic modernisation criteria:

- reducing heat consumption (improvement of building envelope insulation),
- reducing the emission of gaseous pollutants, especially of particular matter and carbon dioxide,
- reducing electricity consumption through the use of modern equipment (replacement of traditional light bulbs with LED lights, household appliances meeting certain requirements included on the List of Eligible Materials and Equipment (LEME)).

Both IHAs and loans should be accompanied by technical and economic assistance (something like an energy audit combined with investment advice), tax exemptions and comprehensive promotional activities. Only such a large-scale action implemented at the national level should encourage investors to spend money on renovating their houses (instead of buying a car or a holiday abroad).

At-risk-of-extreme-poverty rates in 2012 according to the class of the place of residence (% of people per household)



Source: Poverty in Poland in the light of research carried out by the Central Statistical Office of Poland, 2013

There are several reasons why people on low incomes should receive state aid:

- these are often elderly people battling against ill-health, living in old and poorly heated buildings in need of renovation,
- people on "low incomes"" usually heat their homes with the cheapest fuel or with waste (mining or municipal) thereby emitting a significant amount of pollution into the air.

It is difficult to estimate the exact number of people who should receive aid due to their "low income". The expression "low income" is not precise – people living in rural areas achieve lower income than urban dwellers, but their expenditure is also relatively lower. It also happens that people with low available income have significant assets at their disposal (e.g. a person living on his/her own in a large house in the city centre for sentimental reasons).

Finding a solution to the problem of the least well-off is probably the greatest financial, legal, organisational and social challenge. Unfortunately, the problem of poverty has many aspects and a few different tools will have to be developed in order to address it properly. Particular focus should be placed on the fact that:

- a lot of people experiencing poverty live in rural areas where buildings are often very poorly insulated and young people move to cities,
- the least well-off people do not have spare funds because they spend all their money on satisfying basic daily needs (bills, food).

Subsidies (for investment and maintenance) may serve as suitable support instruments for the least well-off.

SUPPORT INSTRUMENTS
FOR THE MODERNISATION OF SINGLE-FAMILY BUILDINGS

TECHNICAL AND ECONOMIC ASSISTANCE – has a significant (but qualitatively different) impact on individual target groups. Assistance provided to people on the highest incomes should focus on highlighting the advantages of using energy efficient technologies, people on middle-incomes should additionally be made aware of the available co-financing options and the possibility of dividing the investment into stages, and those on the lowest incomes should also be assisted in obtaining subsidies (both in rural and in the most polluted areas).

MODERNISATION CREDIT AND LOANS – with a large-scale programme, commercial credit and loans (maybe state-guaranteed to some extent) should constitute an attractive incentive for people on middle and high incomes (90% of the population).

INDIVIDUAL HOUSING ACCOUNTS – a support instrument for economical people, aimed mainly at those on middle or high incomes who have a financial surplus.

PREFERENTIAL LOANS – should make it possible to finance expensive renovation investments (a solution to the problem of up-front costs). Preferential loans are, for example, partly remitted and granted by such institutions as the Regional Fund for Environmental Protection and Water Management.

TAX EXEMPTION – may refer to VAT or income tax. Income tax exemption will be the most advantageous for people paying the highest taxes. Another solution, more attractive from the social point of view, may be a VAT exemption.

CLEAN FUEL SUBSIDIES – this instrument should be available to people on the lowest incomes who, for various reasons, are unable to have their stove/boiler replaced (the building is not their property, they do not pay the rent, they live in buildings which require a thorough renovation etc.).

STOVE/BOILER REPLACEMENT SUBSIDIES – such subsidies have been available for some time in the voivodship of małopolskie. Their effectiveness is limited in the absence of appropriate regulations banning the use of stoves/boilers in which waste and the worst types of coal can be burnt. Such subsidies should mainly be aimed at people on the lowest incomes.

THERMAL MODERNISATION SUBSIDIES – they should be aimed at promoting comprehensive (!) thermal modernisation that includes heating system replacement and improvement of building envelope insulation; just like stove/boiler replacement subsidies, this instrument should mainly be targeted at people on low incomes. The granting of a subsidy should be made conditional on the comprehensiveness of actions to be taken and the preparation of an "investment plan".

MATERIALS AND EQUIPMENT SUBSIDIES – this instrument is relatively uncommon in Poland; Lists of Eligible Materials and Equipment (LEME), promoted by the EBRD and NFEP&WM, constitute an example. In this case, eligible materials and equipment must meet some specific performance criteria (e.g. a 20% decrease in energy consumption as compared with the "initial situation").

FINANCIAL PRODUCTS DISTRIBUTED WITH ENERGY BILLS – these can include, for example, loans for the purchase of energy efficient appliances. This type of financing is not popular in countries where energy distributors are actively involved in financing and promoting energy efficiency. Financing the replacement of traditional light bulbs with LED lights is among the most popular programmes. Linking a financial product with energy bills has

many advantages, e.g. it may significantly reduce the cost of the financial product (due to low customer acquisition costs and limited risk).

SUPPORT PROGRAMME FOR RURAL AREAS – it should take into account the specific characteristics of rural areas, e.g. the possibility of linking a financial product (loan) with agricultural subsidies – which should substantially reduce the risk. The programme should also have its specific "distribution channel", one of which is currently the Agency for Restructuring and Modernisation of Agriculture.

BIOMASS PROMOTION PROGRAMME – in rural areas, biomass is a relatively common fuel used for heating (around 30% of energy used for heating single-family buildings is generated from biomass). Biomass has a few important advantages: it is a renewable source of energy, farmers often have access to biomass (as it is made from agricultural waste) or it is cheap, it is a locally sourced raw material. On the negative side, "clean combustion" of biomass may be difficult, the raw material may be difficult to process (drying, pelleting), biomass volume is relatively large and its prices are highly volatile. Promoting clean combustion of biomass in rural areas should focus on highlighting the natural advantages of the raw material and minimising its disadvantages. Possible solutions include co-financing the purchase of biomass boilers which meet certain criteria, e.g. relating to the price or emission performance.

The table below presents an evaluation of the "product attractiveness/usefulness" for the target groups described above. The evaluation is approximate and was made on the basis of experience gained over the years by the author. Target groups at which a given instrument is aimed are marked in green and other groups which may also benefit from an instrument are marked with "X" (the more Xs, the more suitable a given instrument is for a given group).

Support instruments constituting the National Programme for the Modernisation of Single-Family Buildings

Support instrument	Group				
	10% of the poorest	80% of the moderately rich	10% of the richest	People living in rural areas	People living in the most polluted areas
Technical and economic assistance	XXX	XXX	XXX	XXX	XXX
Modernisation loans		XXX	XX		XXX
Preferential loans	XX	XXX		X	XX
Individual Housing Accounts		XXX	XX	XXX	X
Tax exemption	XXX	XXX		XXX	XXX
Clean fuel subsidy	XXX	X			XXX
Stove/boiler replacement subsidy	XXX	XX			XXX
Thermal modernisation subsidy	XXX	XX			X
Materials and equipment subsidy	XXX	XXX	XXX	XXX	XXX
Financial products distributed with energy bills		XXX	XX		
Support programme for rural areas		XXX		XXX	
Biomass promotion programmes				XXX	

Source: own analysis

As seen from the above, the largest number of support instruments can be targeted at the group comprising 80% of Poles who are "moderately rich" (or moderately poor as compared with the countries of Western Europe).

TECHNICAL CONDITION OF SINGLE-FAMILY BUILDINGS IN POLAND – COMMENTS ON THE RESEARCH

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We are pleased to present a report entitled "Technical condition of single-family buildings in Poland – renovation needs, heat sources and energy performance standards" which is based on survey research carried out in 2017 among owners of single-family houses. The report was prepared as a contribution to the building modernisation programme which was announced by the Polish Government at the beginning of 2017. Questions related to modernisation needs identified by owners of single-family houses constitute a novelty in comparison to previously conducted surveys. Although this part of the report is not long, readers will find a number of surprising answers relating to important questions concerning the shape of the programme that is being developed. The answers lead to the following conclusions:

1. the scale of modernisation required is enormous and investors lack financial resources to implement the renovation work as desired (in large measure this problem can be solved through loan products, although to what degree is unclear);
2. modernisation is not just about thermal modernisation but includes also other renovation work, such as roof, bathroom or kitchen renovation;

3. support is essential for comprehensive renovation projects (encouraging comprehensive building modernisation through subsidies, housing modernisation rebates and other instruments).

The report analyzing renovation needs comprises three complementary parts.

The first part deals with modernisation needs identified by owners of single-family houses. It is not possible to refer to research in previous years in this regard. But a surprisingly large number of respondents claimed that the heating system in their home needed replacement. It is likely that the high level of concern focused on home heating systems results from increased public awareness concerning air quality problems. If this turns out to be the case, the change should be regarded as the most significant transformation of environmental attitudes among Poles of recent years. When asking about the scope of modernization, we included questions about kitchen and bathroom refurbishment, as typically kitchen and bathroom renovation is linked to the modernization of heating systems (it is often necessary to renovate the kitchen, install hot water supply, install/cut off gas supply, modernise/ replace electrical installations, or install underfloor low-temperature heating and ventilation systems).

The next part draws on research concerning modernisation priorities. It is interesting to note that, in the city, refurbishment of the kitchen and bathroom seems to be more urgent than installing wall insulation, which would be more beneficial from a financial perspective. On the other hand, it should be noted that a much higher percentage of buildings have already been insulated in urban areas than in rural areas, which results from the fact that city residents use more expensive heating sources. Window replacement is not a priority due to the fact that the majority of windows in Polish houses have already been replaced (unfortunately installation of new air-tight windows is not usually associated with installation of appropriate ventilation solutions).

The third part is about matching financial needs to the renovation needs identified. Based on our internal comparative analysis and discussions with specialists, we can assume that the average investment size estimated by respondents is surprisingly accurate and reflects the real situation. But it is worth taking a closer look at the average cost of roof renovation as estimated by homeowners, who indicated that completing this type of work is key to their investment needs. This situation confirms that roof work should not be restricted only to insulation – it needs to be comprehensive in scope to include replacement of the roof cover and sometimes also adaptation of the top floor for residential use. It should be stressed, however, that installation of roof thermal insulation without concurrent renovation of roof covering typically means money wasted (as insulating materials lose their properties when exposed to damp conditions). This is an important consideration for all those preparing modernisation programmes – roof modernisation is expensive, necessary and – due to its high cost – often remains unattainable. Solving this problem requires loans and tax rebates along with a customised advisory programme.

TECHNICAL CONDITION OF SINGLE-FAMILY BUILDINGS IN POLAND
RENOVATION NEEDS, HEAT SOURCES AND ENERGY PERFORMANCE STANDARDS

REPORT FROM RESEARCH

ŁUKASZ **PYTLIŃSKI**
CEM MARKET AND PUBLIC OPINION RESEARCH INSTITUTE

INFORMATION ON THE SURVEY RESEARCH

Timing

The research was commissioned by the Institute of Environmental Economics and was carried out by the CEM Market and Public Opinion Research Institute between 18th April and 12th May 2017.

Research methods used

The research was conducted using the CATI telephone survey method. All interviews were carried out by experienced interviewers form the CATI studio located in the CEM Institute offices in Krakow.

The research sample

The survey research involved a representative sample of 1 000 owners of single-family houses in Poland.

For the purposes of the research, decision-makers responsible for technical decisions in the home were targeted. Sampling made use of both stationary and mobile telephone databases. The sampling process took into account the geographical location of the buildings in question (city/rural).

Research tools

The research made use of a standardised survey questionnaire with mostly closed-ended questions.

INTRODUCTION

Taking into account the data gathered during the 2011 National Population and Housing Census and the annual average number of new buildings delivered, it can be estimated that at the end of 2016 there were 5 367 000 single-family buildings in Poland. Over 70% of them are located in rural areas, which has a significant impact on the structure of fuels used for heating purposes.

The results of the research show that **less than every fifth single-family building in Poland is heated with fuels which do not have a negative impact on the quality of air**. At the same time, solid fuels are used for heating purposes in nearly 4.5 milion single-family buildings. Coal-fired boilers used in as many as 1.7 milion buildings are 10 years old or older. The vast majority of these appliances are simple, manually-fed boilers in which all types of solid fuels can be burnt, including the most environmentally harmful coal sludge, flotation concentrate, municipal or construction and demolition waste. A further 50 thousand of buildings are still heated with coal-fired boilers. A large number of respondents use boilers or fireplaces burning wood or another type of biomass. Biomass or wood are the main heating fuels in nearly 1 million buildings. Wood is used as an additional heating fuel in 70% of buildings equipped with coal-fired boilers. It means that over 3.2 milion buildings are heated with wood. To this figure must be added

the significant number of buildings in which fireplaces are used as an additional or alternative source of heating. It is also worth mentioning that **40% of single-family buildings in Poland do not have their external walls insulated against heat loss** and in the case of insulated buildings, the average thickness of wall insulation layer does not exceed 10 cm.

It follows from the above that **single-family buildings constitute a key source of air pollutant emissions in Poland**. Without significant intervention measures taken by the state and involving the introduction of quality standards for solid fuels and solid fuel boilers, the situation is unlikely to change in the near or more distant future. The results of the research make it clear that **the scope of modernisation activities planned to be taken by owners of single-family buildings themselves (i.e. heat source replacement or shift from coal to another heating fuel) is far from sufficient to change the existing structure of heating fuels and consequently to significantly reduce particulate emissions from this sector.**

RENOVATION NEEDS

Maintaining single-family houses in good technical condition requires the owner to carry out regular renovation work. Some of the essential renovation work, especially work related to the building outer shell, such as roof renovation or thermal insulation of exterior walls, can generate considerable costs depending on the scope of work and the size of the building. The majority of owners of single-family houses cannot afford such expenditures as they exceed the resources they have available in their day to day budgets. For this reason, undertaking major renovation work demands that the investor saves for many years prior to the planned renovation intervention or applies for financial support from external sources, such as bank loans or bank credits.

The survey research completed in 2017 involved a representative random sample of owners of single-family houses (N=1 000). Based on the responses obtained a diagnosis of the technical condition of the buildings was prepared, with reference to thermal insulation of walls and quality of the heating sources used. Respondents were asked to indicate renovation work needs related to their houses. The research involved presenting house owners with a standard list of typical renovation interventions carried out in single-family houses and asking respondents to indicate if a given intervention was, in their opinion, necessary for their building.

The results obtained indicate that the scale of investment needed by single-family houses is enormous. The majority of respondents indicated the renovation work were of significant scale. Only 30% of single-family house owners were of the opinion that no significant interventions were needed.

Investment needs related to heating system modernisation and boiler replacement were indicated most often as priorities. The fact that heating sources topped renovation needs may be evidence of the effectiveness of air quality protection actions, which were started a few years ago as community-based initiatives and pointed to low-stack emissions as the key contributor to air pollution in Poland (this issue possibly still requires further research). Factors such as regular media coverage of air pollution and what causes it, increased local government support in the form of heating modernisation programmes, and introduction of air pollution into Poland's political discourse, have all contributed to raising awareness throughout Polish society. According to the research, owners of single-family houses, are in the main using obsolete and energy-intensive heating sources and have come to recognise that the heating systems of their buildings require modernisation. The research findings confirm that it is the owners of single-family houses located in urban areas who indicate more frequently the need to modernise their heating systems (39% of respondents living in urban areas pointed to the need for modernising heating systems and replacing

the heating source as one of their key renovation needs, whereas in rural areas this need was indicated by 32% of respondents). Overall in cities, the heating sources using solid fuel do not dominate as is the case in rural areas. This means that public pressure to eliminate or modernise such heating sources may be higher in urban areas. At the same time, the cities which introduced special regulations and guidelines in relation to solid fuel use indicate that the standards as currently applied to heating sources will be significantly modified whether in the short or long term.

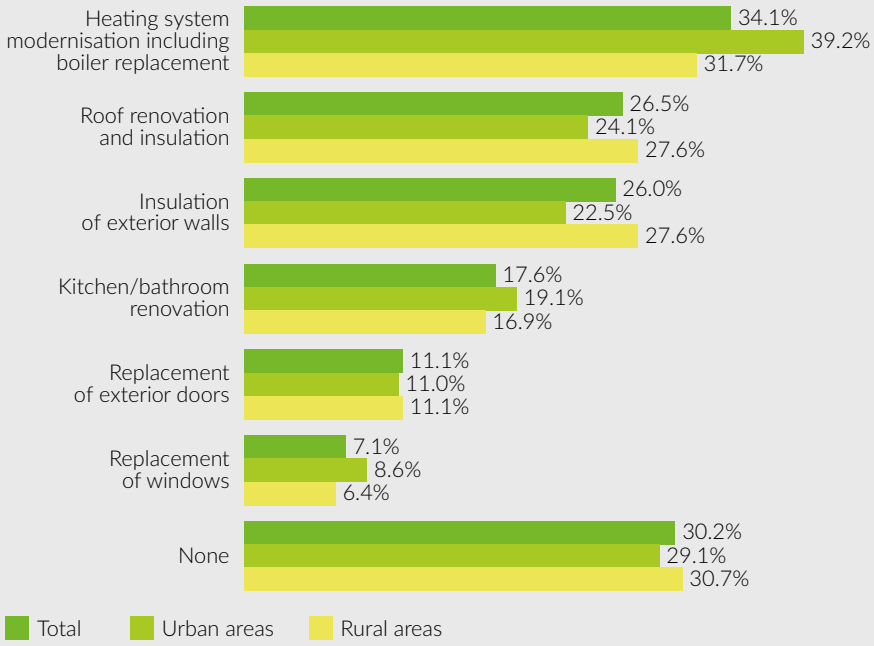
Other interventions, often indicated by the research respondents, include roof renovation and thermal insulation of exterior walls (each of these was selected by a quarter of respondents). These two types of intervention were selected more often as investment needs by those resident in rural areas. This difference can be readily explained by the fact that the percentage of houses with insulated exterior walls is several percent higher in the city than in rural areas (13% more in urban areas with respect to thermal insulation of exterior walls and more than 10% with respect to thermal insulation of top structural ceilings or attics), which is associated with higher heating costs in the city and leads to higher investment cost-effectiveness of thermal insulation work. As a result, replacement of heating sources has become one of the key investment priorities in this segment. It needs to be taken into account in the future.

Kitchen and/or bathroom renovation was indicated as one of the renovation needs identified as being of equal significance regardless of place of residence

Every tenth owner of a single-family house indicated the need to replace their exterior doors. Not many respondents indicated the need to replace windows (only 7%). But the research findings indicate that this type of investment had already been partly or completely implemented in the majority of buildings.

It is only natural that residents of houses built recently (after 2000), indicated renovation needs less frequently. Nevertheless, a quarter of respondents thought that the heating system in their building was in need of modernisation.

Which of the following renovation work should be carried out in your house?



Source: CATI 2017; Sample N=1 000; own analysis

Which of the following renovation work should be carried out in your house?	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Heating system modernisation including boiler replacement	34.1%	31.7%	35.9%	36.8%	26.2%	31.6%	38.1%
Roof renovation and insulation	26.5%	28.6%	30.4%	26.2%	8.0%	30.7%	23.7%
Insulation of exterior walls	26.0%	29.1%	31.9%	19.7%	5.8%	31.7%	22.0%
Kitchen/bathroom renovation	17.6%	14.3%	19.7%	18.7%	11.8%	16.2%	20.0%
Replacement of exterior doors	11.1%	8.3%	11.7%	13.5%	9.5%	13.6%	10.2%
Replacement of windows	7.1%	6.7%	5.8%	12.0%	5.9%	6.9%	7.9%
None	30.2%	30.0%	26.1%	29.1%	49.1%	29.0%	28.4%
SAMPLE (N)	1 000	183	518	175	124	544	456

Source: CATI 2017; Sample N=1 000; own analysis

KEY INVESTMENTS

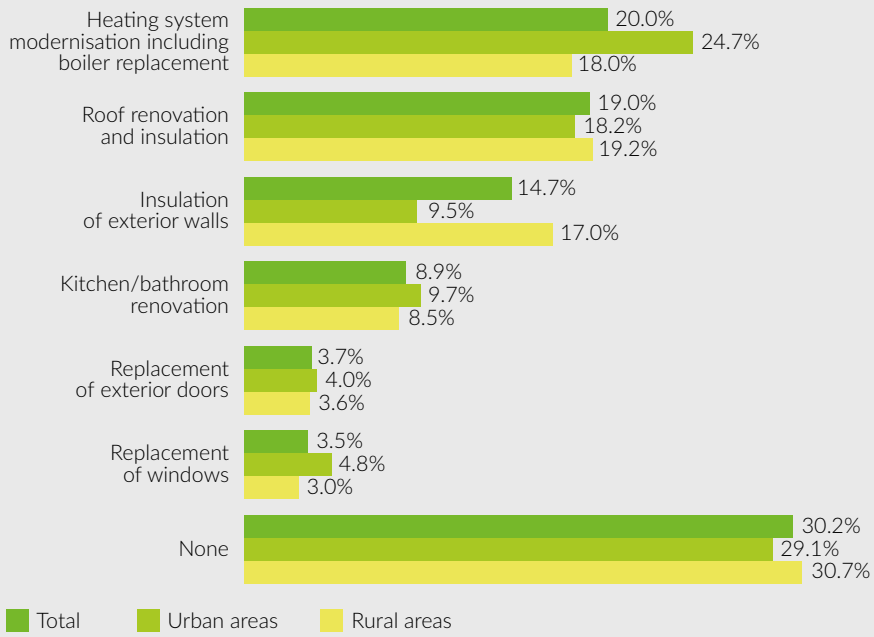
One fifth of single-family house owners indicated heating system modernisation or boiler replacement as the key priority interventions. This was also the intervention most often selected among key renovation needs for the building. This situation relates especially to urban area residents. A quarter of single-family house owners living in the city indicated the need to modernise their heating systems.

Roof renovation ranked second among the priority interventions selected by respondents. Rural residents indicated roof renovation to be a priority more often than heating system modernisation.

One in seven respondents listed thermal insulation of exterior walls among their priority investments. This intervention was selected more often by respondents living in rural areas. Somewhat fewer respondents indicated kitchen and bathroom renovation as priorities, although it should be noted that among city residents this type of intervention was ranked at a similar level as thermal insulation of exterior walls.

Replacement of windows and exterior doors was selected least frequently as a priority intervention.

Which of the investments indicated is a priority in your opinion?



Source: CATI 2017; Sample N=1 000; own analysis

Heating system modernisation was selected most frequently as a priority investment, regardless of building age. It is interesting to note that this type of investment was indicated most frequently as a priority for respondents who were better off. The priority was selected more frequently by city residents where average household incomes were higher than in rural areas.

Which of the investments indicated is a priority in your opinion?	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Heating system modernisation including boiler replacement	20.0%	21.8%	19.2%	20.5%	20.1%	14.6%	26.0%
Roof renovation and insulation	19.0%	20.1%	22.3%	16.1%	7.1%	23.6%	15.7%
Insulation of exterior walls	14.7%	14.0%	18.0%	12.7%	5.3%	18.5%	11.7%
Kitchen/bathroom renovation	8.9%	8.9%	9.7%	7.1%	8.0%	7.4%	10.3%
Replacement of exterior doors	3.7%	3.1%	2.3%	7.0%	6.4%	3.7%	4.2%
Replacement of windows	3.5%	2.1%	2.4%	7.5%	4.0%	3.2%	3.7%
None	30.2%	30.0%	26.1%	29.1%	49.1%	29.0%	28.4%
SAMPLE (N)	1 000	183	518	175	124	544	456

Source: CATI 2017; Sample N=1 000; own analysis

ESTIMATING
FINANCIAL NEEDS

We have tried to estimate the cost for each type of renovation intervention at the national level based on the surveyed expected cost of priority renovation interventions. The table below lists an average cost for investments based on calculations carried out by the respondents themselves. The estimates calculated in this way constitute only an indicative value, as the cost of renovation work may vary considerably depending on the size of the building. Similarly, the scale of intervention required may also vary significantly. These differences are most clearly visible in relation to roof renovation work. They can be limited to a simple and relatively low-cost renovation, which involves laying mineral wool in the attic at a cost of a couple of thousand PLN or may require a complete rebuilding of the entire top floor, with costs reaching PLN 100 milion or more. Analysing the data compiled below, it is important to note that the quantitative estimates listed reflect the subjective assessment and needs of individual single-family house owners and are not based on detailed cost calculations as prepared by professional building contractors. This means that the actual cost of the proposed renovation work could be considerably higher.

The average total value of investment needs among respondents who identified at least one renovation need amounted to PLN 21 thousand (67% of respondents).

Estimates of the financial resources required to implement priority investment needs in single-family houses were based on the expected costs cited by respondents. Scaling up to match the total number of single-family houses in Poland, the total financial resources needed can be estimated as nearly PLN 80 bilion (a thousand million).

The largest portion of the total sum relates to costs of roof renovation and thermal insulation of exterior walls. The total cost of these two types of interventions is estimated as amounting to more than PLN 50 bilion. The expected cost of the investment which was most frequently named as the main priority – heating system modernisation

– amounts to PLN 16 bilion. The least costly interventions in the overall investment ranking include replacement of exterior doors and replacement of windows. These costs are estimated at slightly above PLN 30 bilion.

The estimate of PLN 80 bilion may be regarded as excessive. But if we consider that such an investment would meet the most urgent renovation needs of nearly half of Poland's population, it can be seen as reasonable.

	Average expected cost	Percent of buildings for which this type of investment was indicated as priority	Number of buildings in poland, for which this type of investment was indicated as priority	Expected total cost of the investment
Insulation of exterior walls	PLN 26 100	14.7%	788 949	PLN 20 591 568 900
Roof renovation including thermal insulation	PLN 29 200	19.0%	1 019 730	PLN 29 776 116 000
Replacement of exterior doors	PLN 4 500	3.7%	198 579	PLN 893 605 500
Replacement of windows	PLN 12 800	3.5%	187 845	PLN 2 404 416 000
Kitchen/bathroom renovation	PLN 17 800	8.9%	477 663	PLN 8 502 401 400
Heating system modernisation including boiler replacement	PLN 14 800	20.1%	1 078 767	PLN 15 965 751 600
TOTAL				**PLN 78 133 859 400**

Source: CATI 2017; Sample N=1 000; own analysis

Average expected cost for specifics elements of a buildings and estimated total expected costs of investment in Poland

PLN 29 200
Average expected cost of particular modernization activities

PLN 29 776 116 000
Expected total cost of the investment

ROOF RENOVATION INCLUDING THERMAL INSULATION

PLN 12 800
Average expected cost of particular modernization activities

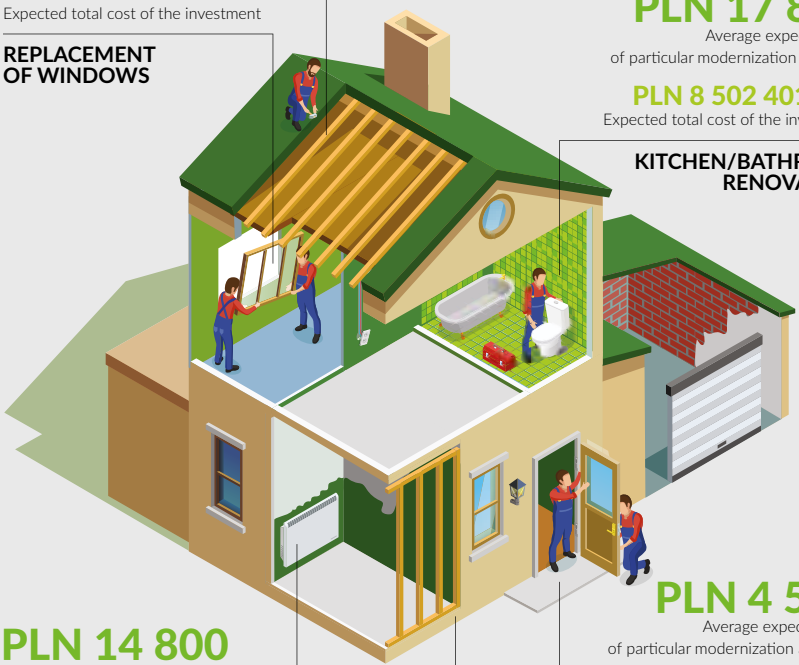
PLN 2 404 416 000
Expected total cost of the investment

REPLACEMENT OF WINDOWS

PLN 17 800
Average expected cost of particular modernization activities

PLN 8 502 401 400
Expected total cost of the investment

KITCHEN/BATHROOM RENOVATION



PLN 4 500
Average expected cost of particular modernization activities

PLN 893 605 500
Expected total cost of the investment

REPLACEMENT OF EXTERIOR DOORS

PLN 14 800
Average expected cost of particular modernization activities

PLN 15 965 751 600
Expected total cost of the investment

HEATING SYSTEM MODERNISATION INCLUDING BOILER REPLACEMENT

PLN 26 100
Average expected cost of particular modernization activities

PLN 20 591 568 900
Expected total cost of the investment

INSULATION OF EXTERIOR WALLS

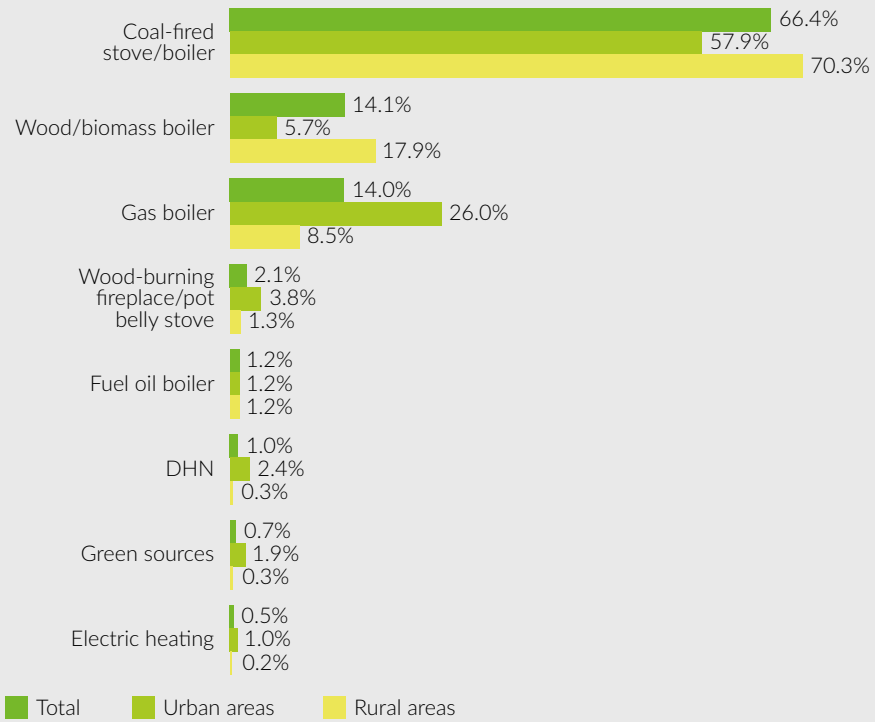
PLN 78 133 859 400

Source: CATI 2017; Sample N=1 000; own analysis

THE STRUCTURE OF HEAT SOURCES

The research conducted in 2017 on a randomly selected group of single-family house owners shows that solid fuel boilers and stoves are still predominant in the structure of heat sources in Polish single-family houses. **Coal-fired boilers and stoves are the main source of heat in nearly 70% of houses. 14% of them use boilers burning wood or another type of biomass.** 2% of respondents claim that they use wood-burning fireplaces. It must be pointed out, however, that biomass and wood are often used also

How do you heat your home? Please specify the main source of heat



Source: CATI 2017; sample N=1 000; own analysis

by those respondents who heat their houses with coal-fired boilers, hence the biomass-related percentage mentioned above may in fact be underestimated.

Boilers in which coal and wood are burnt interchangeably were identified as the main source of heat by as many as 21% of the respondents, which in fact means that users of coal-fired boilers use biomass as an additional or alternative fuel. As far as wood-burning appliances are concerned, the situation is similar – some owners burn coal in them as well.

Around 14% of single-family houses are heated with gas boilers. A small share of buildings use oil-fired boilers, electric heating, district heating network (DHN) and green sources (e.g. heat pumps, geothermal energy).

The percentage of coal-heated buildings in cities is lower than in the total sample and reaches nearly 60%. There are also fewer houses which mainly rely on wood-burning installations. At the same time, gas boilers are used in quite a lot of buildings (26%).

In rural areas nearly 90% of houses are heated with solid fuels. Other buildings are mainly heated with gas boilers – one in ten owners of a single-family building mentions a gas boiler as the main source of heating. Nearly one in five owners of single-family buildings located in rural areas use wood or biomass burning boilers. The share of green energy sources in rural areas is marginal.

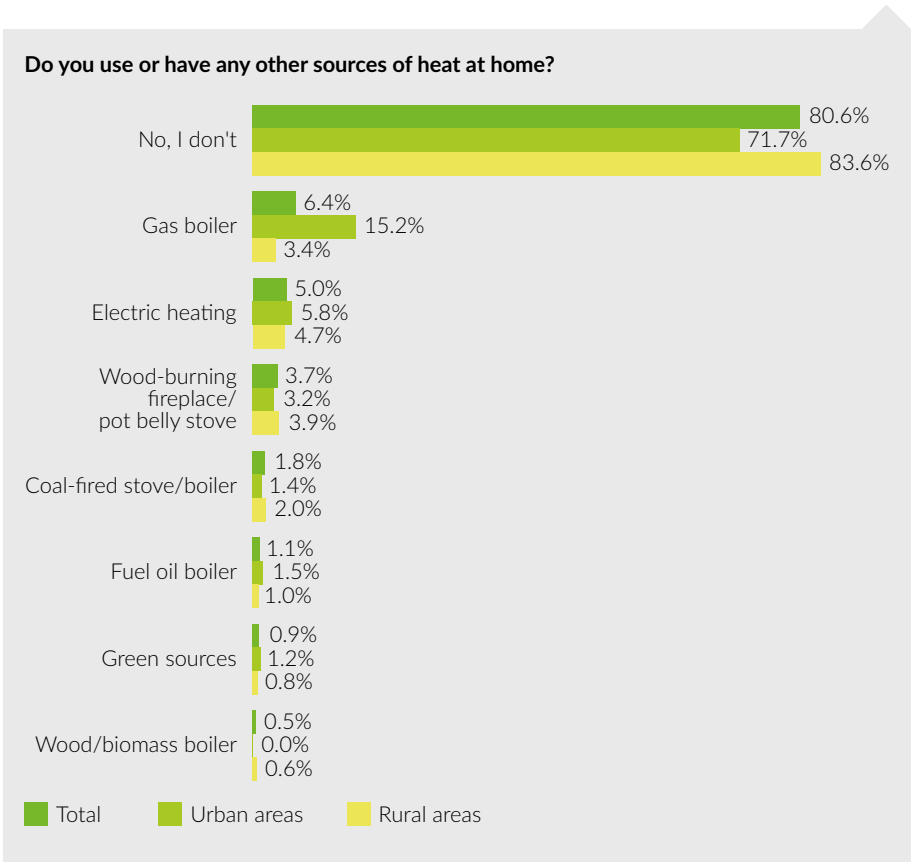
The share of coal heating is significantly lower in houses built after the year 2000. However, over 50% of buildings in this segment are heated with solid fuels. The structure of heating sources also depends on the income level. Solid fuels are used more commonly by less well-off respondents than by the wealthier ones.

How do you heat your home? Please specify the main source of heat	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Coal-fired stove/boiler	66.4%	62.9%	74.6%	57.8%	49.5%	70.7%	62.9%
Wood/biomass boiler	14.1%	22.3%	12.4%	10.1%	14.6%	16.6%	11.7%
Gas boiler	14.0%	7.2%	10.8%	23.1%	24.5%	9.6%	18.7%
Wood-burning fireplace/pot belly stove	2.1%	2.8%	0.8%	3.1%	5.0%	1.0%	2.5%
Fuel oil boiler	1.2%	2.0%	0.8%	1.8%	0.7%	0.8%	1.5%
DHN	1.0%	1.3%	0.4%	2.4%	0.7%	0.8%	1.2%
Green sources	0.7%	0.7%	0.0%	1.7%	3.0%	0.5%	0.7%
Electric heating	0.5%	0.8%	0.2%	0.0%	2.0%	0.0%	0.8%
SAMPLE (N)	1 000	183	518	175	124	544	456

Source: CATI 2017; Sample N=1 000; own analysis

Over 80% of the respondents from the analysed group claim that a coal-fired boiler or stove is the only source of heat in the building. Other alternative or supplementary sources are used in one out of five houses. These mainly include gas boilers (6% of the total sample). Fireplaces, cast iron pot belly stoves and electric heaters are slightly less common. In some buildings both coal-fired boilers and stoves are installed.

One in seven respondents who have got alternative or supplementary heating sources claim that they use them as frequently as the coal-fired boiler or stove. The others admit that they use these alternative or supplementary sources much less frequently (over 60% respondents from the analysed segment use them only sporadically).

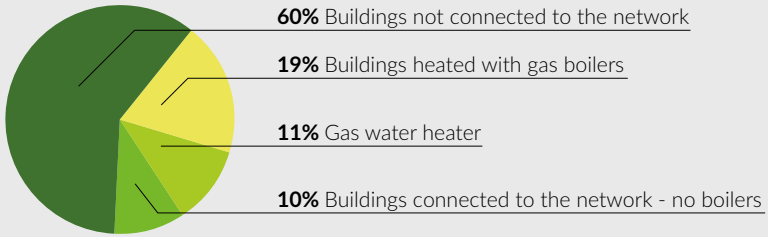


Source: CATI 2017; Sample N=824 (buildings heated mainly with solid fuels); own analysis

The analysis of the above data concerning the use of gas boilers as the main or alternative source of heat shows that nearly every fifth single-family building is fitted with a gas boiler used for heating purposes.

In a further 11% of buildings water heaters or gas boilers are used for domestic water heating and 10% of buildings are connected to a gas network but no heating appliances are used in them.

The structure of buildings based on access to gas network



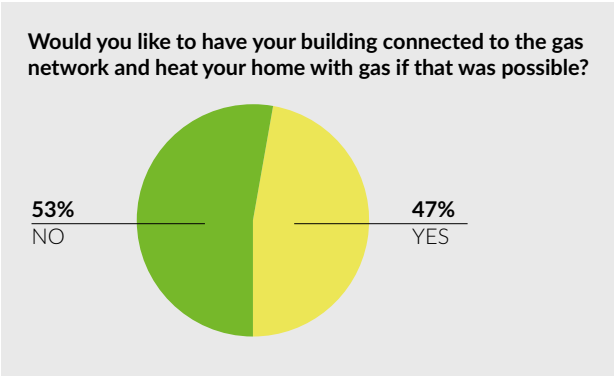
Source: CATI 2017; sample N=1 000; own analysis

As illustrated by the results of the research, **60% of single-family buildings in Poland are not connected to the gas network**. Unsurprisingly, the situation is more common in rural areas – **68% of the analysed buildings in this group have no access to the gas network**. The corresponding figure for urban areas is 40%. The largest proportion of buildings which are not connected to the gas network can be observed among the oldest buildings (erected before WWII); these buildings are also among the most poorly insulated ones.

The structure of buildings based on access to gas network	Total	Building construction years				Location of the building	
		Before WWII	1945–1988	1989–2000	2001+	Urban areas	Rural areas
Gas boiler	19.4%	11.4%	17.3%	26.9%	29.1%	36.3%	11.6%
Gas water heater	11.0%	6.7%	13.5%	10.7%	7.3%	12.2%	10.5%
Buildings connected to the network – no boilers	10.1%	6.1%	10.6%	12.2%	11.1%	11.8%	9.4%
Buildings not connected to the network	59.5%	75.8%	58.6%	50.2%	52.5%	39.7%	68.5%
SAMPLE (N)	1 000	183	518	175	124	312	688

Source: CATI 2017; Sample N=1 000; own analysis

Nearly 50% of Poles living in buildings which are not connected to the gas network would like to have their home heated with gas if that was possible.



Source: CATI 2017; Sample N=595 (buildings not connected to the gas network); own analysis

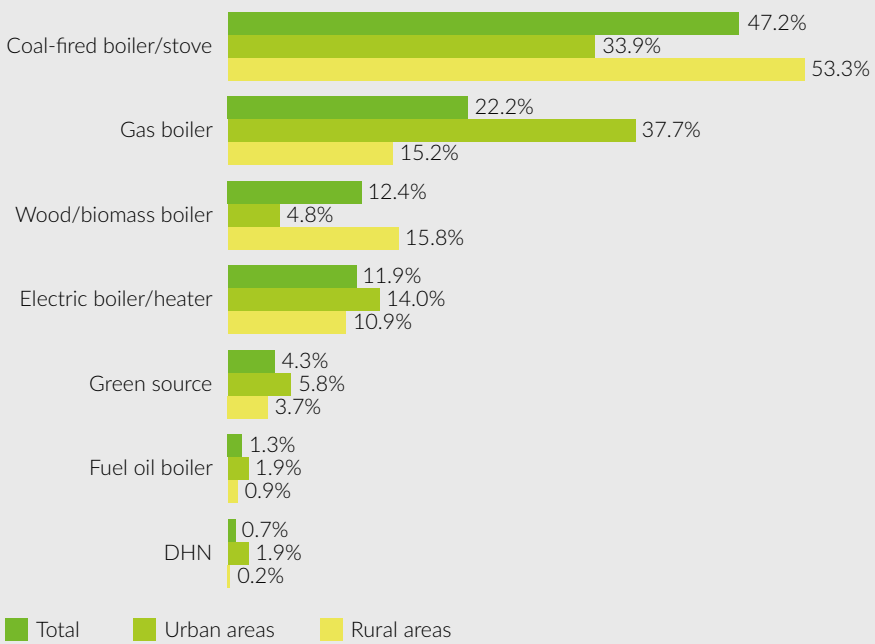
A more detailed analysis of the data shows that every fourth building connected to the gas network in which gas heating is currently not used was heated with gas in the past. It means there is a trend towards substituting gas heating with other sources based on solid fuels. Answers provided by the respondents from this segment suggest that such conversions were particularly frequent at the beginning of the previous decade.

THE STRUCTURE OF DOMESTIC HOT WATER SOURCES

The structure of domestic hot water sources is more heterogeneous than the structure of heat sources. Coal-fired boilers and stoves are used in 47% of buildings. Water is heated with gas heaters in every fifth building. 12% of the respondents use wood or biomass boilers for that purpose. A similar percentage of owners prepare their hot water using electric boilers and heaters. **A further 4% of respondents claim that they use installations based on green sources, the most frequently mentioned ones include solar collectors**. Oil boilers

are used only sporadically. The structure of domestic hot water sources in towns and cities is significantly different from the corresponding structure in rural areas. Gas boilers are much more common and the share of coal-fired boilers is much lower. **In rural areas the most common sources of domestic hot water include coal-fired, wood and biomass boilers.** Gas boilers are used in every seventh and electric heaters in every tenth building.

Which source of hot water do you use? Please specify the main source



Source: CATI 2017; Sample N=1 000; own analysis

Both the age of the building and the level of wealth of its owners have a significant impact on how domestic hot water sources are chosen. **Coal-fired stoves and boilers are most commonly used in buildings erected before 1989 and owned by the least well-off respondents.** There is a growing trend towards using gas boilers and green sources among respondents with higher incomes.

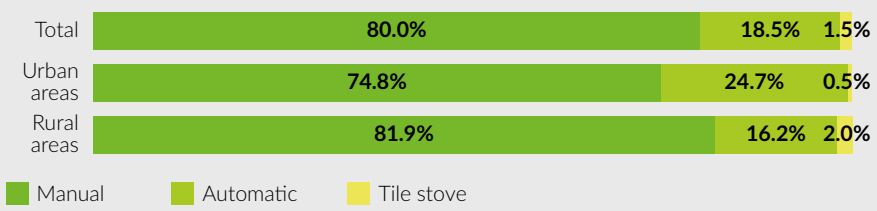
Which source of hot water do you use? Please specify the main source	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Coal-fired boiler/stove	47.2%	50.6%	50.5%	39.4%	39.3%	53.7%	40.1%
Gas boiler	22.2%	11.1%	22.2%	28.2%	29.8%	16.2%	29.0%
Wood/biomass boiler	12.4%	17.7%	10.7%	8.8%	16.4%	12.8%	11.6%
Electric boiler/heater	11.9%	17.2%	11.3%	13.2%	4.8%	13.3%	11.4%
Green source	4.3%	1.6%	4.3%	5.5%	7.0%	2.9%	5.5%
Fuel oil boiler	1.3%	0.5%	0.8%	3.0%	2.0%	0.6%	1.4%
DHN	0.7%	1.3%	0.2%	1.9%	0.7%	0.5%	1.0%
SAMPLE (N)	1 000	183	518	175	124	544	456

Source: CATI 2017; Sample N=1 000; own analysis

CHARACTERISTICS OF COAL-FIRED BOILERS USED IN POLAND

Most of the coal-fired boilers installed in single-family houses are manually fed. They are used by 80% of the respondents. In towns and cities this percentage is slightly lower than in the total sample and the share of automatic boilers is nearly 25%. In rural areas, only 16% of coal-heated buildings are equipped with automatic boilers. Tile stoves are used only sporadically. They can be found in a small percentage of pre-war and early post-war buildings.

What kind of coal-fired boiler do you have?



Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

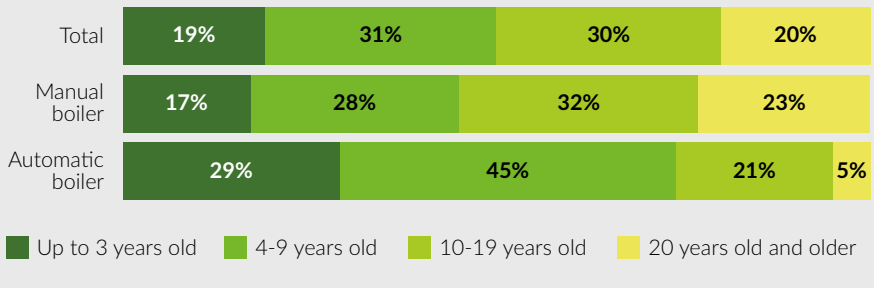
Automatic boilers are much more common in buildings erected after the year 2000. **Manual boilers are still used, however, in over 60% of houses built in this century, which makes their share considerable.** Automatic boilers are used a little more frequently by wealthier house owners.

What kind of coal-fired boiler do you have?	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Manual	80.0%	86.1%	82.9%	75.5%	57.6%	86.2%	71.7%
Automatic	18.5%	10.0%	15.8%	23.7%	42.4%	11.9%	28.0%
Tile stove	1.5%	3.9%	1.3%	0.8%	0.0%	1.9%	0.3%
SAMPLE (N)	664	116	383	104	61	343	258

Source: CATI 2017; Sample N=1 000; own analysis

Most coal-fired boilers are rather outdated. Relatively new boilers, up to 3 years old, constitute only 19% of the whole sample. A further 31% of the appliances are between 4 and 10 years old. The remaining 50% of boilers are 10 years old or older. The average age of automatic boilers (average value = 7 years; median value = 5 years) is much lower than the age of manually-fed boilers (average value = 13 years; median value = 10 years).

Age of the coal-fired boiler

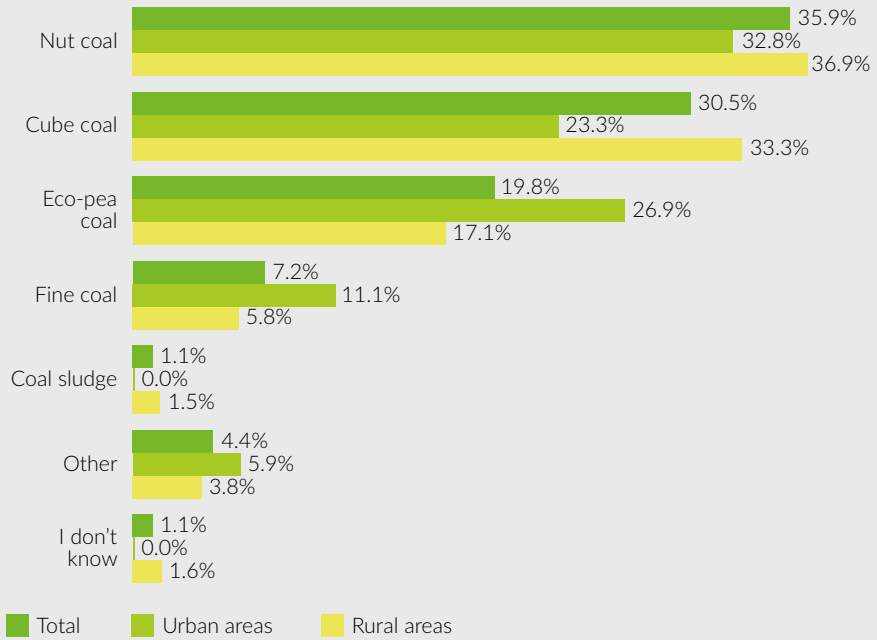


Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

Nut and cube coal are the most common types of fuel used in coal-fired boilers. Nut coal is used in 36% of buildings and cube coal in around 30% of buildings heated with coal. **A further 20% of the respondents heat their homes with eco-pea coal and 7% of them use fine coal.** As for the type of coal used, there are no significant differences between urban and rural areas. However, eco-pea coal seems to be used much more frequently in cities*.

* It must be pointed out, however, that the question was imprecisely worded as a result of which the sort of coal referred to as eco-pea coal can be confused with the trade name "Eco-pea coal".

What kind of coal do you usually buy?

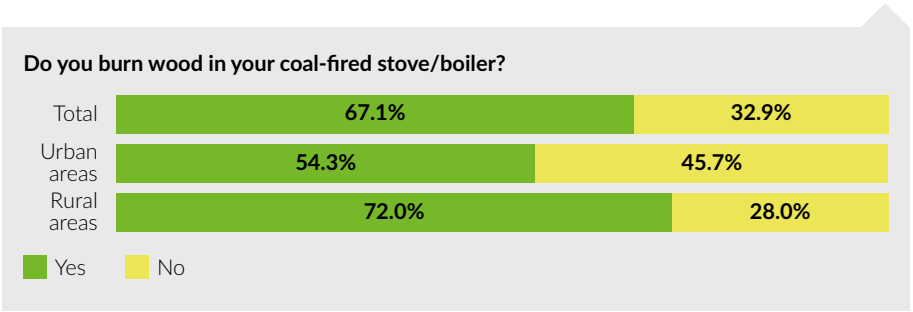


Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

What kind of coal do you usually buy?	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Nut coal	35.8%	44.5%	34.5%	34.9%	28.6%	36.2%	35.8%
Cube coal	30.5%	23.8%	34.9%	31.9%	13.4%	36.6%	22.8%
Eco-pea coal	19.8%	10.0%	16.9%	25.2%	47.3%	13.8%	27.7%
Fine coal	7.2%	7.0%	8.5%	3.2%	6.7%	8.6%	6.5%
Coal sludge	1.1%	3.1%	0.9%	0.0%	0.0%	1.2%	1.2%
Other	4.5%	9.7%	3.1%	4.0%	4.0%	2.7%	5.1%
I don't know	1.1%	1.9%	1.2%	0.8%	0.0%	0.9%	0.9%
SAMPLE (N)	664	116	383	104	61	343	258

Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

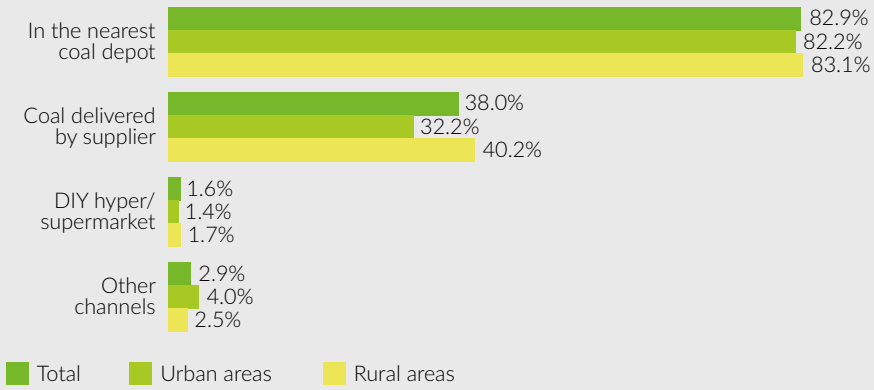
Wood is another type of fuel commonly used in coal-fired boilers and stoves. 67% of owners of single-family houses equipped with coal-fired sources use wood as an additional type of fuel. **This is more common in rural areas where wood is used in 72%** of households, whereas in towns and cities the corresponding figure is 55%.



Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

Over 80% of the respondents buy coal in the nearest coal depot. In 38% of cases coal is delivered to house owners directly by the supplier. It is sporadically bought in DIY hypermarkets. As far as wood is concerned, 40% of the respondents claim that they rely on their own resources.

Where do you usually buy coal?

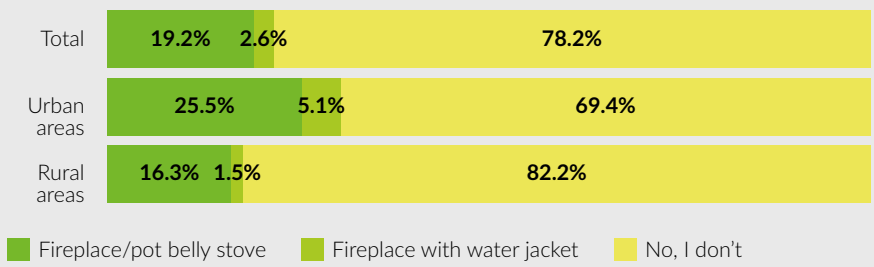


Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

FIREPLACES

21% of the respondents have a fireplace at home. Just under 3% of the fireplaces are fitted with a water jacket. Fireplaces are more frequently used in single-family buildings located in urban areas. Over 30% of the interviewed urban residents claim that they have a fireplace. The corresponding percentage in rural areas is much lower but we need to bear in mind that the vast majority of rural buildings are equipped with boilers in which wood can be burnt. It may

Do you have a fireplace or a wood burning pot belly stove at home?



Source: CATI 2017; Sample N=1 000; own analysis

be expected that **the number of buildings equipped with fireplaces will be systematically growing** as 5% of the respondents are planning to have a fireplace installed over the next two years.

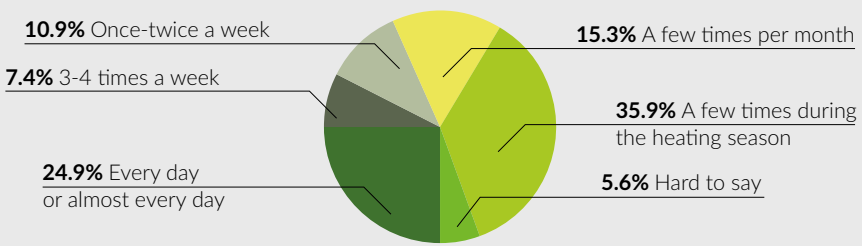
Fireplaces can be found in over 50% of buildings erected after the year 2000. Having a fireplace or a pot belly stove is also directly linked with the respondents' financial position – every third respondent from the wealthier group has a fireplace at home.

		Building construction years				Household monthly net income	
Do you have a fireplace or a wood burning pot belly stove at home?	Total	Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Fireplace/pot belly stove	19.1%	17.9%	10.7%	29.1%	42.1%	13.2%	25.4%
Fireplace with water jacket	2.6%	0.5%	1.5%	3.4%	9.3%	1.3%	2.9%
No, I don't	78.3%	81.6%	87.8%	67.5%	48.6%	85.5%	71.7%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**544**	**456**

Source: CATI 2017; Sample N=1 000; own analysis

Every fourth owner of a fireplace uses it every day or almost every day during the heating season. 18% of the respondents from the analysed group use it at least once a week and 36% of them only sporadically.

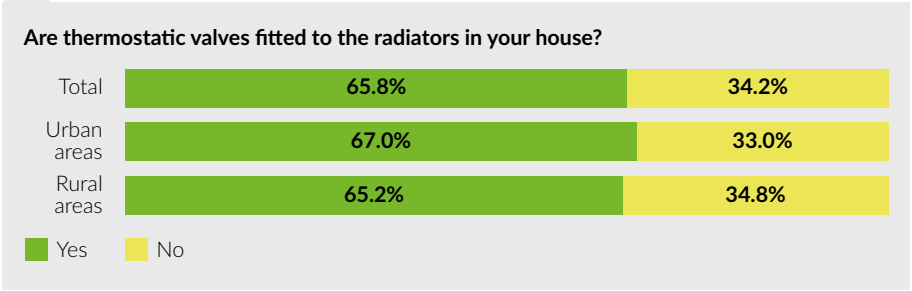
How often do you use the fireplace during the heating season?



Source: CATI 2017; Sample N=218 (buildings in which fireplaces or wood burning pot belly stoves are used); own analysis

HEATING
SYSTEM

66% of the respondents claim that they have thermostatic valves fitted to the radiators. These estimates should, however, be taken with caution due to the fact that owners of single-family buildings often cannot tell the difference between a thermostatic head and a standard shut-off valve fitted to most radiators which do not have thermostats.



Source: CATI 2017; Sample N=1000; own analysis

Despite the fact that thermostatic valves are most commonly used in the newest buildings, it must be noted that in a lot of them (including those erected after the year 2000) this important part of the heating system is missing.

Statistically, there is no difference here between urban and rural areas.

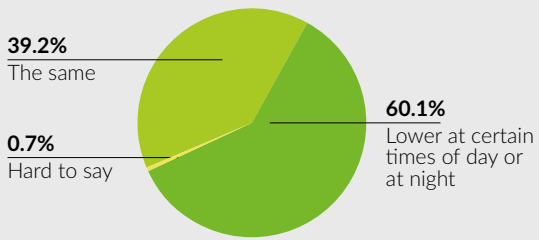
		Building construction years				Household monthly net income	
Are thermostatic valves fitted to the radiators in your house?	**Total**	Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Yes	65.8%	57.5%	62.7%	72.5%	81.4%	58.7%	72.6%
No	34.2%	42.5%	37.3%	27.5%	18.6%	41.3%	27.4%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**544**	**456**

Source: CATI 2017; Sample N=1 000; own analysis

75% of the respondents claim that they are able to adjust the operating temperature of the heating system with the controller fitted to the boiler.

During the heating season, a lot of respondents adjust the indoor temperature depending on the time of day. Less than 50% of the respondents try to keep the temperature at the same level around the clock.

During the heating season, is the temperature in your house the same all the time or is it lower at certain times of day?



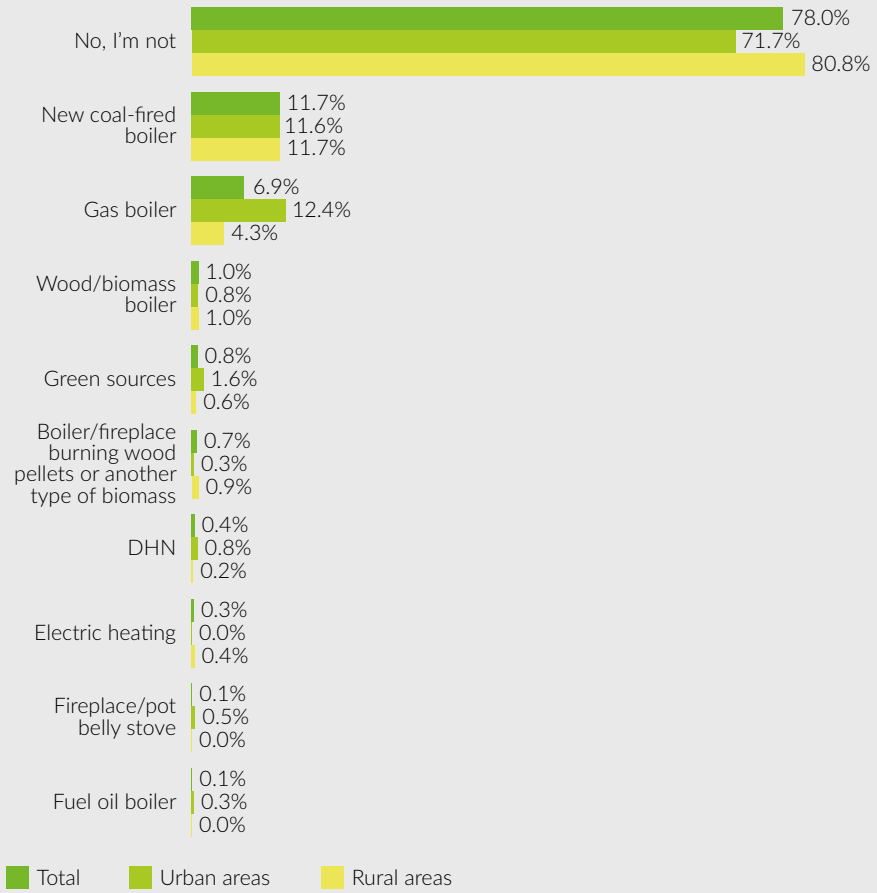
Source: CATI 2017; Sample N=1 000; own analysis

PLANS CONCERNING THERMAL MODERNISATION

Every fifth owner of a single-family building heated with coal (approximately 20% of the respondents) is planning to have the heat source replaced in the near future.

Among those planning to modernise their heat source, 50% of house owners are interested in replacing their coal-fired boilers or stoves with more modern but also coal-fired models. Every third owner of a single-family building is interested in having a gas boiler installed. This trend is much more common in cities. A small number of respondents are also planning to use green sources, especially heat pumps.

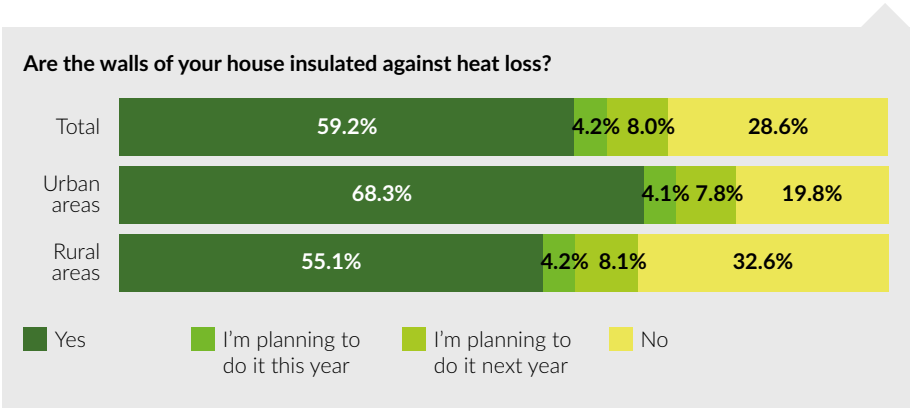
Are you planning to have your heat source replaced within the next 2 years? If yes, which source are you going to choose?



Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

BUILDING ENVELOPE

59% of the respondents claim that the external walls of their houses are insulated and 12% of them are planning to have their houses insulated by the end of next year. More buildings are insulated in urban than in rural areas. **According to the respondents, every fourth building is not insulated at all and will not be insulated in the nearest future.**



Source: CATI 2017; Sample N=1 000; own analysis

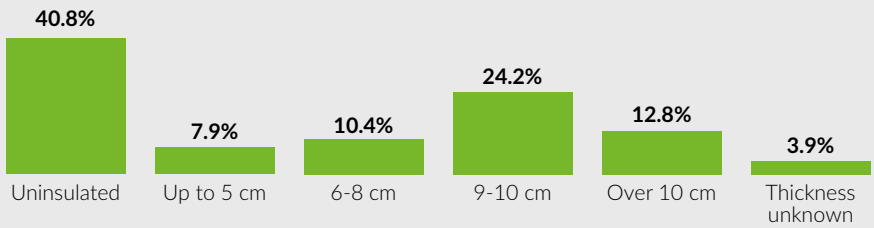
The existence of wall insulation, even the thinnest one, is closely associated with the age of the building. Among owners of houses built before WWII, 47% declare that the walls are insulated. The percentage is slightly higher for houses built between 1945-1989 and 1989-2000, and much higher for those erected after the year 2000 (85%). **The existence of wall insulation seems to be linked with income levels too** – the percentage of thermally insulated houses is slightly higher among the wealthier respondents.

		Building construction years				Household monthly net income	
Are the walls of your house insulated against heat loss?	Total	Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Yes	59.2%	47.3%	53.2%	71.2%	85.0%	51.0%	67.5%
I'm planning to do it this year	4.2%	5.5%	5.3%	2.5%	0.0%	4.4%	4.2%
I'm planning to do it next year	8.0%	8.7%	10.5%	4.1%	2.3%	10.0%	6.6%
No	28.6%	38.5%	31.0%	22.2%	12.7%	34.6%	21.7%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**544**	**456**

Source: CATI 2017; Sample N=1 000; own analysis

Wall insulation layers are usually thin. Thicker layers (more than 10 cm) have only been used in 13% of insulated buildings. The average thickness of wall insulation is 10 cm, but in quite a lot of insulated houses it does not exceed 8 cm. In the newest houses, erected after the year 2000, the average thickness of wall insulation is 12 cm. Similar thickness (slightly more than 12 cm) is mentioned by house owners who are planning to invest in thermal modernisation in the next 2 years.

How thick is the insulation layer?



Source: CATI 2017; Sample N=1 000; own analysis

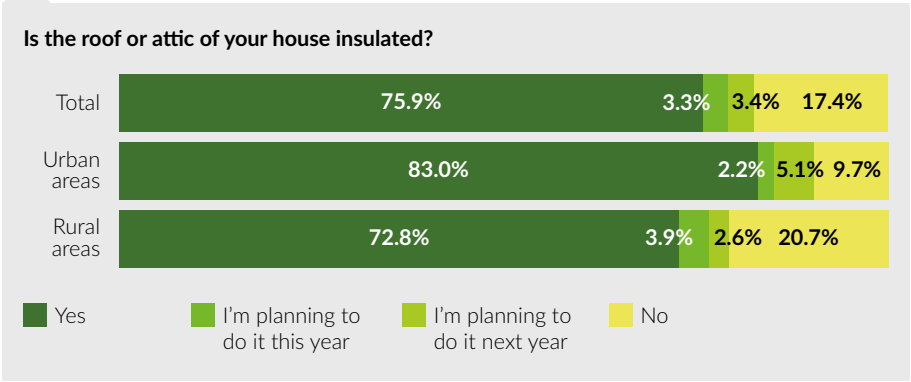
Average thickness of the wall insulation layer

TOTAL		**9.9 cm**
Location of the building	Urban areas	10.1 cm
	Rural areas	9.7 cm
Building construction years	Before WWII	9.4 cm
	1945-1988	9.2 cm
	1989-2000	9.5 cm
	2001+	12.4 cm
Household monthly net income	< 4000 PLN	10.3 cm
	> 4000 PLN	9.0 cm

Source: CATI 2017; Sample N=1 000; own analysis

76% of the respondents claim that the roof or attic of their house is insulated and a further 7% are planning to make such an investment by the end of next year. Analysis of results relating to buildings located in urban and rural areas shows that the number of buildings with an insulated

roof or attic is slightly higher in cities and towns. More urban dwellers also seem to be planning to make such an investment in the future.



Source: CATI 2017; Sample N=1 000; own analysis

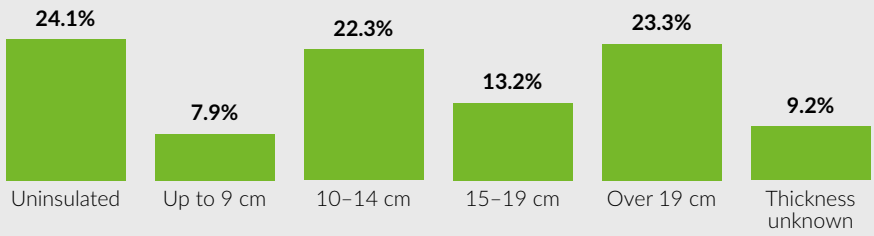
The existence of roof insulation also depends on the age of the building. As far as houses built before WWII are concerned, 61% of the respondents claim to have insulated roofs. The percentage is higher for houses built between 1989-2000 (83%) and among the newest buildings it reaches 94%.

		Building construction years				Household monthly net income	
Is the roof or attic of your house insulated?	Total	Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Yes	75.9%	60.8%	74.5%	83.1%	94.3%	69.1%	83.6%
I'm planning to do it this year	3.3%	4.5%	3.2%	4.4%	0.7%	2.9%	3.4%
I'm planning to do it next year	3.4%	5.0%	3.1%	2.3%	3.9%	4.1%	2.3%
No	17.4%	29.7%	19.2%	10.2%	1.1%	23.9%	10.7%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**544**	**456**

Source: CATI 2017; Sample N=1 000; own analysis

Every fourth respondent from the analysed group claims that roof insulation layer in their house is at least 20 cm thick or thicker. At the same time, the insulation layer in every tenth building does not exceed 9 cm. The average thickness of roof insulation is 16 cm and in the newest houses it is about 19 cm.

How thick is the roof or attic insulation layer?



Source: CATI 2017; Sample N=1 000; own analysis

Average thickness of roof or attic insulation layer

TOTAL		15.7 cm
Location of the building	Urban areas	15.8 cm
	Rural areas	15.6 cm
Building construction years	Before WWII	14.6 cm
	1945-1988	14.5 cm
	1989-2000	16.7 cm
	2001+	19.4 cm
Household monthly net income	< 4000 PLN	14.5 cm
	> 4000 PLN	16.6 cm

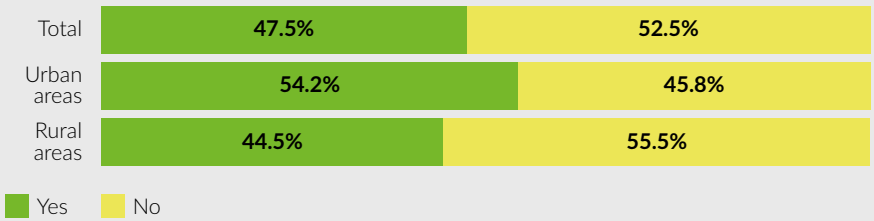
Source: CATI 2017; Sample N=1 000; own analysis

FINANCING
THERMAL MODERNISATION PROJECTS

47% of the respondents claim to have heard about the availability of co-financing programmes aimed at reducing the consumption of heat in single-family houses. The level of awareness seems to be much higher among urban populations. The most frequently mentioned forms of co-financing include subsidies for the purchase of **solar collectors or photovoltaic installations and for the replacement of heat sources.**

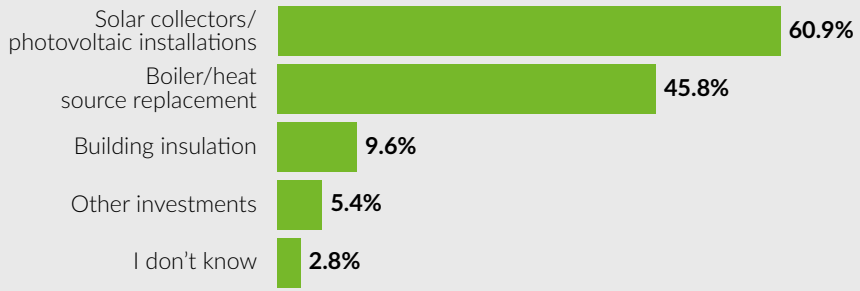
Opinions expressed by the respondents are probably exaggerated.

Have you heard of any forms of public aid available for single-family house owners wishing to invest in thermal modernisation?



Source: CATI 2017; Sample N=1 000; own analysis

What type of thermal modernisation works can be co-financed?

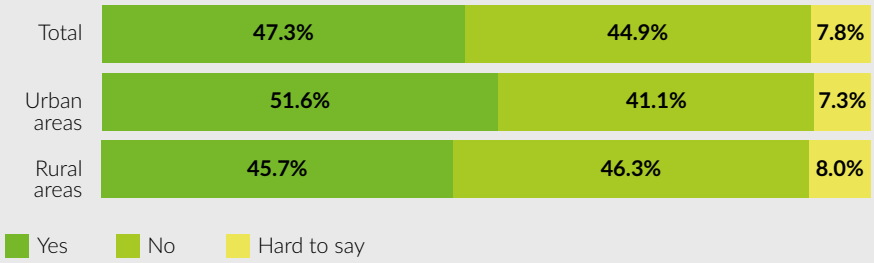


Source: CATI 2017; Sample N=475 (100%: respondents who claim to have heard about some forms of public aid); own analysis

WILLINGNESS TO HAVE COAL-FIRED BOILERS REPLACED AND TO MAKE THERMAL MODERNISATION INVESTMENTS

One of our goals was to determine whether and to which extent owners of coal-heated single-family buildings are willing to have their boilers or stoves replaced with modern models or switch to emission-free sources in the next 5 years. Respondents from the analysed group were asked the following question, preceded by a short introduction: "Poland is one of the European countries with the most polluted air. The main air pollutants include particulate matter emitted by individual coal-fired boilers. Therefore, it is possible that all obsolete coal-fired boilers and stoves will have to be replaced within the next few years with modern coal, biomass or gas boilers. Would you be willing to have your coal boiler replaced within the next 5 years given the fact that the average price of a new boiler is approximately PLN 8 thousand?".

Would you be willing to have your coal-fired boiler replaced given the fact that the average price of a new boiler is approximately PLN 8 thousand?



Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

47% of the respondents replied in the affirmative. The result may seem very optimistic, but it must be pointed out that the five-year perspective is quite a long-term one, which definitely has an impact on the motivation to carry

out such an investment. The level of readiness is much higher among urban residents – as much as 50% of the respondents from this group are sure they will have their boilers replaced within the indicated timeframe. The corresponding figure for rural areas is 46%.

There is little correlation between the willingness to have a coal-fired boiler replaced and the age of the building. The age of the boiler appears to play a more important role here – users of older boilers are more willing to invest in their modernisation. Unsurprisingly, among those respondents who are not planning to make any investments are mainly those who have bought their boilers relatively recently.

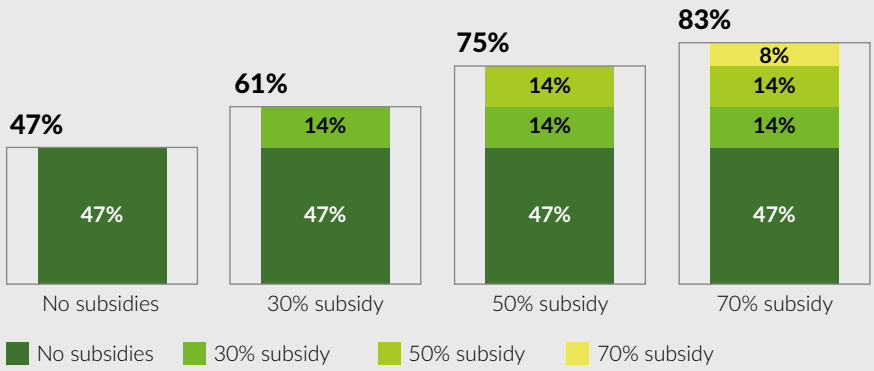
Would you be willing to have your coal-fired boiler replaced given the fact that the average price of a new boiler is PLN 8 thousand?	Total	Building construction years				Household monthly net income	
		Before WWII	1945–1988	1989–2000	2001+	< 4000 PLN	> 4000 PLN
Yes	47.3%	43.1%	46.5%	52.7%	50.9%	41.2%	58.8%
No	44.9%	47.3%	46.5%	35.9%	45.1%	52.0%	33.6%
Hard to say	7.8%	9.6%	7.0%	11.4%	4.0%	6.8%	7.6%
SAMPLE (N)	664	116	383	104	61	343	258

Source: CATI 2017; Sample N=1 000; own analysis

One of the most prominent barriers to investment involving heat source replacement is the lack of sufficient financial resources. If the question concerning willingness to have the heat source replaced by 2023 was answered in the negative, respondents were asked the same question again, but this time they were told that 30% of the investment would be co-financed from the state budget. Information about the co-financing encouraged a further 14% of the respondents to answer in the affirmative.

If the answer was still in the negative, the level of co-financing was hypothetically increased to 50% and then to 70%. If half of the costs were covered by a subsidy, a further 14% of the respondents would be willing to make the investment, which means that in total nearly 75%

Willingness for boiler replacement depending on the subsidy level

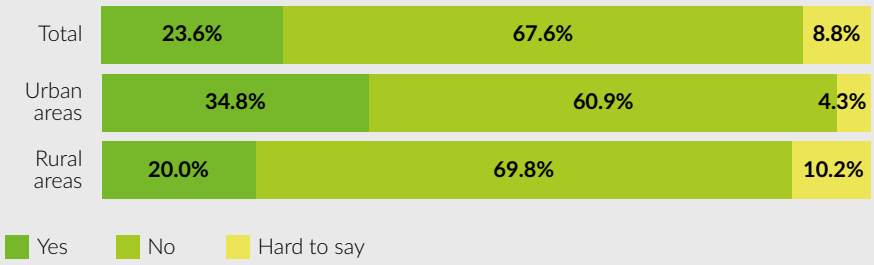


Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

of boilers in coal-heated houses could be replaced then. If the subsidy covered 70% of costs, over 80% of the respondents would be interested in making the investment.

Respondents living in buildings with uninsulated external walls were asked if they would invest in thermal modernisation assuming that reduced-interest loans specifically dedicated to financing that sort of works were available.

Would you be willing to invest in thermal modernisation if you were granted a reduced-interest loan?



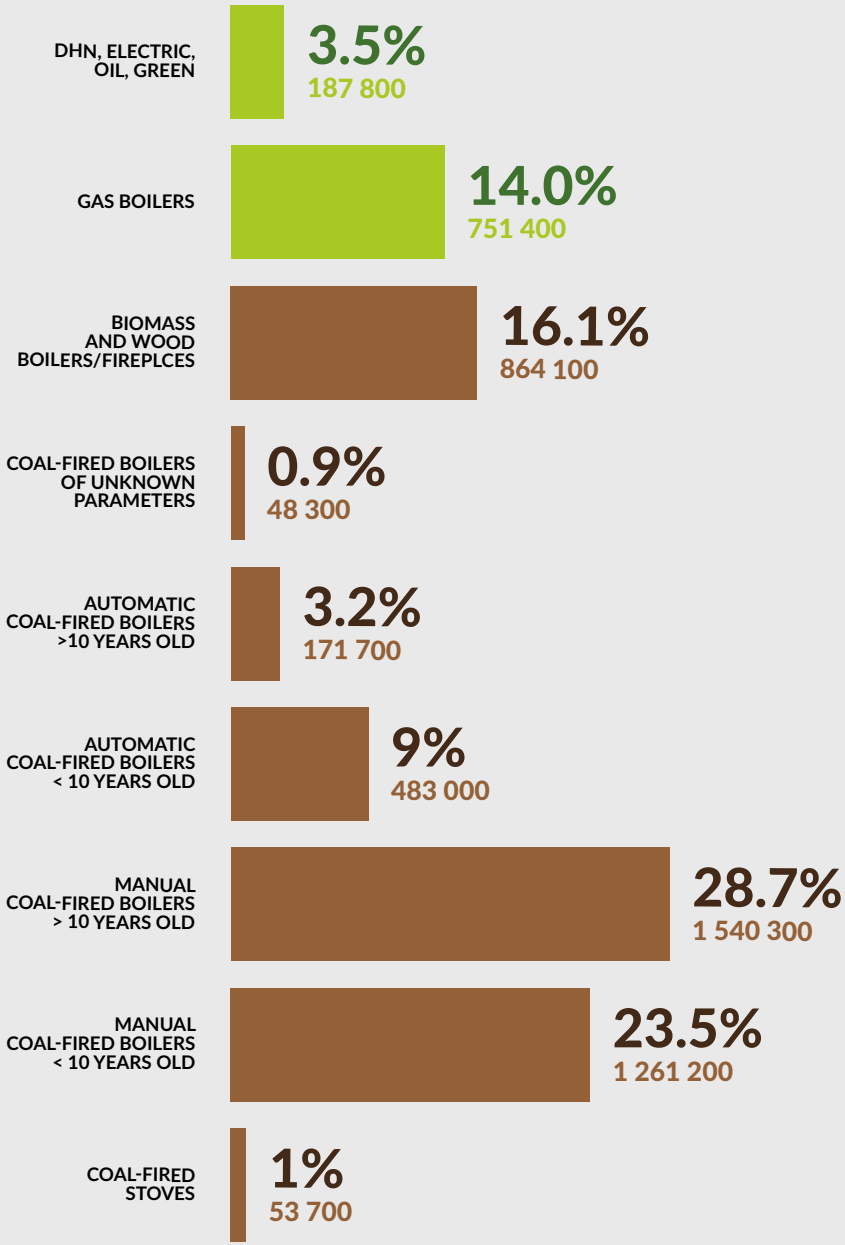
Source: CATI 2017; Sample N=664 (buildings in which coal-fired boilers are used); own analysis

The question asked ("The average cost of insulating a building against heat loss is approximately PLN 50 thousand. Insulation helps reduce heating costs, improve thermal comfort and aesthetics of the building. Would you be willing to make such an investment if you were granted a reduced-interest 10-year loan with a monthly instalment of PLN 500?") briefly described the basic characteristics of such a financial instrument, the main of which referred to the amount of the instalments not exceeding PLN 500 for a period of 10 years. **Every fourth owner of an uninsulated building would like to benefit from such support. The solution appeared much more attractive to urban dwellers. Nearly 35% of them answered the question in the affirmative. As far as rural areas are concerned, only 20% of the respondents expressed their interest in the proposed solution.**

SOURCES OF HEAT – ESTIMATION OF THE NUMBER OF BUILDINGS

The results of the research served as the basis for estimating the number of heat sources installed in single-family buildings in Poland (by source type). Considering the fact that the estimated number of single-family houses at the end of 2016 was around 5.4 milion, **the number of the most common heat sources, i.e. manual coal-fired boilers which are 10 years old or older, exceeds 1.5 million. Newer boilers of the same type (up to 10 years old) are used in over 1 million buildings.** The number of buildings heated with appliances burning biomass, mainly wood, is also considerable. This type of fuel is used as the main source of heat in nearly 1 million buildings.

The structure of heat sources – estimation of the number of buildings



Source: CATI 2017; Sample N=1 000; own analysis

940 thousand single-family buildings in Poland rely on heat sources characterised by low particulate emissions, such as gas boilers, electric heaters or DHN. Their share in the whole structure of single-family buildings in Poland is 17.5%.

Gas boilers are used by three times as many urban residents as rural residents. In the latter group though biomass boilers are used twice as often as in urban areas.

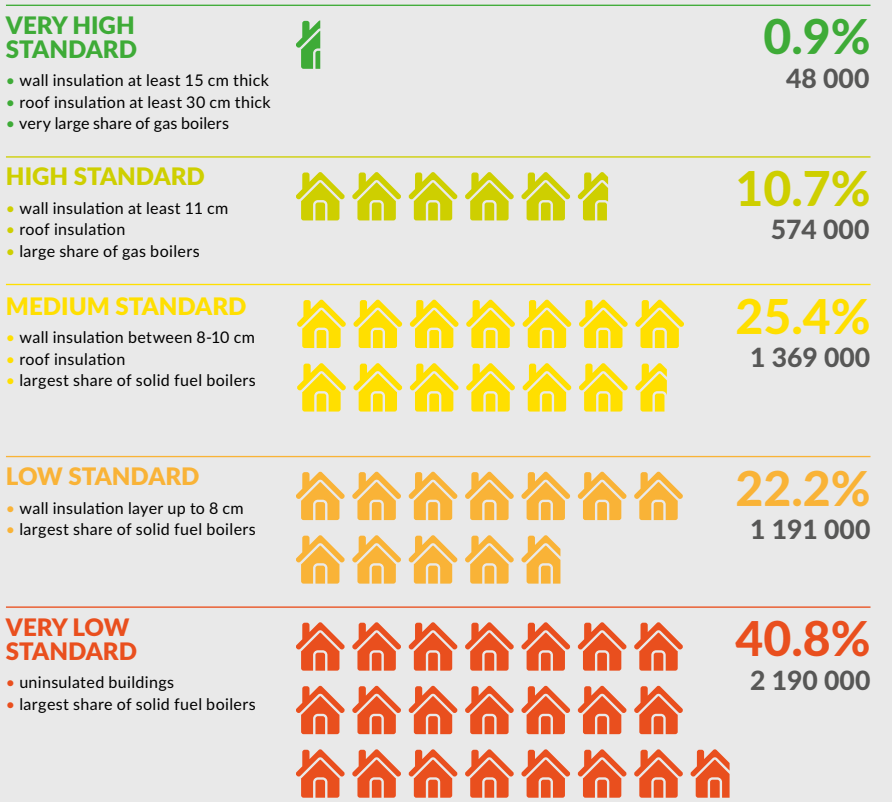
		Building construction years				Location of the building	
The structure of heat sources	Total	Before WWII	1945–1988	1989–2000	2001+	Urban areas	Rural areas
DHN, electric, oil, other	3.5%	4.9%	1.4%	6.0%	6.4%	6.6%	2.1%
Gas boilers	14.0%	7.2%	10.8%	23.1%	24.5%	26.0%	8.5%
Biomass and wood boilers/fireplaces	16.1%	25.1%	13.2%	13.2%	19.6%	9.5%	19.1%
Manual coal-fired boilers >10 years old	28.7%	27.8%	32.0%	27.4%	17.9%	25.7%	30.2%
Manual coal-fired boilers <10 years old	23.6%	25.1%	28.6%	16.1%	10.0%	17.4%	26.3%
Automatic coal-fired boilers >10 years old	3.2%	0.9%	3.0%	5.7%	4.1%	4.7%	2.5%
Automatic coal-fired boilers <10 years old	9.0%	5.6%	8.8%	7.5%	17.5%	9.5%	8.8%
Coal-fired stoves	1.0%	2.0%	1.0%	0.5%	0.0%	0.3%	1.3%
Coal-fired boilers of unknown parameters	0.9%	1.4%	1.2%	0.5%	0.0%	0.3%	1.2%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**312**	**688**

Source: CATI 2017; Sample N=1 000; own analysis

ENERGY PERFORMANCE OF SINGLE-FAMILY HOUSES IN POLAND – ESTIMATION OF THE NUMBER OF BUILDINGS

The results of the research served as the basis for estimating the number of buildings according to their energy performance standard. The size of the analysed sample was 5 million single-family buildings. The buildings were divided into 5 classes according to energy performance

Energy performance standard of single-family buildings in Poland – estimation of the number of buildings



Source: CATI 2017; Sample N=1 000; own analysis

criteria which they met. Only 48 thousand buildings (1%) were classified as the best performing ones. The two worst performing classes comprise nearly 3.5 million buildings.

The majority of buildings meeting high and very high standards have been erected in the last few years. The largest proportion of buildings with uninsulated external walls can be observed among those erected before WWII and those located in rural areas. Unsurprisingly, the standard of the building is closely associated with household income. **In urban areas there are twice as many buildings characterised by high and very high standard as in rural areas where nearly 50% of buildings are characterised by very low standard.**

		Building construction years				Location of the building	
Energy performance standard	Total	Before WWII	1945–1988	1989–2000	2001+	Urban areas	Rural areas
Very high standard	0.9%	0.0%	0.3%	0.5%	5.4%	1.6%	0.6%
High standard	10.7%	4.2%	6.4%	12.1%	36.0%	15.2%	8.6%
Medium standard	25.4%	19.9%	25.0%	30.5%	28.6%	26.3%	25.1%
Low standard	22.2%	23.2%	21.5%	28.1%	15.0%	25.2%	20.8%
Very low standard	40.8%	52.7%	46.8%	28.8%	15.0%	31.7%	44.9%
SAMPLE (N)	**1 000**	**183**	**518**	**175**	**124**	**312**	**688**

Source: CATI 2017; Sample N=1 000; own analysis

FINANCING BUILDINGS MODERNISATION FROM THE EU ETS FUNDS

ALEKSANDER **ŚNIEGOCKI**
WISE EUROPA

Low energy efficiency and obsolete, emission intensive heat sources used in Polish buildings generate high economic, social and environmental costs. The only solution to this problem is the implementation of a large-scale programme for supporting comprehensive modernisation of buildings in Poland. However, despite the growing awareness of the public and decision-makers concerning the necessity to take measures in this area, the source of financing for such a programme remains an unsolved issue. Due to the scale of necessary investments, its scope would have to largely exceed the solutions that are currently applied in Poland. It is, therefore, necessary to find new sources of financing the investments in energy efficiency and heat sources replacement in Polish buildings. One of the options is the use of funds from the EU Emissions Trading System (EU ETS) that Poland can expect in a dozen years to come. **The EU ETS may become a key source of financing the modernisation of buildings in Poland**. It is, however, necessary to change the current attitude that is focused mainly on the investment needs in the power sector. It is also indispensable to address the risk connected with the possibility to direct the majority of funds from the EU ETS to the national budget and not to the dedicated mechanisms supporting the investments that increase energy efficiency and improve the quality of air in Poland.

ESTIMATION OF FUNDS AVAILABE FROM THE EU ETS

The estimation of funds available from the EU ETS in various variants of prices and decisions on derogation for power industry is presented in the table below.

Funds from the EU ETS that may be allocated for modernisation investments outside the power industry in 2018-2030, in billion PLN (in fixed prices of 2017)

		Modernisation Fund	Auction revenues	Total
Increase in prices of allowances (average in 2018-2030: 22 EUR/t)	Base variant – 40% derogation	14	83	**97**
	Derogation increased from 40% to 60% and enlarged Modernisation Fund	29	53	**82**
	No derogation for power industry	14	113	**127**
Maintained low prices of allowances (average in 2018-2030: 5 EUR/t)	Base variant – 40% derogation	3	20	**23**
	Derogation increased from 40% to 60% and enlarged Modernisation Fund	6	14	**20**
	No derogation for power industry	3	27	**30**

Source: WiseEuropa own analysis

Evaluation of estimates obtained in terms of using funds from the EU ETS to finance the modernisation of buildings in Poland leads to the following conclusions:

- **The amount of funds available is significant and largely exceeds the scale of the public support for thermal modernisation provided so far** even in the variant of maintained low prices of emission allowances.
- Auction revenues are several times higher than the funds that Poland will obtain as part of the Modernisation Fund. The decision concerning division of auction revenues between the national budget and modernisation investments will therefore be crucial.
- Greater support for power industry (derogation) reduces the total amount of funds than may be directed to other sectors. However, simultaneously, the scale of the Modernisation Fund, i.e. funds that do not risk being directed to the budget instead of supporting modernisation investments, is enlarged.

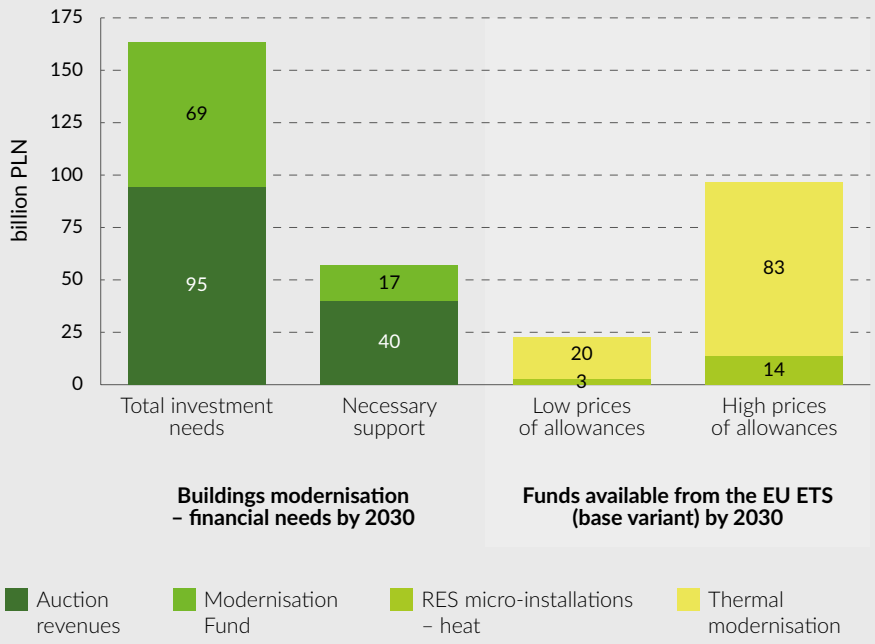
Will the funds from the EU ETS be sufficient to meet the financial needs related to the implementation of the comprehensive programme for the modernisation of Polish buildings? The answer to this question is included in the comparison of forecast receipts from the emissions trading system to estimates concerning the scale of support necessary to implement investments in thermal modernisation and replacement of heat sources with RES low-emission micro-installations (e.g. modern biomass boilers, heat pumps, solar collectors). Such a comparison was made by the WiseEuropa Institute in mid-2017, on the basis of their own forecasts on the EU ETS and estimates provided by the Institute for Renewable Energy (IEO) and the Polish National Energy Conservation Agency (KAPE) experts, concerning total financial needs and the scale of support necessary to encourage households to make investment efforts. As a result of implementing the analysed investment scheme until 2030, energy consumption in buildings would be reduced by 3.8 Mtoe, low-emission generation of heat would be increased by 1.4 Mtoe and emission of harmful pollutants from buildings would be reduced by over 40%*.

The comparison results indicate that in the case of an increase in prices of allowances, **the funds from the EU ETS will be sufficient to cover with interest the costs of the scheme for supporting the comprehensive modernisation of buildings in Poland by 2030.** However, it will be vital to use not only the Modernisation Fund but also a part of receipts from the auction sale of allowances. The remaining revenues from the sale of allowances could be allocated for investments in other sectors (e.g. heat engineering, electromobility), protection of energy-consuming industries or support for restructuring in Silesia and in other centres that depend on high-emission branches of economy.

In the case of maintaining very low prices of emission allowances, the allocation of funds from the auction sale of allowances for modernisation purposes is all the more crucial. If the derogation mechanism for power industry is abandoned and total funds from the EU ETS are directed to investments in buildings modernisation, it will be possible to finance approximately a half of the analysed investment scheme.

* Detailed results of the analysis have been presented in the report *Unlocking the hidden potential. Economic influence of investments in RES micro-installations and buildings thermal modernisation* (WiseEuropa 2017).

Comparison of the amount of funds available from the EU ETS to the financial needs regarding the comprehensive modernisation of buildings in Poland until 2030



Source: WiseEuropa own study based on the report Analysis of the use of Auction Revenues by the Member States (Ramboll 2017)

PRIORITY LINES OF SUPPORT: BUILDINGS ENERGY EFFICIENCY AND HEATING MODERNISATION VERSUS POWER SECTOR

Despite considerable investment needs in the area of thermal modernisation and replacement of heat sources in Polish buildings, the national public debate held so far on the use of the funds from the EU ETS is focused on modernisation needs in the power sector. It concerns both the derogation mechanism and the Modernisation Fund that tends to be treated as an instrument dedicated to energy sector and not to the entire Polish economy.

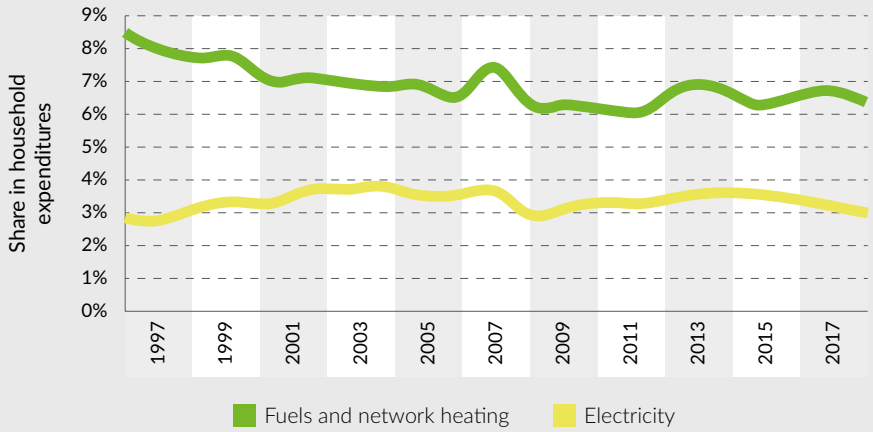
Numerous economic, social and environmental arguments suggest reorientation of priorities in managing the funds from the EU ETS from the power sector to buildings:

- The power sector and buildings alike require considerable investment outlays in the years to come. However, households encounter much greater problems with obtaining financing for investments than energy companies; they also struggle with greater information barriers and expect a quicker return on investment. **Market fallibility calling for public intervention is, therefore, much higher in the case of buildings modernisation than in the case of investments in the power sector.**
- Heating expenses exceed electricity expenses in household budgets more than twice. If the motivation of support provided to the power sector is the indirect influence on reducing citizens' electricity expenses, a direct support for investments in thermal modernisation is a more effective alternative. In the case of subsidies on buildings modernisation, it is possible to diversify the support intensity, e.g. depending on the level of beneficiaries' income.
- Lack of support for the power sector does not jeopardise the achievement of an environmental effect as the emission standards are binding. In the case of buildings, lack of financial support for investments in thermal modernisation and replacement of heat sources (particularly for low-income households) may cause that obsolete, inefficient and emission-intensive heating sources will continue to be used.

EU ETS
BASIC INFORMATION

The EU ETS is a key instrument of the European Union climate policy aiming to stimulate the reduction in greenhouse gases emission in the selected sectors, including power sector and heavy industry. It is a *cap and trade* system. The general pool of emission allowances is limited (*cap*) and companies may trade in them among themselves (*trade*). It means certainty of reduction in emissions

Share of expenses on electricity and on energy carriers used for heating purposes in the consumption expenditures in Poland in 1997-2017



Source: WiseEuropa own study based on Eurostat data

on the scale of the entire system while simultaneously maintaining the flexibility of actions at the level of particular installations. The future price of allowances is not certain though and depends on the relation between supply and demand on the market. The allowances are introduced into the market through a free allocation as well as at auctions, whereas the latter mechanism is consistently growing in importance. In 2012, the allocation of free allowances for the power sector was completed (except for the so-called derogation mechanism enabling the maintenance of a partial allocation of free allowances in the Central European countries, including Poland). In the case of other sectors, the allocation of allowances granted free of charge is gradually dropping. In the following decade, over a half of allowances available as part of the system will be sold at auctions.

At auctions, the vast majority of allowances are sold by the Member States. The pool of allowances to be sold is established for particular countries on the basis of historical emissions. Relatively low-income countries, including Poland, additionally benefit from preferential rules of allocating the allowances. Currently, as part of the EU ETS,

the Polish government gains more funds from auctions than national companies are forced to spend on the purchase of allowances – Poland is a net beneficiary of cash flows as part of emissions trading. A change in the level of national emissions does not affect the income from the sale of allowances received by the Polish government (in this regard, the EU ETS differs from the national tax on CO_2 emission). However, if the emissions from the national power sector and industry are not reduced, the present positive balance of cash flows as part of the system between Poland and foreign countries will deteriorate.

THE EU ETS REFORM AND THE PROSPECT OF FINANCING MODERNISATION INVESTMENTS UNTIL 2030

In November 2017, the final details were established on the EU ETS reform that defines the rules of the system functioning in 2021-2030. It is an answer to the problems encountered by the EU ETS in the course of the last decade. The economic crisis and lack of coherence with other policies (e.g. faster development of the RES than it was assumed) led to the reduction in demand and to the excessive supply on the market of allowances. Consequently, low prices of allowances are maintained and have not exceeded the value of 10 EUR/t for years. The reform of the EU ETS assumes a reduction in the excessive supply of allowances through their temporary moving to the so-called stabilisation reserve, as well as the permanent withdrawal of some of them from the market. Even though the final impact of these changes on the price of allowances is uncertain, many forecasts predict its increase to the level of 20-30 EUR/t in the future decade. Additionally, the reform streamlines the rules of protecting heavy industry from the *carbon leakage* phenomenon (emission leakage to the countries not included in the EU ETS) and introduces two instruments financed from the sale of allowances at auctions: the Fund

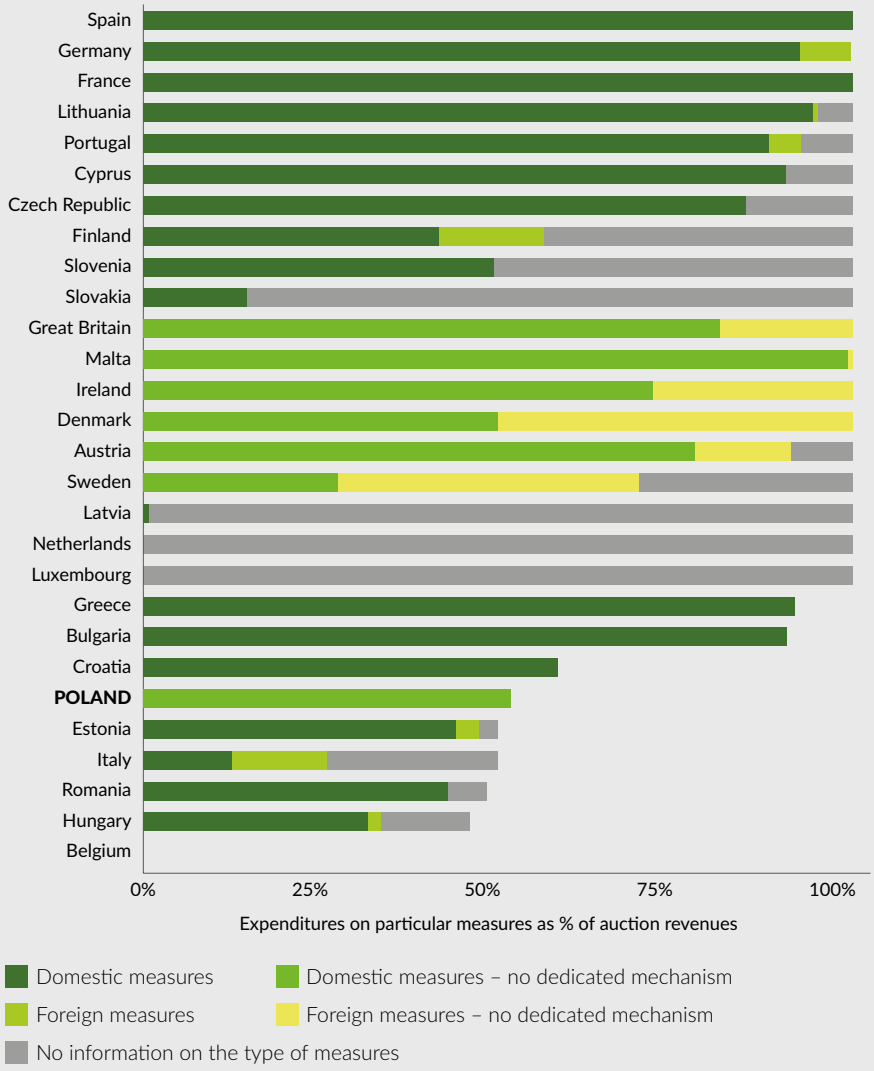
for Innovation for Power Sector and Industry and the Modernisation Fund that is to support low-emission investments in Central Europe, including Poland. Furthermore, the period of validity of derogation for the power sector was extended: Central European countries will be able to allocate 40% of their pool of allowances free of charge to the power sector in exchange for modernisation investments. It is possible to increase this rate from 40% to 60%, provided however that an equivalent pool of allowances is simultaneously allocated to the Modernisation Fund. Possibilities of investing in coal energy sector were also limited as part of the derogation mechanism and in the case of the Modernisation Fund it will not be possible whatsoever. The amount of funds to be allocated for investments in buildings modernisation will therefore depend on the prices of allowances and on decisions on the degree of using the derogation mechanism.

USING THE FUNDS FROM THE EU ETS AUCTIONS
EXPERIENCE GAINED SO FAR BY POLAND AND THE EU

The EU ETS directive contains the guidelines on the use of receipts from the sale of allowances by the Member States. In accordance with these guidelines, at least a half of the funds gained at auctions should be allocated for the climate policy purposes including e.g. investments in the renewable energy sources and energy efficiency as well as financing low-emission investments in the third countries as part of the development aid. Thus, the potential directing of funds from the EU ETS to buildings modernisation perfectly fits into the EU climate policy framework.

The annual reports on the use of auction revenues that are submitted by the Member States show that the vast majority of them declare climate expenditures exceeding 50% of funds from the EU ETS. It should be noted, however, that such declarations do not have to necessarily

Funds from the auction sale of allowances allocated to the measures connected with the climate and energy policy in 2013-2015



Source: WiseEuropa own study based on the report Analysis of the use of Auction Revenues by the Member States (Ramboll 2017)

translate into the actual increase in modernisation expenditures. Only some of the countries have implemented dedicated, transparent mechanisms for allocating funds from the EU ETS to the measures connected with climate policy. In other cases, for official reporting purposes, governments may show initiatives that would anyway be financed from the public funds, regardless of the additional stream of revenues from the emissions trading system. It concerns also Poland that in 2013-2015 obtained over EUR 450 milion from the sale of allowances at auctions.

Pursuant to the Polish Act on emissions trading system, the funds obtained from the sale of emission allowances constitute the national budget's income. Further provisions of the Act are consistent with the guidelines included in the EU ETS directive and provide for the allocation of at least a half of the funds obtained for the purposes connected with energy and climate policy. However, the analysis of national reports in this regard* indicates that in the previous years there was no actual increase in financing modernisation investments (including the area of energy efficiency) thanks to the funds obtained from the EU ETS. The projects pointed out by Poland in the reports of 2013-2015 as those supported by auction revenues were financed by the National Fund for Environmental Protection and Water Management and by regional funds for environmental protection (e.g. *KAWKA* or *Prosument* programmes). These funds are financed from other sources than EU ETS auctions. Therefore, there is nothing to suggest that receipts from allowance auctions in the national budget would translate into a greater number of investments in energy efficiency or low-emission sources of energy.

A different attitude was adopted e.g. by France that allocated total funds obtained from the sale of allowances to buildings modernisation as part of the scheme *Habiter Mieux*. Central European countries also apply dedicated mechanisms that enable transparent management of the receipts from the EU ETS (e.g. Czech thermal modernisation programme *Nova Zelena Usporam* and Slovak scheme for supporting energy efficiency improvement in public buildings).

* The reports are published on the website http://rod.eionet.europa.eu/obligations/698/deliveries

THE ASSESSMENT OF LABOUR DEMAND GENERATED BY SINGLE-FAMILY BUILDINGS MODERNISATION PROJECTS IMPLEMENTED IN THE VOIVODSHIPS OF MAŁOPOLSKIE AND ŚLĄSKIE

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INTRODUCTION

The adoption of anti-smog resolutions in the voivodships of małopolskie and śląskie implicates the necessity to replace heat sources in the vast majority of single-family houses located in this region. Thermal modernisation interventions may have a positive effect on the labour markets in these voivodships, thus creating additional labour demand, particularly among poorly qualified persons who face greater risk of unemployment than those having a secondary school diploma or a university degree. This study shows what labour demand can be created by thermal modernisation measures taken in single-family houses in the voivodships that were the first in Poland to adopt anti-smog resolutions. With this end in view, we use a labour demand and labour supply model. We consider various

We would like to thank Mr Szymon Firląg (BPIE) and Mr Adrian Chmielewski (Warsaw University of Technology) for their technical support in the field of single-family buildings and Mr Szymon Górka (IBS) for his analytical assistance.

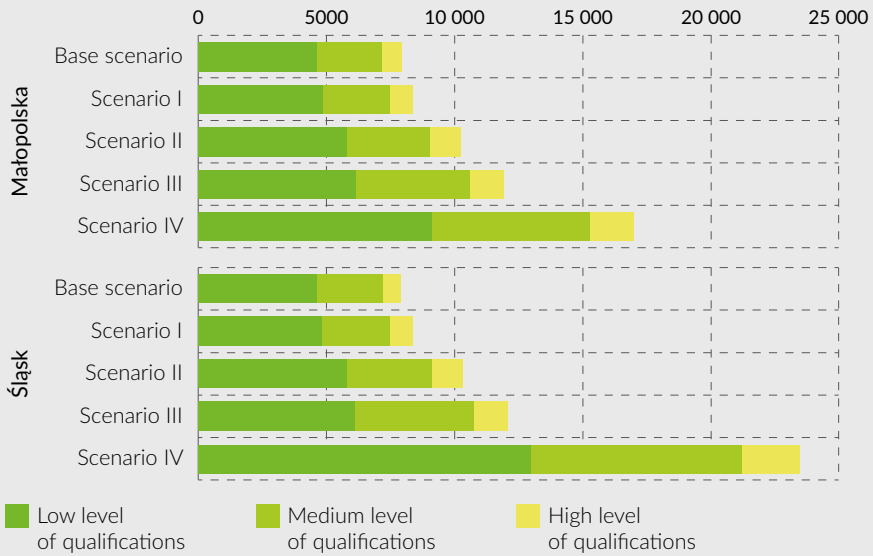
scenarios of measures taken – from meeting the resolutions' requirements to the comprehensive thermal modernisation including not only the replacement of boilers and the modernisation of systems but also buildings complete insulation and installation of solar collectors. **The simulations that we have carried out indicate that the effect for the labour market may be significant provided that a more comprehensive thermal modernisation of buildings is conducted and not only boilers' replacement.** A simultaneous systems modernisation and installation of solar collectors may bring additional 8 thousand jobs in total in these voivodships, whereas a comprehensive thermal modernisation – four times more.

RESULTS

According to our estimates, in each of the voivodships, naturally implemented thermal modernisation measures engage approximately 8 thousand persons, as expressed in annual full-time equivalents. An extended scope of thermal modernisation interventions resulting from the implementation of anti-smog resolutions could increase this number by even 2.5 times. **However, if only obligatory measures, i.e. replacement of heat sources (boilers, scenario I), are taken as a result of the resolutions, the employment in this area will rise insignificantly, only by 6% in each of the voivodships.** The effects will be more noticeable if the replacement of heat sources is accompanied by additional interventions. In the case of a simultaneous modernisation of central heating and domestic hot water systems (scenario II), the number of persons working on thermal modernisation would be 20% higher and would exceed 10 thousand persons (as expressed in annual full-time equivalents) in each of the voivodships. Installation of solar collectors (scenario III) would require two thousand more employees in each of the voivodships. The rate of employment in the area of thermal modernisation would exceed 12 thousand persons in both voivodships, i.e. it would be 50% higher than in the base scenario.

It is, however, insulation of buildings – their external walls, roofs and floors held simultaneously with the replacement of windows (scenario IV) that would have the most significant impact on the labour market. The comprehensive thermal modernisation of single-family houses in the voivodships of śląskie and małopolskie could create jobs even for 32 thousand additional persons. It should be noted that even if the influence of heat sources replacement and systems modernisation scenarios on the rate of employment is similar in both voivodships, the impact of insulation would be more significant in the voivodship of śląskie (15.5 thousand persons) than in the voivodship of małopolskie (9 thousand persons). It results from the fact that the number of single-family houses that will be subject to the heat sources replacement requirement is similar in both voivodships but the number of non-insulated houses is higher in the voivodship of śląskie.

Estimation of average annual labour demand related to thermal modernisation measures taken in the voivodships of małopolskie and śląskie by the level of qualifications (number of persons employed on a full time basis)



Source: Own analysis

The structure of labour demand created by thermal modernisation measures divided by the level of qualifications is also of major importance for the labour market. Over a half of these jobs require poorly qualified employees, i.e. persons who completed vocational training. Creating such jobs may be particularly useful in the areas where branches that traditionally need such employees fall into decay, especially traditional industries. Furthermore, poorly educated persons face a greater risk of unemployment than better educated people. Therefore, the labour demand created by thermal modernisation measures may contribute to lowering the unemployment rate. According to our estimates, **a drop in the unemployment rate would be noticeable in the case of the labour-consuming scenario IV that encompasses a comprehensive thermal modernisation and would reach 0.3 pp of the unemployment rate in the voivodship of małopolskie and 0.4 pp of the unemployment rate in the voivodship of śląskie. The scenarios that are limited to systems modernisation have an insignificant influence on the unemployment rate (it does not exceed 0.15 pp).**

CONTEXT

The anti-smog resolutions adopted in 2017 in the voivodships of śląskie and małopolskie constitute an important step towards improvement of the quality of air in Poland. The provisions contained in the documents are a significant incentive to increase the pace of replacing heat sources with more environmentally friendly ones, and the necessity to take the measures refers particularly to owners of single-family buildings. In 2016, in the voivodship of małopolskie there were 563.7 thousand single-family buildings, of which 435 thousand were equipped with solid fuel boilers*. 547.2 thousand single-family buildings, of which 470 thousand were equipped with boilers, were located in the voivodship of śląskie**. As it is stipulated in anti-smog resolutions, in the voivodship of małopolskie, coal or wood boilers that meet no emission standards

* Data obtained from the CEM Market and Public Opinion Research Institute.

** Details of an inventory drawn up by the Marshal's Office of the Śląskie Voivodship.

whatsoever should be replaced by the end of 2022, whereas class 3 and 4 boilers – by 2026 (time horizon: 6 and 10 years respectively). In the voivodship of śląskie, boilers that do not meet emission standards can be used for a maximum of 8 years, till the end of 2025. To sum up, in a horizon of approximately 10 years, nearly one million stoves are to be replaced in both voivodships.

However, the resolutions are not a direct incentive to take other thermal modernisation measures, such as systems replacement or houses insulation, by the owners of buildings. Therefore, a question arises whether these regulations will contribute to considerable improvement of energy efficiency in residential buildings. A policy that would accompany these resolutions and that would encourage owners to take thermal modernisation measures on a larger scale could be a facilitator. Currently, single examples of similar profile programmes can be pointed out – e.g. *Jawor* programme handled by the Małopolska Fund for Environmental Protection and Water Management that offers preferential loans to cover the costs of single-family buildings insulation. **Much stronger environmental effects than those obtained only through the replacement of heat sources constitute serious arguments for supporting the comprehensive thermal modernisation.** A significant improvement in buildings energy efficiency also translates into the quality of life of their inhabitants and into savings in household budgets. The financial aspect is of particular importance in the context of new heat sources that require using more expensive, better quality fuels.

The influence of thermal modernisation measures' intensification on the labour market may also be vital for the public policy. Although the rate of unemployment* in 2016 was low both in Poland (6.3%) and in the analysed voivodships (śląskie – 5.5%, małopolskie – 5.3%), it was considerably higher among poorly qualified employees and amounted to 9.2% in Poland, 9.2% in the voivodship of śląskie and 7.2% in the voivodship of małopolskie. As we prove in this paper, poorly qualified unemployed persons will be able to find jobs related to buildings modernisation.

* The rate of unemployment for the population aged 15-64. Own calculations based on the Central Statistical Office's Research on Population Economic Activity (2016).

ESTIMATION OF LABOUR INTENSITY OF ENERGY RETROFIT

In order to estimate labour demand and its influence on the level of unemployment, single-family buildings were divided into two categories taking into account their age – into those built before 1970 and newer ones. Then, a model building with average or most typical features was assigned to each category. Buildings erected before 1970 are represented by a one-storey house of 76 m^2 of usable floor area, with a non-habitable attic, gable roof and non-insulated external walls made of solid brick. For buildings erected after 1970, the model building is a two-storey house of 137 m^2 of usable area, with a full basement, flat roof and non-insulated external walls made of brick*.

In the next step, thermal modernisation works were matched to both model buildings according to their specificity. We took into account not only building envelope insulation and replacement of window frames but also heating system modernisation. For particular interventions conducted in a given building, we determined the necessary labour inputs divided into work of persons having low, medium and high level of qualifications. The labour inputs were expressed in man-hours and calculated on the basis of the Construction Pricing Guide (KNR – Katalog Nakładów Rzeczowych) that are used to make a cost estimate of construction works and constitute the only comprehensive source of knowledge about labour consumption of construction works. Labour inputs of highly qualified persons – auditors and energy advisors, managers in construction companies and employees responsible for design documentation were estimated separately with the use of expertise**. The results of this estimation were presented in the table below. The most labour-consuming intervention for both types of buildings is insulation of external walls, then insulation of floor/ceiling above the basement in buildings erected before 1970 and replacement of windows in buildings erected after 1970. **All the works except for the installation of solar collectors require particularly labour input of poorly qualified persons.**

* Detailed characteristics of the model buildings can be found in the methodological report on the website www.ibs.org.pl.

** Currently, thermal modernisation of single-family buildings requires work of highly qualified persons to a lesser extent. It was however assumed that introduction of public support programmes would impose at least partial professionalization of the method of thermal modernisation interventions.

Labour inputs necessary to conduct thermal modernisation works, divided by type of single-family buildings and qualifications of employees [man-hours]	Building 1 (erected before 1970)			Building 2 (erected after 1970)		
	Low level of qualifi-cations	Medium level of qualifi-cations	High level of qualifi-cations	Low level of qualifi-cations	Medium level of qualifi-cations	High level of qualifi-cations
Insulation of external walls	388	230	20	789	379	33
Insulation of flat roof / attic	50	0	20	59	46	32
Replacement of windows	41	38	20	87	80	32
Ground level floor/ ceiling above basement	109	0	20	18	14	32
Central heating system	58	27	7.5	38	28	8.5
Domestic hot water system	3	6	7.5	3	7	8.5
Boiler	12	4	7.5	12	4	8.5
Solar collectors	12	64	7.5	18	70	8.5
IN TOTAL	673	369	110	1024	628	163

Source: Own study for IBS prepared by Adrian Chmielewski, Faculty of Civil Engineering, Warsaw University of Technology

SINGLE-FAMILY HOUSES THERMAL MODERNISATION SCENARIOS

The scope of thermal modernisation measures influences a change in characteristics of single-family buildings and the necessary labour demand alike. As it is impossible to determine in advance the scope of measures taken as a result of anti-smog resolutions entered into force in the voivodships of małopolskie and śląskie, four different scenarios are taken into account.

The first scenario assumes that house owners and administrators will fulfil only their minimum obligation imposed by the resolutions, i.e. they will replace class 3 and 4 boilers as well as boilers that meet no emission standards whatsoever. The second scenario assumes that while replacing

a boiler, central heating and domestic hot water system will also be modernised. The third scenario assumes that apart from the replacement of a boiler and modernisation of central heating and domestic hot water system, solar collectors will also be installed. Finally, **the most challenging scenario (IV) assumes that the above-mentioned modernisations connected with heat supply will be accompanied by building comprehensive insulation: insulation of external walls, roof, ground level floor or ceiling above the basement and replacement of windows. In terms of energy efficiency and low-stack emission reduction, it is the most desirable scenario.** Anti-smog resolutions indicate various time horizons for different class boilers but accessible data do not enable us to estimate the share of particular classes in the current stock of boilers. Therefore, in order to facilitate comparisons between the scenarios, it is assumed for each of them that selected interventions included in a given scenario will be implemented within 10 years on the entire stock of single-family houses – in the case of interventions concerning heat sources, on the entire stock of houses equipped with stoves and in the case of walls insulation, in all uninsulated buildings. It is simultaneously assumed that interventions not included in a given scenario will be conducted in the current pace.

Housing stock subject to modernisation

	Buildings erected before 1970		Buildings erected after 1970	
Voivodship	Uninsulated buildings in total	Buildings equipped with solid-fuel stoves (insulated and uninsulated)	Uninsulated buildings in total	Buildings equipped with solid-fuel stoves (insulated and uninsulated)
Małopolskie	83 458	190 573	107 042	244 427
Śląskie	146 331	234 569	146 869	235 431

Source: Data obtained from the CEM Market and Public Opinion Research Institute and from the Marshal's Office of the Śląskie Voivodship, divided into the buildings erected before and after 1970 in accordance with the National Census 2011.

The scenarios are analysed with reference to the base scenario, i.e. the annual pace of thermal modernisation measures that would be taken regardless of the adopted anti-smog resolutions. **On the basis of data obtained from the Central**

Statistical Office*, the annual pace of conducting insulation works was estimated at 2.7%** in the case of buildings erected before 1970 and at 1.7% in the case of buildings erected after 1970. As the decision on building insulation is not always accompanied by modernisation of heat sources, it is assumed that the natural pace of replacing boilers, modernisation of central heating and domestic hot water system as well as installation of solar collectors is 50% slower than the pace of insulation works, i.e. 1.3% per year for buildings erected before 1970 and 0.8% per year for buildings erected after 1970 (accessible data do not enable a more accurate estimation).

* Research on household budgets and survey on consumption of fuels and energy in households, 2012 and 2015.

** With reference to the entire stock of a given type of buildings, insulated and uninsulated ones.

Thermal modernisation scenarios in single-family houses located in the voivodships of małopolskie and śląskie	Intervention pace			
	Boiler replacement	Modernisation of central heating and domestic hot water systems	Installation of solar collectors	Insulation of external walls, roof, ground level floor or ceiling above the basement and replacement of windows
Base scenario	natural	natural	natural	natural
Scenario I – basic	accelerated – the entire stock modernised within 10 years	natural	natural	natural
Scenario II – intermediate	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years	natural	natural
Scenario III – intermediate with RES elements	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years	natural
Scenario IV – advanced	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years	accelerated – the entire stock modernised within 10 years

Source: Own analysis

LABOUR MARKET MODEL

We have used a labour market model that provides projections of employment and labour supply in Poland and in particular voivodships, altogether and by employees' qualifications. The projection is based on the Central Statistical Office population forecast and encompasses the period until 2030. This model description can be found in the methodological report available on the IBS website.