ENERGY EFFICIENCY IN POLAND
2013 REVIEW

SINGLE FAMILY HOUSES
ENERGY EFFICIENCY AND AIR QUALITY

Institute of Environmental Economics

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TABLE OF CONTENTS

INTRODUCTION

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We are pleased to present the second volume of the annual review of "Energy Efficiency in Poland".* This year we have decided to focus on the issue of energy efficiency in single-family buildings, paying special attention to air pollution.

* The English version contains only selected articles – the full version is available only in Polish.

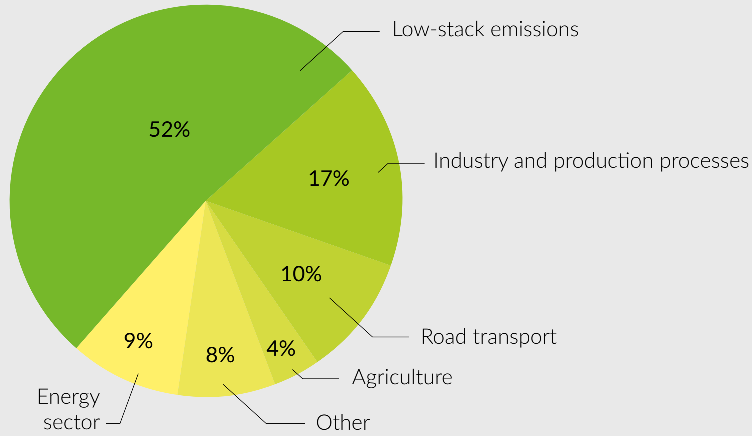
Poland is in the unenviable position of being the leading European country in terms of poor air quality. In 2012, out of 46 zones established in Poland for the purposes of air monitoring, 38 were categorised as class C due to a large number of days when daily PM_{10} values were exceeded. Annual $PM_{2.5}$ concentrations were exceeded in nearly half of the zones. All the country has serious problems with the concentrations of mutagenic and carcinogenic benzo[a]pyrene – B[a]P. The annual EU limit of 1 ng/m^3 was exceeded in as many as 42 zones. What is worth stressing , the scale of the violation was frequently serious – in many towns and cities the norm was exceed over 1000%, and in the worst case it reached the level of nearly 2000%.

The bill we pay for this includes several billion in external costs – in particular costs of life and health loss, as well as a reduction in productivity for Poles. The European Commission has initiated legal proceedings against Poland for its persistent violations of air quality standards. Therefore, it is likely that another bill will soon have to be paid in the form of EU financial penalties which could cost us hundreds of millions a year.

There are over 5 million single-family houses in Poland, most of which are poorly insulated against heat loss or not insulated at all. Poles heat them using old and inefficient coal boilers, often fired with low-quality coal. This is why the air quality in our country is so terrible. House heating is the main source of such pollutants as particulate matter, polycyclic aromatic hydrocarbons, heavy metals and dioxins. The largest concentrations of particular matter and benzo[a]pyrene can be observed during the heating season – from October to March. For PM_{10} and $PM_{2,5}$, concentrations during winter may be even three times higher (depending on the city) than in late spring through early autumn. For benzo[a]pyrene this difference between warm and cold months is even larger and frequently amounts to around 50 times or more.

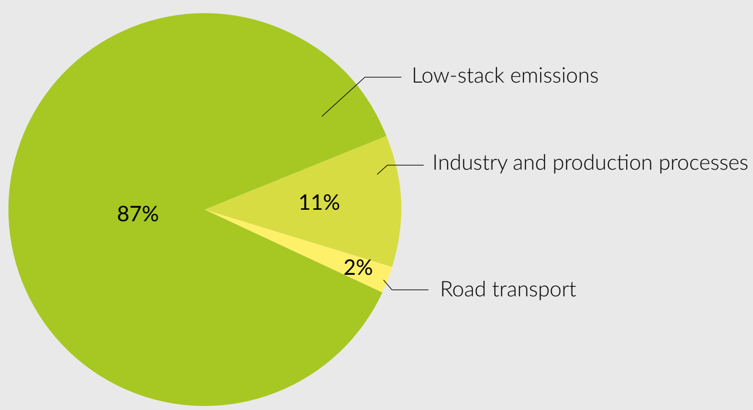
The data of the National Centre for Emission Balancing and Management prove that low-stack emission (i.e. emission from household heating appliances) accounts for 52% of PM_{10} emissions and 87% of polycyclic aromatic hydrocarbon emissions.

PM10 emission sources in Poland (2012)



Source: Based on the data provided by the National Centre for Emission Balancing and Management

Emission sources of polycyclic aromatic hydrocarbons (e.g. benzo[a]pyrene) in Poland (2012)



Source: Based on the data provided by the National Centre for Emission Balancing and Management

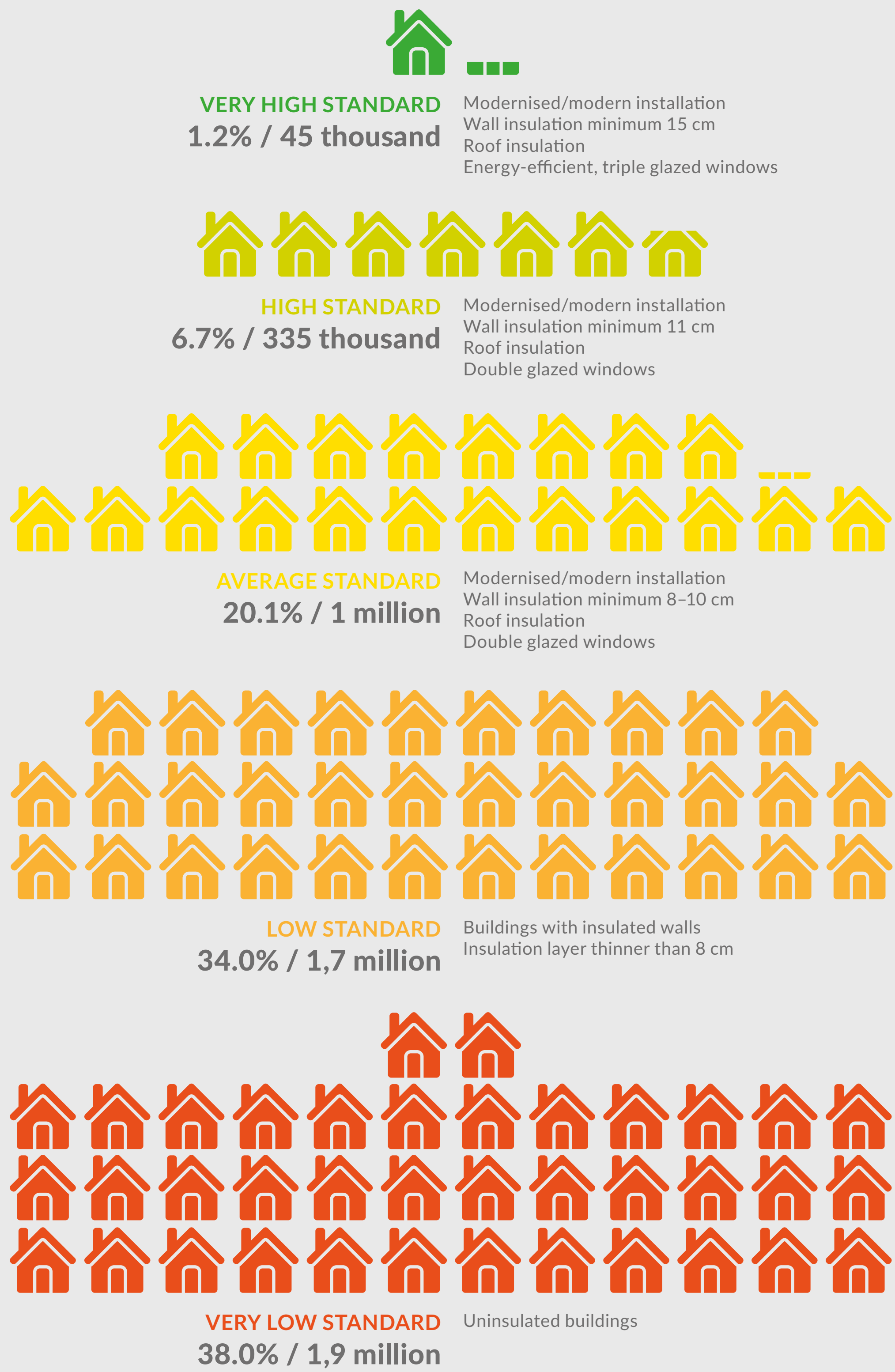
Although the energy efficiency of newly constructed single-family houses is increasing, the technologies and materials that improve energy performance above the level of minimum technical requirements are still used only to a limited extent. On the other hand, the popularity of coal heating continues to grow. Investors and architects fail to realize that the greatest energy savings can be achieved during the design and construction phases.

The relatively poor thermal insulation of single-family buildings and the lack of emission standards for boilers and fuels contribute to increasing low-stack emission and will compound the problem of inefficient energy management for many years to come. They also limit the possibility of ensuring energy security by providing Polish homes with the most reliable “fuel”, i.e. energy efficient buildings.

As far as support for renovation and modernisation is concerned, Polish energy and environmental policies have not focused so far on the sector of single-family buildings. Policy makers ignore single-family houses, probably assuming that if someone owns a house, they can afford to have it renovated. Most single-family buildings, however, are located in low-income rural areas. Institutions providing support for thermal modernisation and renovation tend to choose large projects – single-family houses do not stand a chance against housing associations and public buildings.

As seen in other European countries, the modernisation of single-family buildings can be effectively supported to the benefit of both the economy and society. In Poland, this support could have another dimension: playing an important role in the struggle for clean air and the improved health of our citizens. This year's edition of the "Review" is unique, as the energy performance of single-family houses had not yet been diagnosed. We hope that the research results presented herein will help create mechanisms to support the modernisation of the housing stock in Poland.

Standard of buildings based on the criterion of thermal insulation – estimation of the number of buildings



Source: Own research-based analysis of CEM; sample N= 500

COAL, OLD STOVES AND POOR INSULATION

HEATING SYSTEMS AND THERMAL INSULATION IN SINGLE-FAMILY HOUSES IN POLAND REPORT FROM RESEARCH

ANALYSIS OF RESULTS:
ŁUKASZ **PYTLIŃSKI**
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SUMMARY

The main conclusion that can be drawn on the basis of these research results is as follows: Poles live in houses which are poorly insulated against heat loss or not insulated at all, the most popular fuel is coal, often of very low quality, while heating technology is outdated – based on inefficient, manually fed coal-fired boilers, which largely contribute to polluting the air with such substances as particulate matter or the carcinogenic benzo[a]pyrene.

It is estimated that over 70% of single-family buildings in Poland (3.6 million) have no thermal insulation or their insulation layers are too thin. Although Poles are willing to use thicker layers of insulation, the condition of buildings – even newly constructed ones – leaves a lot to be desired. Only 1% of all single-family houses in Poland are energy efficient.

Most of the buildings that meet the highest energy efficiency standards were built over the last few years. Most buildings with uninsulated walls are those constructed before the Second World War. Household income is another factor that strongly determines the standard of the building.

ŁUKASZ **PYTLIŃSKI**

Graduated from the Jagiellonian University with a master's degree in sociology and statistical analysis. Cooperated with the Foundation for Energy Efficiency, implementing energy saving projects in residential buildings. Co-founder of Krakow Institute for Sustainable Energy, acting as its president since 2010. In the area of market and public opinion research, he specialises in the power industry, sustainable development and social attitudes towards environmental issues. Since 2011 he has been also analysing the ESCO market in Poland. Participated in numerous international projects, including USAID, GEF and 4biomass. Author and co-author of reports and publications which cover the energy sector in Poland.

Standard of buildings based on their thermal insulation status	Total	Age of the building				Household net income	
		Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Very high	1.2%	0.0%	0.2%	1.0%	9.5%	2.2%	0.0%
High	6.7%	1.3%	5.1%	5.8%	29.4%	8.6%	4.6%
Average	20.1%	18.1%	16.6%	31.1%	29.5%	23.2%	15.8%
Low	34.0%	31.8%	35.5%	41.6%	21.7%	32.8%	37.8%
Very low	38.0%	48.8%	42.5%	20.6%	9.9%	33.1%	41.7%
Sample (N)	500	121	267	63	50	245	227

Source: Own research-based analysis of CEM; sample N = 500

Almost 70% of single-family houses in Poland are heated with coal – that means about 3.5 million coal-fired boilers. The vast majority of these installations (about 3 million) are based on manually fed boilers – technologically outdated, inefficient devices responsible for high emissions of air pollutants. Only 17% of heating sources do not significantly contribute to air pollution – gas boilers, a district heating network (DHN), electricity or renewable sources. Many investors choose manually fed boilers even in newly constructed buildings.

The structure of heating sources – estimates of the number of buildings

Source: Own research-based analysis of CEM; sample N= 500

The structure of heating sources	Total	Age of the building: Erected before WWII	Age of the building: Erected between 1945–1988	Age of the building: Erected between 1989–2000	Age of the building: Erected in 2001 or later	Household net income: Above PLN 3.5 thousand	Household net income: Below PLN 3.5 thousand
Manual coal-fired boilers over 10 years old or older	28.8%	27.5%	33.5%	29.5%	6.4%	23.9%	35.8%
Manual coal-fired boilers up to 10 years old	30.1%	36.4%	31.3%	24.2%	15.3%	30.9%	29.5%
Automatic coal-fired boilers over 10 years old or older	1.5%	1.7%	1.4%	1.4%	1.5%	2.0%	1.1%
Automatic coal-fired boilers up to 10 years old	6.5%	2.0%	7.3%	6.2%	14.0%	7.9%	5.2%
Coal-fired boilers of unidentified parameters	2.4%	0.7%	2.8%	5.8%	0.0%	1.7%	3.4%
Gas boilers	13.5%	11.6%	10.4%	18.8%	27.8%	18.5%	7.8%
Biomass and wood burning boilers/ fireplaces	13.7%	16.4%	10.1%	11.9%	28.6%	10.2%	16.9%
DHN, Electricity, Oil, RES	3.5%	3.6%	3.2%	2.3%	6.5%	4.9%	0.4%
Sample (N)	500	121	267	63	50	245	227

Source: Own research-based analysis of CEM; sample N= 500

COMMENTS ON THE RESEARCH

ANDRZEJ GUŁA
INSTITUTE OF ENVIRONMENTAL ECONOMICS

The results of this year's research clearly indicate a great potential to improve energy efficiency and reduce air pollution emissions in the housing sector.

As many as 70% of single-family buildings have either no or very poor thermal insulation. High energy consumption prompts house owners to use the cheapest and most environmentally harmful heating methods. Coal, and very often coal dust, are burned in primitive, outdated and inefficient devices which generate a lot of air pollution.

This situation results in increased CO2 emissions, thus contributing to climate change. But this is just the tip of the iceberg, as housing sector emissions are also the main source of such air pollutants as particulate matter, polycyclic aromatic hydrocarbons and dioxins.

Effective measures for supporting the thermal modernisation of single-family houses have not been implemented in Poland so far. The Thermal Modernisation Fund, established in 1999, although quite popular, offered support mainly to multi-family buildings.

This year's analysis shows that relatively low support in the form of subsidies would be enough to stimulate modernisation and renovation processes for single-family houses in Poland. Support mechanisms could be based both on EU and national funds, as well as on repayable instruments, i.e. renovation and modernisation loans. The new EU funding perspective (2014-2020) provides a unique opportunity to improve energy efficiency for Polish homes as well as air quality in our country. Are we going to take it?

INTRODUCTION

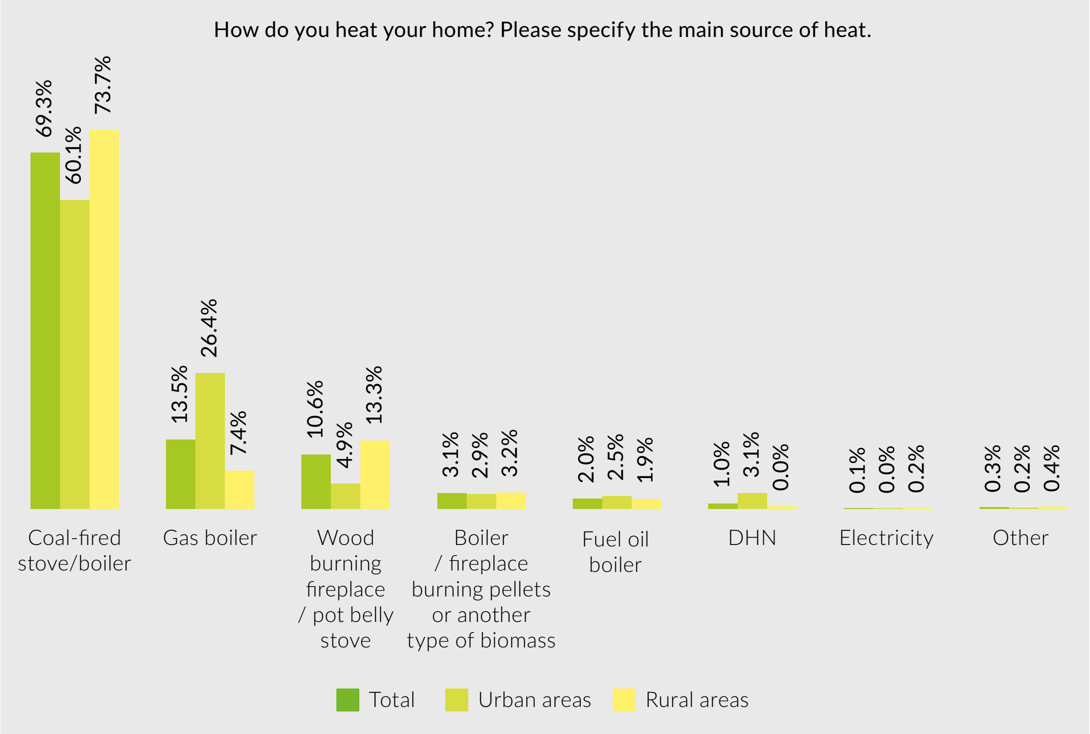
* All statistical data provided by the Central Statistical Office

The single-family housing sector has seen very dynamic development over the last few years. Single-family houses are not only predominant in rural areas, where they constitute 97% of all residential buildings, but also in towns and cities, where their share equals 80%*. In total, **about 5 million single-family houses are used in Poland and they are inhabited by more than half of the country's population**. This sector is developing very quickly – every year about 70-80 thousand new single-family houses are put into use. **Over 50% of all the buildings were erected during the period of real socialism, and almost a quarter were built before the Second World War**. This is, of course, reflected in their current technical condition, especially when analysed from the point of view of energy efficiency and thermal insulation standards.

We can assume that **this sector has significant potential to reduce energy consumption**. So far, the single-family housing sector has not been extensively analysed in the context of thermal insulation standards and energy consumption. The results presented herein, obtained from the research conducted on a randomly selected group of 500 single-family house owners, aim to fill this gap. There were two main objectives of the research. The first was to diagnose the condition of the single-family housing sector, taking into account criteria connected with the thermal parameters of the buildings. The number of insulated buildings was estimated and the quality of insulation was specified. The types of fuel used and the condition of heating installations were also analysed. The second task was to determine the demand for hypothetical, state-subsidized financial instruments whose aim is to stimulate interest in thermal renovation investments.

THE STRUCTURE OF HEATING SOURCES

Boilers and stoves fired by solid fuels are the main source of heating in Polish single-family houses. **Almost 70% of houses are heated with a coal-fired boiler or stove.** The following 11% use fireplaces, cast iron pot belly stoves or wood burning boilers. 3% of respondents claim that they use boilers or fireplaces burning pellets or another type of biomass. It must be pointed out, however, that biomass and wood are often used also by respondents who heat their houses with coal-fired boilers, hence the biomass-related percentage mentioned above is in fact underestimated. 13.5% of single-family houses are heated by gas boilers. A small share of buildings use oil-fired boilers, electric heating, a district heating network (DHN) and renewable sources (solar collectors, heat pumps).



Source: Own research-based analysis; sample N = 500

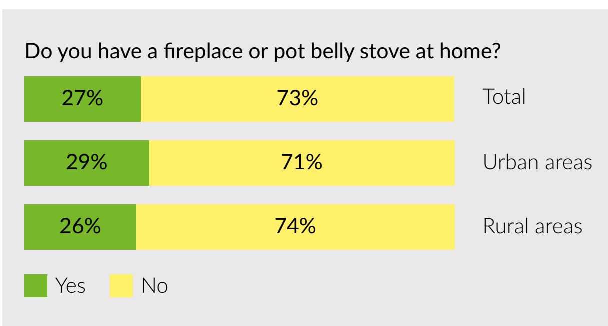
The percentage of coal-heated buildings in cities is slightly lower than in the total sample at 60%. There are also fewer houses which rely on wood burning installations. Gas boilers are used in quite a lot of buildings (26%). The number of houses connected to the district heating network is also relatively high (3%).

In rural areas over 90% of houses are heated with solid fuels. Other buildings are mainly heated with gas boilers but oil boilers and, occasionally, electric heating or renewable heat sources are also used in some rural houses.

The share of coal heating is significantly lower in houses built after the year 2000. At the same time, the number of fireplaces and pot belly stoves has notably increased. The structure of heating sources also directly depends on income level. **Solid fuels are used more commonly by less well-off respondents than by wealthier ones**.

How do you heat your home? Please specify the main source of heat.	Total	Age of the building				Household net income	
		Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Coal-fired stove/boiler	69.3%	68.4%	76.3%	67.0%	37.1%	66.4%	74.9%
Gas boiler	13.5%	11.6%	10.4%	18.8%	27.8%	18.5%	7.8%
Wood burning fireplace/pot belly stove	10.6%	15.7%	6.7%	7.0%	23.8%	8.4%	13.8%
Boiler/fireplace burning pellets or another type of biomass	3.1%	0.7%	3.4%	4.9%	4.8%	1.9%	3.1%
Fuel oil boiler	2.0%	3.6%	1.6%	1.4%	1.7%	2.4%	0.2%
DHN	1.0%	0.0%	1.6%	0.4%	0.9%	1.9%	0.2%
Electricity	0.1%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%
Other	0.3%	0.0%	0.0%	0.5%	2.7%	0.7%	0.0%
Sample (N)	500	121	267	63	50	245	227

Source: Own research-based analysis; sample N = 500



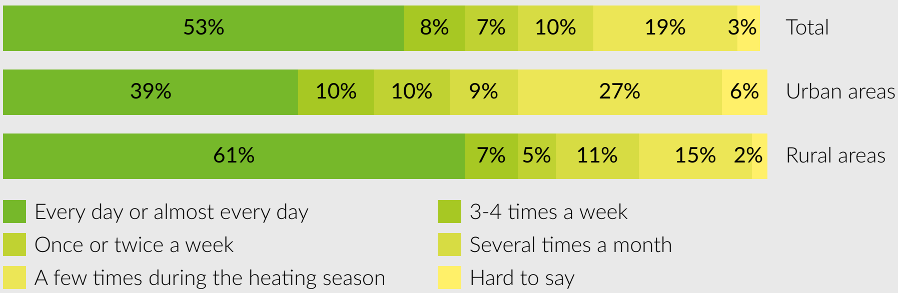
Source: Own research-based analysis; sample N = 500

The research shows that in every fourth building there is a fireplace or a pot belly stove. The percentage of houses in which fireplaces are used is similar in rural and urban areas. Wood burning devices have been installed in the majority of houses built after the year 2000. It is worth pointing out that such additional heating sources are mainly used in higher-income households.

Do you have a fireplace or pot belly stove at home?	Total	Age of the building				Household net income	
		Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Yes	27.0%	24.7%	19.4%	26.1%	74.6%	30.0%	22.9%
No	73.0%	75.3%	80.6%	73.9%	25.4%	70.0%	77.1%
Sample (N)	500	121	267	63	50	245	227

More than half of the respondents who have fireplaces declare that they use them every day or almost every day during the heating season. About 20% of single-family house owners in this group use fireplaces only occasionally – a few times during the heating season. Wood burning devices are used much more frequently in rural areas. As many as 61% of respondents in this group admit that they use fireplaces or pot belly stoves every day or almost every day during the heating season, while the corresponding share among city dwellers stands at 39%.

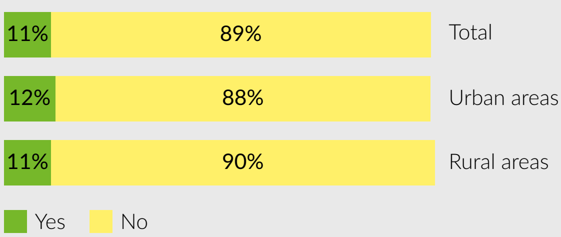
How often do you use the fireplace during the heating season?



Source: Own research-based analysis; sample N = 135 (100%: fireplace or pot belly stove users)

Among respondents who do not have a fireplace or a pot belly stove, one in ten intends to buy this type of device in the next two years. Responses to this question are not differentiated on the basis of place of residence.

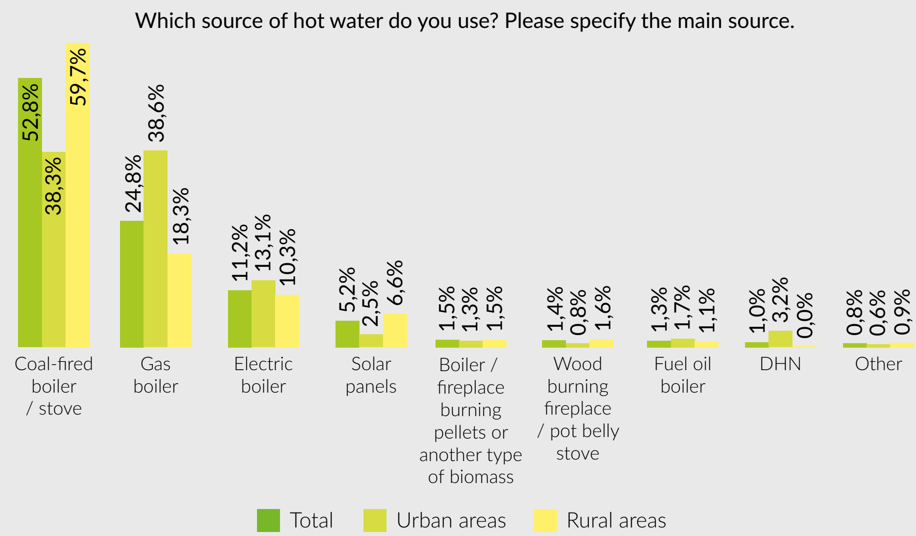
Are you planning to have a fireplace
or pot belly stove installed in the next two years?



Source: Own research-based analysis; sample N = 365 (100%: respondents who do not own a fireplace or pot belly stove)

THE STRUCTURE OF DOMESTIC HOT WATER SOURCES

The structure of domestic hot water sources, just as in the case of house heating, is dominated by coal-fired boilers and stoves. They are used for such purposes in more than half of all buildings. In 25% of single-family houses hot domestic water is prepared in gas boilers, while electric boilers and heaters are used by one household in ten. 5% of respondents claim to use solar power installations. Wood and biomass boilers are mentioned less frequently. The structure of domestic hot water sources in towns and cities is significantly different than in rural areas. Coal and gas boilers are used by a similar number of respondents (38% each), the share of solar panels is much lower and, naturally, some buildings are connected to the hot water network. Coal-fired boilers are predominant in rural areas, although gas boilers are used in almost one in five single-family buildings. Water is heated by means of solar panels in almost 7% of houses. Among other sources, the most frequently mentioned ones include heat pumps.



Source: Own research-based analysis; sample N = 500

Coal-fired boilers are slightly less common in newly erected buildings than in those built in the previous century. The younger the building the higher the share of gas boilers. The share of this source of hot water is also closely associated with income level. **Less well-off respondents are more likely to use coal-fired boilers**.

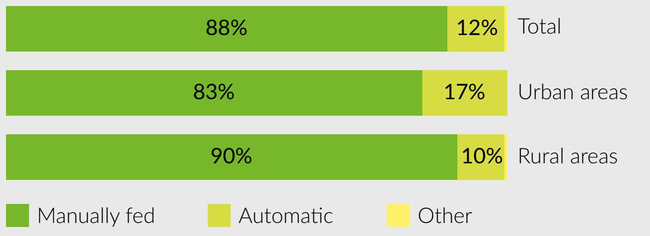
		Age of the building				Household net income	
Which source of hot water do you use? Please specify the main source.	Total	Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Coal-fired boiler/stove	52.8%	59.4%	52.5%	53.2%	37.6%	48.9%	58.6%
Gas boiler	24.8%	15.8%	25.2%	28.7%	39.8%	31.6%	18.1%
Electric boiler	11.2%	20.2%	8.9%	7.0%	6.8%	8.8%	13.6%
Solar panels	5.2%	0.7%	7.0%	5.4%	6.6%	5.1%	4.2%
Boiler/fireplace burning pellets or another type of biomass	1.5%	0.0%	1.9%	2.9%	0.9%	0.5%	2.2%
Wood burning fireplace/pot belly stove	1.4%	1.6%	1.7%	0.5%	0.0%	1.0%	1.9%
Fuel oil boiler	1.3%	2.3%	0.7%	1.9%	1.7%	1.7%	0.2%
DHN	1.0%	0.0%	1.7%	0.4%	0.9%	1.5%	0.6%
Other	0.8%	0.0%	0.4%	0.0%	5.8%	1.0%	0.7%
Sample (N)	500	121	267	63	50	245	227

Source: Own research-based analysis; sample N = 500

CHARACTERISTICS
OF COAL-FIRED BOILERS USED IN POLAND

Among the coal-fired boilers installed in single-family houses, **manually fed boilers – characterised by very low efficiency and high level of particulate matter emissions – are most common. They are used by 88% of respondents**. In towns and cities the percentage is slightly lower than in the total sample and the share of automatic boilers is 17%. In rural areas only one in ten coal-heated buildings has been equipped with an automatic boiler.

What type of a coal-fired boiler do you have?



Source: Own research-based analysis; sample N = 338 (100%: coal-fired boiler users)

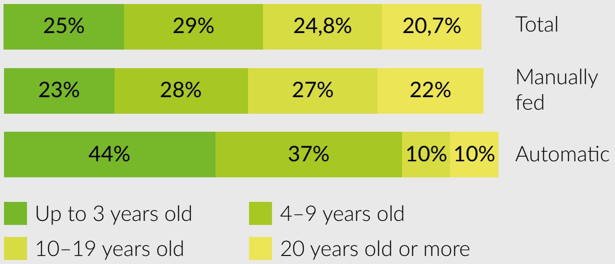
Automatic boilers are more commonly installed in buildings erected after 2000. They are more often used by wealthier house owners.

		Age of the building				Household net income	
What type of a coal-fired boiler do you have?	Total	Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Manually fed	87.8%	94.5%	87.8%	87.6%	58.4%	84.2%	91.2%
Automatic	11.9%	5.5%	11.6%	12.4%	41.6%	15.1%	8.8%
Other	0.4%	0.0%	0.6%	0.0%	0.0%	0.7%	0.0%
Sample (N)	338	82	199	38	19	161	163

Source: Own research-based analysis; sample N = 338 (100%: coal-fired boiler users)

Most coal-fired boilers are rather outdated. Relatively new boilers, up to 3 years old, constitute only 25%. The next 29% of the devices are between 4–10 years old. As many as 45% of boilers are 10 years old or older. The average age of automatic boilers (8 years) is slightly lower than the age of manually fed boilers (12 years).

Age of coal-fired boilers

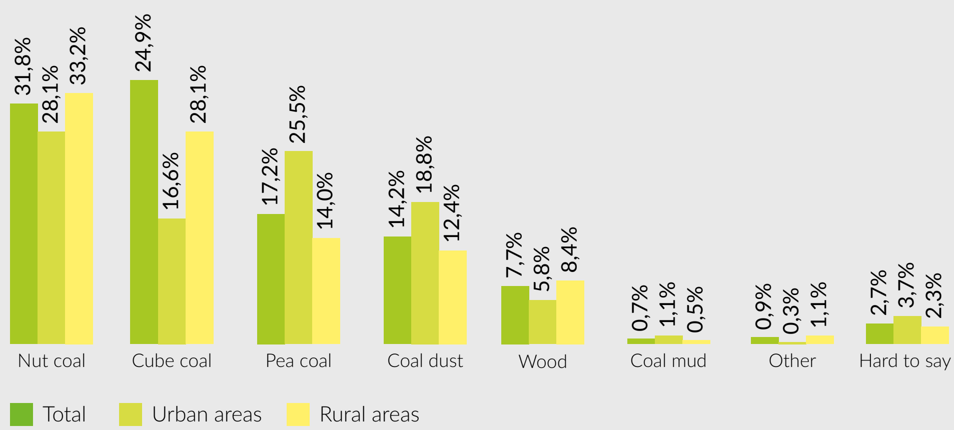


Source: Own research-based analysis; sample N = 338 (100%: coal-fired boiler users)

* In Poland there are no quality standards for coal types sold for households. Coal is differentiated according to grain size: cube coal – 200–60 mm, nut coal – 80–20 mm, pea coal – 25–5 mm, coal dust – 6–0 mm and coal mud – 1–0 mm. Coal dust and coal mud are by-products from coal extraction and processing.

The most common type of fuel used in coal-fired boilers is nut coal (32%). Cube coal is used by every fourth respondent. **17% of respondents use pea coal and 14% use coal dust***. About 8% of respondents declare that they mainly use wood.

What type of fuel do you use most frequently?



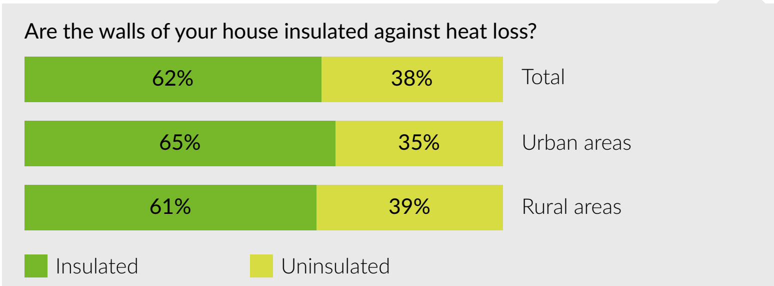
Source: Own research-based analysis; sample N = 338 (100%: coal-fired boiler users)

		Age of the building				Household net income	
What type of fuel do you use most frequently?	Total	Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Nut coal	31.8%	39.1%	28.4%	39.4%	20.5%	29.4%	34.6%
Cube coal	24.9%	22.9%	28.3%	21.5%	4.5%	24.8%	23.6%
Pea coal	17.2%	14.2%	16.1%	15.6%	45.8%	18.2%	16.8%
Coal dust	14.2%	10.7%	16.2%	11.0%	14.7%	18.0%	11.0%
Wood	7.7%	5.5%	7.8%	8.3%	14.5%	3.8%	11.0%
Coal mud	0.7%	0.0%	1.2%	0.0%	0.0%	0.0%	1.4%
Other	0.9%	0.0%	1.3%	0.8%	0.0%	1.8%	0.0%
Hard to say	2.7%	7.5%	0.8%	3.4%	0.0%	4.0%	1.6%
Sample (N)	338	82	199	38	19	161	163

Source: Own research-based analysis; sample N = 338 (100%: coal-fired boiler users)

BUILDING ENVELOPE

62% of respondents claim that the external walls of their houses are insulated against heat loss. This declaration is more frequently made by people living in towns and cities. However, the percentage of insulated houses in urban and rural areas is similar.



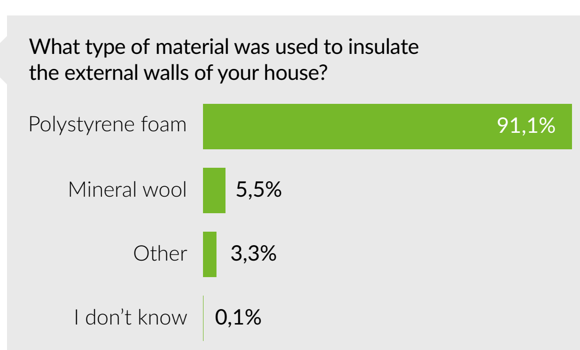
Source: Own research-based analysis; sample N = 500

The existence of wall insulation is closely associated with the age of the building. Among owners of houses built before World War II, 51% declare that their walls are insulated. The percentage is much higher for houses built between 1989–2000 (79%), and very high for those erected after 2000 (90%). The existence of wall insulation seems to be also linked with income levels – **the percentage of thermally insulated houses is slightly higher among wealthier respondents**.

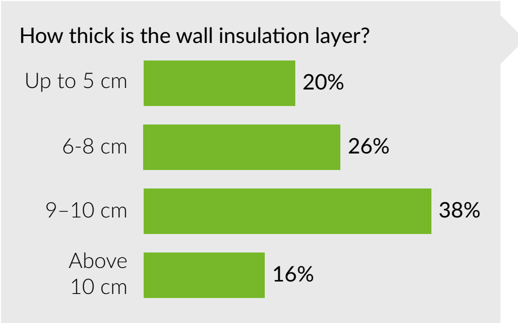
		Age of the building				Household net income	
Are the walls of your house insulated against heat loss?	Total	Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Above PLN 3.5 thousand	Below PLN 3.5 thousand
Insulated	62.0%	51.2%	57.5%	79.4%	90.1%	66.9%	58.3%
Uninsulated	38.0%	48.8%	42.5%	20.6%	9.9%	33.1%	41.7%
Sample (N)	500	121	267	63	50	245	227

Source: Own research-based analysis; sample N = 500

Polystyrene foam is the most common material used for wall insulation. Over 90% of respondents say that polystyrene foam was used as an insulation layer for external walls of their houses. Mineral wool is mentioned only by one in twenty owners of insulated buildings.



Source: Own research-based analysis; sample N = 310
(100%: respondents who claim to have had their walls insulated)



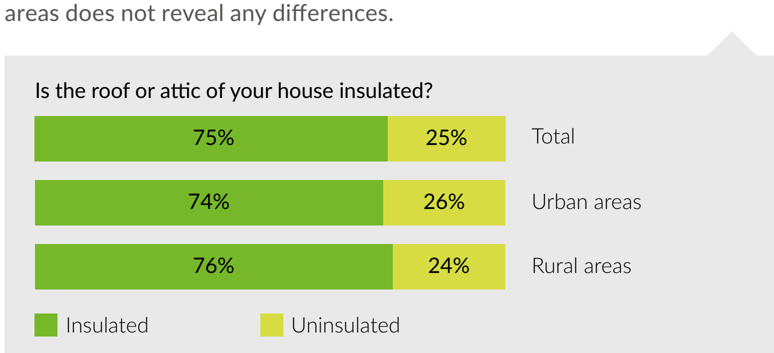
The insulation layer is usually thin or very thin. Thicker layers (more than 10 cm) have only been used in 16% of insulated buildings; **the insulation layer does not exceed 5 cm in one in five buildings.** The newer the building the thicker its insulation layer but even in the newest houses, erected after 2000, the average thickness of insulation only slightly exceeds 10 cm.

Source: Own research-based analysis; sample N = 310 (100%: respondents who claim to have had their walls insulated)

Average thickness of the wall insulation layer		
Total		9.0 cm
Location of the building	Urban areas	9.3 cm
	Rural areas	8.8 cm
Age of the building	Erected before WWII	7.9 cm
	Erected between 1945–1988	8.6 cm
	Erected between 1989–2000	9.5 cm
	Erected in 2001 or later	11.1 cm
Insulation material	Polystyrene foam	8.9 cm
	Mineral wool	9.4 cm
Net income for the household	Above PLN 3.5 thousand	9.5 cm
	Below PLN 3.5 thousand	8.2 cm

Source: Own research-based analysis; sample N = 310
(100%: respondents who claim to have had their walls insulated)

76% of respondents claim that the roof or attic of their house is insulated. Analysis of the results relating to buildings located in urban and rural areas does not reveal any differences.



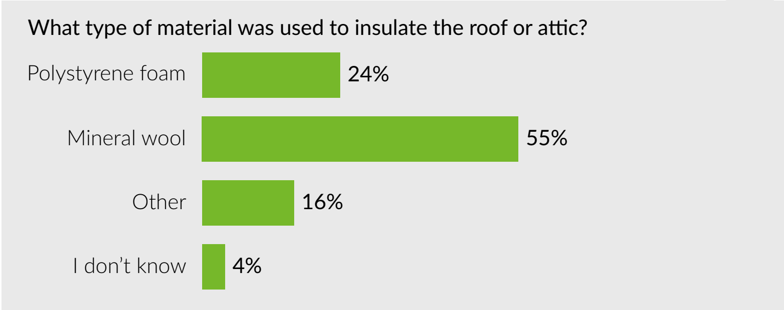
Source: Own research-based analysis of CEM; sample N= 500

The existence of roof insulation also depends on the age of the building. As far as houses built before the Second World War are concerned, 55% of respondents claim to have insulated roofs. The percentage is higher for houses built between 1989–2000 (89%) and among the newest buildings it almost reaches 100%.

Is the roof or attic of your house insulated?	Total	Age of the building: Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Household net income: Above PLN 3.5 thousand	Below PLN 3.5 thousand
Insulated	75.5%	54.9%	79.1%	83.6%	95.9%	78.8%	71.5%
Uninsulated	24.5%	45.1%	20.9%	16.4%	4.1%	21.2%	28.5%
Sample (N)	500	121	267	63	50	245	227

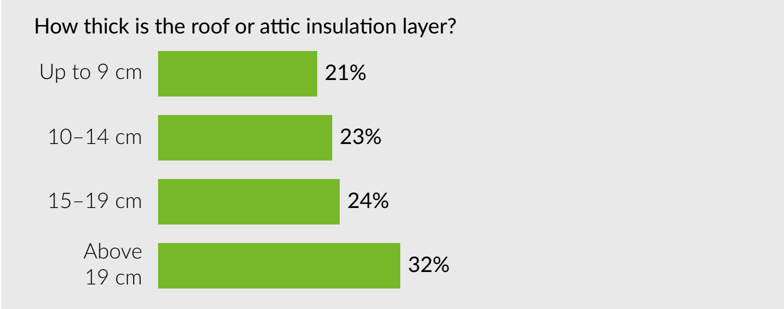
Source: Own research-based analysis; sample N = 500

Mineral wool is the most common material used for roof insulation. It is mentioned by over half of the respondents. Polystyrene foam was used by only one in four respondents from the group analysed. Other materials and technological solutions are applied to roof insulation too: usually, a combination of polystyrene foam and mineral wool, sawdust or even straw.



Source: Own research-based analysis; sample N = 377
(100%: respondents who claim to have had their roof or attic insulated)

Roof or attic insulation is usually thicker than wall insulation. Every third respondent 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 fifth building does not exceed 9 cm. **The average thickness of roof insulation is 15 cm and in the newest houses it is about 20 cm.**



Source: Own research-based analysis; sample N = 377
(100%: respondents who claim to have had their roof or attic insulated)

Average thickness of roof or attic insulation layer		
Total		14.7 cm
Location of the building	Urban areas	15.0 cm
	Rural areas	14.6 cm
Age of the building	Erected before WWII	13.9 cm
	Erected between 1945–1988	13.8 cm
	Erected between 1989–2000	14.3 cm
	Erected in 2001 or later	20.0 cm
Insulation material	Polystyrene foam	14.9 cm
	Mineral wool	17.3 cm
Household net income	Above PLN 3.5 thousand	14.7 cm
	Below PLN 3.5 thousand	14.5 cm

Source: Own research-based analysis; sample N = 377 (100%: respondents who claim to have had their roof or attic insulated)

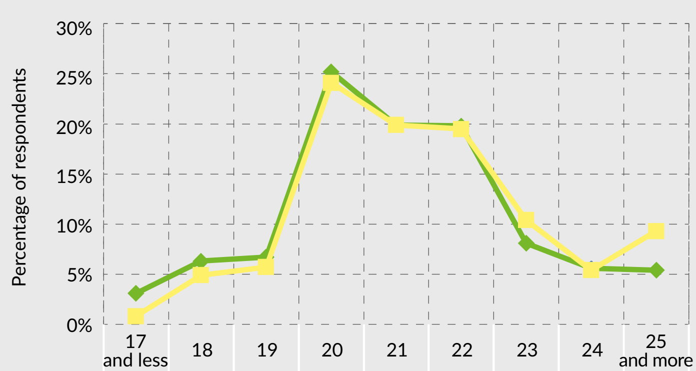
The results of the research show that **double glazed windows have already become a standard solution**. 90% of respondents claim to have had such windows fitted in their houses.

THERMAL COMFORT

An analysis of responses to questions concerning the average temperature in a building during the heating season versus the desired temperature indicates that **people living in single-family houses are generally satisfied with the thermal comfort of their buildings**. Actual and desired temperature values are more or less the same. The average declared temperature in single-family houses is 21°C, whereas the desired value is not much higher, as it exceeds the actual one by only 0.4°C. Some small discrepancies can be noticed

Source: Own research-based analysis; sample N = 500

Average temperature in the building vs desired temperature (in °C)



	17 and less	18	19	20	21	22	23	24	25 and more
Actual temperature	3%	6%	7%	25%	20%	20%	8%	6%	5%
Desired temperature	1%	5%	6%	24%	20%	20%	10%	5%	9%

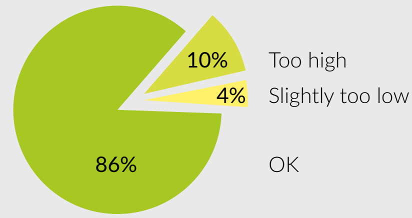
when analysing extreme temperatures – below 17°C and above 24°C – but this should be seen as a natural phenomenon: some respondents who claim that the temperature in their homes is very low, would like it to be slightly higher; a small group of them would prefer much higher temperatures.

As a result, the vast majority of single-family house owners claim that the temperatures in their homes are optimal and every tenth even says that they are too high. Interestingly enough, neither this opinion nor the value of declared temperature are affected by any independent variable such as the existence of building insulation or the type of heating used.

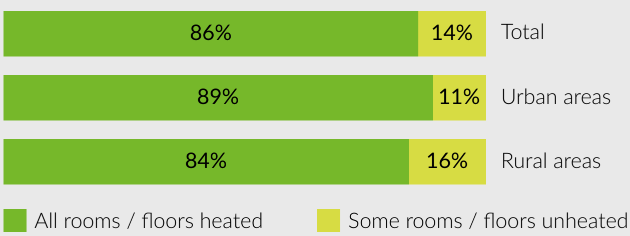
Residents of every seventh single-family building refrain from heating a part of its useful floor area during the heating season. Such practices are more common in rural areas. In houses where this solution is applied only 60% of the useful floor area is heated.

Source: Own research-based analysis; sample N = 500

In your opinion, the temperature in your house during the heating season is...



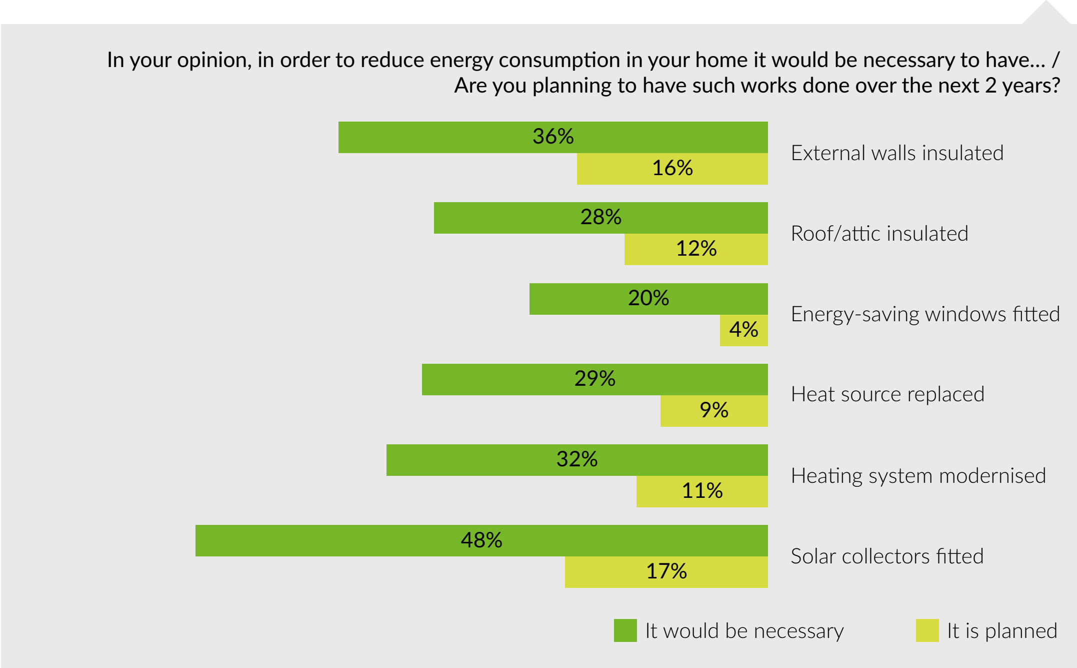
Are all the rooms/floors in your house heated during the heating season or only some of them?



Source: Own research-based analysis; sample N = 500

REQUIREMENTS AND PLANS CONCERNING THERMAL MODERNISATION

A large number of respondents admit that their houses require investment in thermal modernisation. However, the number of those who actually plan to take some specific energy-saving measures is much lower. Solar collectors continue to be very popular. As many as half of the respondents agree that installing such devices may prove useful, and 17% of them are thinking of investing in solar panels over the next two years. A similar number of respondents declare an intention to have their walls insulated. It is worth pointing out that in this group are also those owners whose houses are insulated, but whose layer of insulation is too thin. Among more long-term plans, roof or attic insulation and heating system renovation were also mentioned.

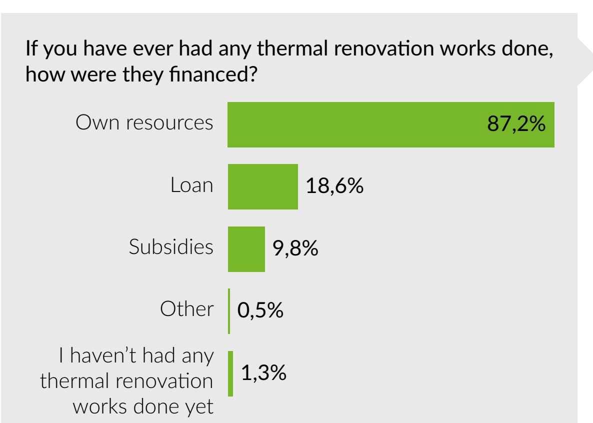


Source: Own research-based analysis; sample N = 500

Fewer respondents plan to have their heat sources replaced. Quite a lot of them think, however, that it would be worthwhile to do so. Respondents are mainly interested in replacing their currently used coal-fired boilers with more modern (automatic) ones and with modern gas boilers. Willingness to have solar panels installed was also expressed quite often. Window replacement is mentioned the least frequently.

FINANCING THERMAL RENOVATION PROJECTS

Not surprisingly, thermal renovation activities are mainly **financed from people's own resources**. Quite a lot of respondents (19%) admit to having taken **bank loans** too. Every tenth respondent mentions **subsidies**. Most subsidies were connected with the installation of solar collectors and the replacement of roof cladding (asbestos being replaced with other materials), which provided an opportunity to have an extra insulation layer fitted as well.



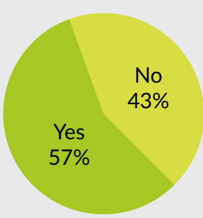
Source: Own research-based analysis; sample N = 500

If you have ever had any thermal renovation works done, how were they financed?	Total	Age of the building: Erected before WWII	Erected between 1945–1988	Erected between 1989–2000	Erected in 2001 or later	Household net income: Above PLN 3.5 thousand	Below PLN 3.5 thousand
Own resources	87.2%	94.2%	84.3%	93.4%	78.0%	87.1%	87.1%
Loan	18.6%	15.7%	18.2%	12.6%	34.9%	18.4%	18.7%
Subsidies	9.8%	3.1%	12.2%	14.0%	8.2%	8.3%	11.5%
Other	0.5%	0.7%	0.4%	1.0%	0.0%	0.5%	0.6%
I haven't had any thermal renovation works done yet	1.3%	0.0%	0.6%	0.9%	8.3%	2.2%	0.3%
Sample (N)	500	121	267	63	50	245	227

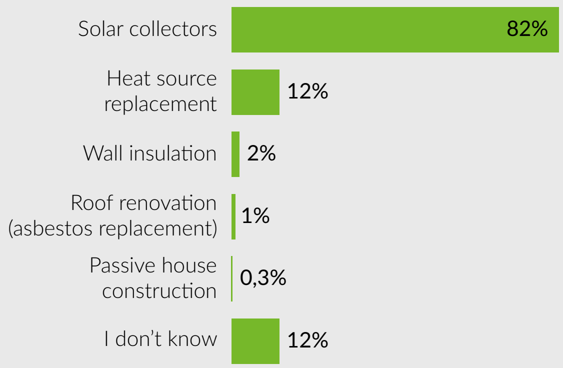
Source: Own research-based analysis; sample N = 500

More than 50% of respondents claim to have heard about the availability of subsidies for reducing the consumption of heat in single-family buildings. Subsidies to solar collectors are mentioned by the vast majority of respondents. One in ten has heard about co-financing for heat source replacement.

Do you know if any forms of co-financing are available for owners of single-family houses wishing to invest in thermal renovation?



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



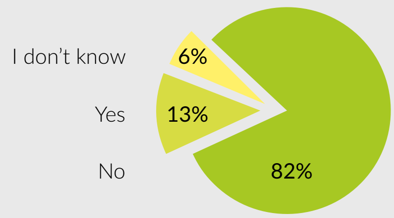
Source: Own research-based analysis; sample N = 500

Source: Own research-based analysis; sample N = 284 (100%: respondents knowing about co-financing possibilities)

PREFERRED FINANCIAL INSTRUMENTS SUPPORTING THERMAL RENOVATION

One of our aims was to estimate the level of interest in carrying out thermal renovation investments that are subsidised, to a varying extent, by the state. During the research we also determined whether single-family house owners would be willing to finance the preparatory works that need to be completed before thermal renovation begins, i.e. if they would agree to pay for an energy audit of the building. Assuming that such an audit would cost PLN 1000 [EUR 250], 13% of all respondents would be interested in using this service. For the group of respondents living in uninsulated buildings, this percentage increases to 15%.

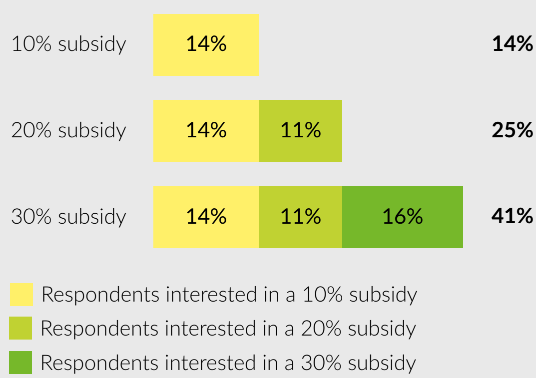
Would you agree to pay for an energy audit whose results would indicate what type of investment your house needs in order to effectively reduce the amount of energy consumed for space and domestic water heating, assuming that such an audit would cost PLN 1000?



Source: Own research-based analysis; sample N = 500

Willingness to invest in state-subsidised thermal renovation was analysed by presenting a hypothetical situation in which, according to energy audit results, it would be necessary to have certain renovation works carried out in their house (e.g. window replacement, wall or attic insulation) and the total cost of such works would reach PLN 30,000 [EUR 7,500]; the investment would pay off, however, within 10 years, in the form of lower energy bills. The respondents were then asked whether they would be willing to undertake such investment activities if they received a 10% state subsidy. Respondents expressing no interest in the proposed solution were asked again – this time the hypothetical subsidy was increased to 20%, and then – for those who remained uninterested – up to 30%. These questions were asked only to the respondents living in uninsulated buildings. Every seventh respondent in this group was interested in thermal renovation investments co-financed by a 10% state subsidy. **A 20% subsidy would encourage 25% of respondents and a 30% one would be attractive enough for 41% of them.**

Interest in carrying out co-financed thermal renovation projects worth PLN 30,000 – owners of uninsulated buildings



Source: Own research-based analysis; sample N = 190 (100%: owners of buildings with uninsulated walls)

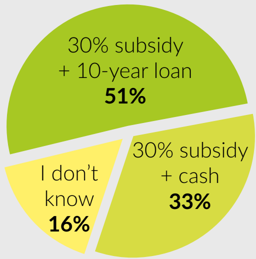
In order to determine the preferred forms of co-financing, two options were presented to the respondents:

- a state subsidy covering 30% of the total project value (i.e. PLN 9,000) and financing the remaining expenses with cash,
- a state subsidy covering 30% of the total project value and financing the remaining expenses with a loan for 10 years at an interest rate of 5% per annum.

Given such choice, more respondents prefer the second option (with a loan). It must be noted, however, that every third respondent says that they would be willing to finance the investment from their own resources.

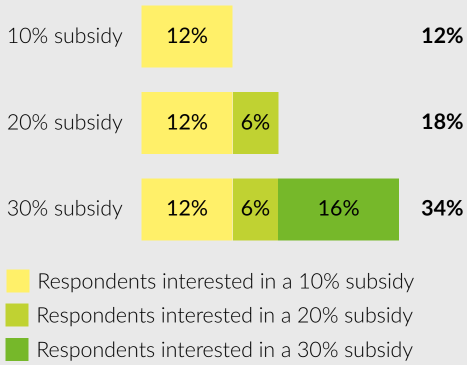
We also wanted to find out how many respondents would be interested in window replacement if they received a state subsidy to co-finance the investment. The results of the research show that with an investment worth PLN 10,000, a 10% subsidy would encourage 12% of the respondents. Increasing the subsidy to 20% results in a further 6% interest, whereas **a 30% subsidy could attract as many as 34% of all respondents**.

Interest in particular financial instruments to finance thermal renovation projects worth PLN 30,000



Source: Own research-based analysis; sample N =500 (100%: owners of buildings with uninsulated walls)

Interest in co-financed window replacement worth PLN 10,000 – all respondents



Source: Own research-based analysis; sample N =500

INFORMATION ABOUT THE RESEARCH

RESEARCH DATE

The research was conducted by the CEM Market and Public Opinion Research Institute and the Institute of Environmental Economics on 3–20 March 2014.

RESEARCH METHODOLOGY

The research was conducted by means of the CATI telephone interview technique. The interviews were carried out by trained interviewers from the CATI centre located in CEM's premises in Krakow.

SAMPLE GROUP

500 adult Poles, owners of single-family houses, were interviewed. The sample group consisted of the people responsible for making technical decisions in their households (due to the specific character of the research, most of the respondents were male). The respondents were randomly selected from databases with fixed line and mobile telephone numbers. The structure of the sample was controlled according to building location (urban/rural areas) and building age.

RESEARCH TOOLS

The research was based on a standardised interview questionnaire, composed mainly of closed questions.

WHY DOES POLAND HAVE THE MOST POLUTED AIR IN EUROPE?

WHY DO PARTICULATE MATTER AND BENZO[A]PYRENE CONCENTRATIONS EXCEED ALL PERMISSIBLE LIMITS?

WHY HAVE WE NOT BEEN ABLE TO MEET AIR QUALITY STANDARDS FOR SO MANY YEARS?

WHY ARE WE JUST WAITING WHILE THE CZECHS ARE ALREADY ACTING?

NO REGULATIONS MEANS NO CLEAN AIR

NO REGULATIONS, NO CLEAN AIR

ANDRZEJ **GUŁA**
INSTITUTE OF ENVIRONMENTAL ECONOMICS

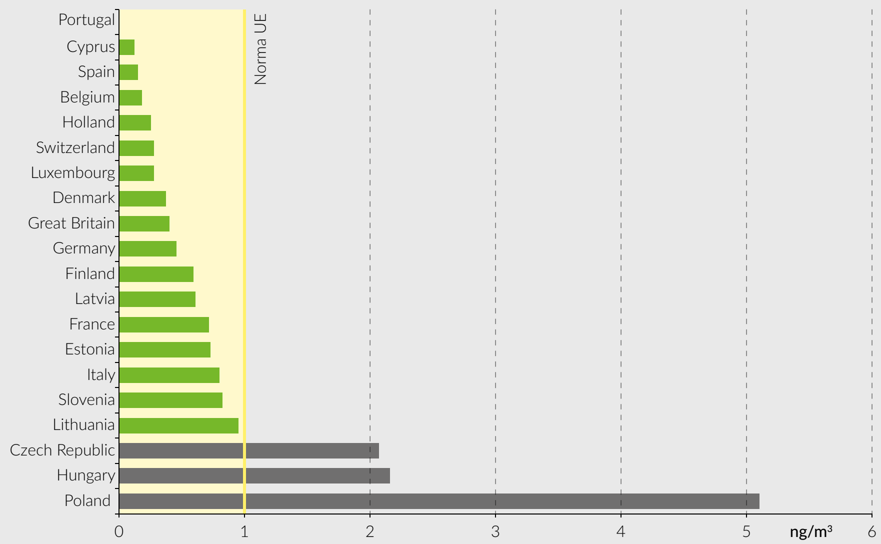
The cause of the problem has been known for a long time. In Poland, the main source of such air pollutants as particulate matter, dioxins, benzo[a]pyrene and other polycyclic aromatic hydrocarbons is so-called low-stack emission coming from individual heating appliances used in households (solid fuel boilers, stoves and furnaces). Concentrations of PM_{10}, $PM_{2.5}$ and benzo[a]pyrene are much higher in Poland than in most European countries. At the end of 2013 the European Environment Agency presented a report whose results indicate how often daily norms for PM_{10}, i.e. 50 µg/m³ (24-hour concentration), are exceeded in almost 400 European cities. **Six out of the top 10 most polluted cities in Europe were in Poland (the remaining ones in Bulgaria)**.

As for particulate matter concentrations, air quality norms are exceeded in 83% of air monitoring areas in Poland. **Benzo[a]pyrene levels are too high almost in all parts of the country** (42 out of 46 air monitoring areas). What is particularly worrying is the extent to which the norms are exceeded – in case of benzo[a]pyrene, annual mean concentrations are several times above the

ANDRZEJ **GUŁA**

Co-founder and President of the Institute of Environmental Economics, expert in energy efficiency and environmental protection. Graduated from the University of Economics in Krakow. Professionally active in the field of environmental protection for over 15 years. A consultant to numerous state and international institutions, i.e. JASPERS, European Investment Bank, OECD. In 2004–2006 a member of the Steering Committee for the Cohesion Fund at the Ministry of the Environment. One of the founders of Krakow Smog Alert – an initiative undertaken by Krakovians fighting for an improvement in air quality.

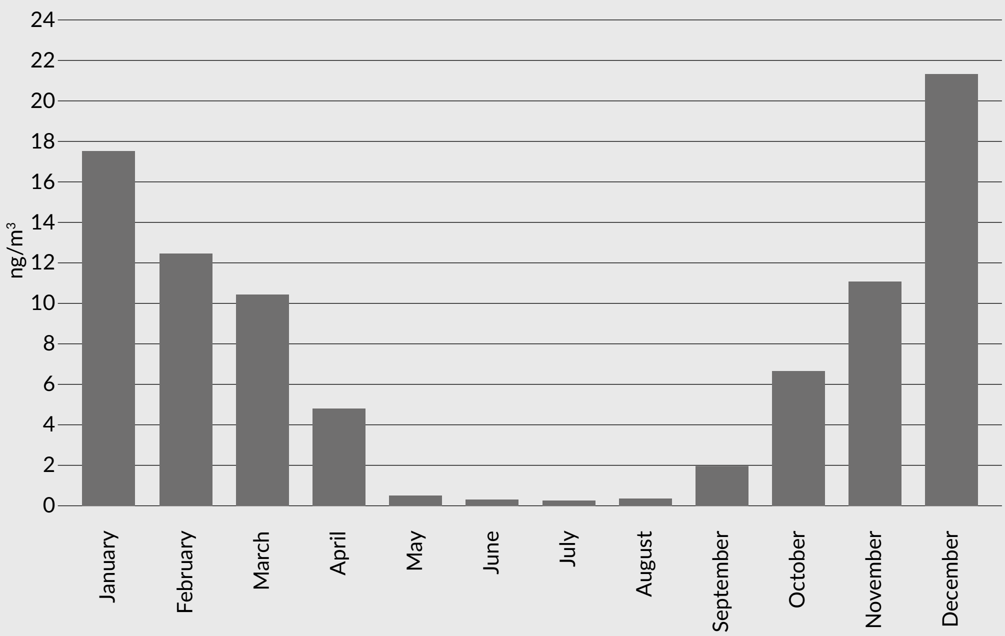
Concentrations of carcinogenic benzo[a]pyrene in the EU countries, 2011



Source: The assessment of air quality in Poland in 2012, Chief Inspectorate for Environmental Protection permissible levels in many Polish towns and cities (in 2012 this undesirable record was broken by Sucha Beskidzka, where benzo[a]pyrene concentrations were almost 20 times higher than the EU norm and reached 19 ng/m^3).

The European Union has launched legal proceedings to impose financial penalties on Poland for its failure to comply with EU regulations concerning air quality protection (CAFE Directive). Poor air quality is a significant public health issue generating external costs in the form of budget expenditures associated with the treatment of pollution-related diseases or the costs of decreased productivity, i.e. absenteeism at work. While no detailed studies have been carried out so far to analyse the costs of low-stack emission coming from Polish households, such estimates are prepared by some municipalities under air quality plans. According to these estimates, the external costs of air pollution in Małopolska amount to PLN 2.8 billion a year. Exceeded pollution norms is a common problem particularly during the colder months, when many residents use solid fuels for household heating, as a result of which a lot of particulate matter is released into the air. Voivodship Inspectorates for Environmental Protection estimate that this type of emission (91% of indications) constitutes the chief reason why permissible daily concentrations go beyond the norm. As far as benzo[a]pyrene is concerned, individual household heating appliances are identified as the main source as well (96% of indications).

Average monthly concentrations of benzo[a]pyrene at the urban background station in Krakow, 2013

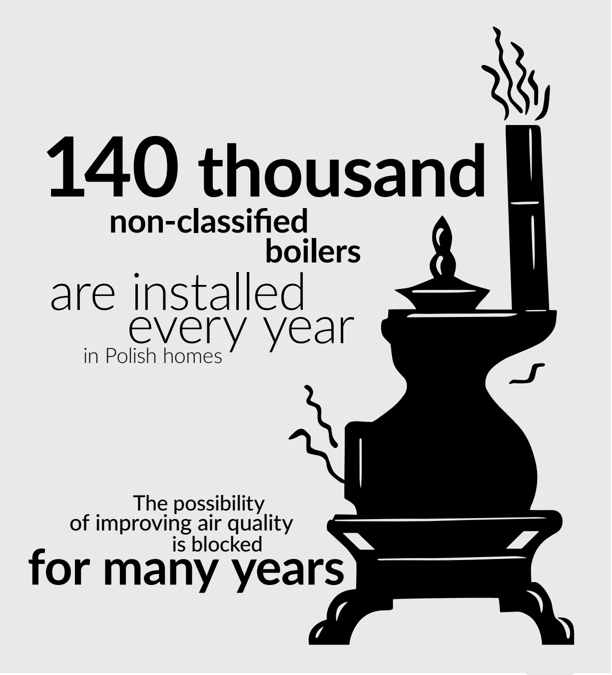


Source: Voivodship Inspectorate for Environmental Protection

Seasonal variability in benzo[a]pyrene concentrations, and its high levels in the heating season (November-April) in particular, is clearly illustrated by the graph above showing the distribution of this pollutant's concentrations at the urban background station in Krakow. Although the levels vary in different locations, the illustrated distribution is representative for the entire country.

Although other sectors also contribute to air pollution (transport, industry), if nothing is done about the problem of low-stack emissions, we will not be able to achieve the air quality standards set by national and EU legislation, not to mention even the more stringent requirements of the World Health Organisation.

The problem of low-stack emission has been grossly neglected for years – there are no basic legal regulations in this field. Consequently, it is difficult for local administrations to take action to improve air quality.



Introducing stringent restrictions on the use of solid fuels in individual heating systems may be necessary in areas with particularly unfavourable topographic and climatic conditions (located in the valleys, with poor ventilation, high frequency of inversion). In more favourably located areas it should be ensured that the heating appliances used in households meet certain emission requirements.

Two issues must be regulated by the state (parliament and ministries) immediately: (1) emission standards for solid fuel boilers and (2) quality standards for solid fuels.

It is estimated that about 200 thousand coal-fired boilers are sold in Poland every year, and most of them (70%) are characterised by very poor emission-related parameters. Their nickname used in the boiler business – "smokers" – speaks for itself. They are still being used though because there are no emission standards for this type of appliances in our country. The fact that 140 thousand of these boilers* are installed in Polish homes every year blocks the possibility of improving air quality for a long time. The boilers remain in use for the following 10, 15 or even 20 years.

* Data presented during the conference: Clear sky over Poland, organised by the Polish Chamber of Ecology, on 28 March 2014, in Katowice.

The problem has already been solved in most EU countries. The Czech Republic, for example, adopted emission standards for boilers – emission limits and minimum requirements concerning the efficiency of low-power boilers (up to 300 kW) have been set. The requirements for coal-fired boilers sold in the Czech Republic provide for the gradual tightening of emission standards:

- as of 1 January 2014 particulate matter emissions not exceeding 125 mg/m^3;
- as of 1 January 2018 particulate matter emissions not exceeding 60 mg/m^3.

Moreover, as of 1 September 2022 all boilers in use will have to comply with emission limits of 125 mg/m^3. The level of emissions generated by typical heating appliances used in Polish households can be up to several times higher. The adopted package of legislative measures is part of a comprehensive state-run programme which aims to improve the quality of air in the Czech Republic. Similar regulations in Poland should be based on the limit values for particulate matter, CO and OGC emissions specified in the *PN EN 303-5:2012* standard referring to heating boilers for solid fuels with a nominal heat output of up to 500kW. In accordance with the standard there are 3 classes of boilers depending on their emission limit values and energy efficiency (5th class being the highest). Emission limits concerning the above mentioned pollutants (CO, OGC, TSP) should already be specified for low--power boilers which are introduced to the Polish market.

Interestingly, the need for a progressive introduction of stricter requirements has also been acknowledged by the manufacturers of heating equipment, associated in the Polish Chamber of Ecology (www.pie.pl), who have approached the Minister of Environment and Minister of Economy asking them to have emission standards specified.

The EU is currently working on regulations concerning Directive 2009/125/EC defining the requirements for heating equipment (including boilers) fired by solid fuels. Standards for new equipment will take effect from 2018 or even 2022. By this time, without the adoption of national regulations, more than 1 million inefficient boilers emitting very high levels of pollutants, particulate matter and toxic substances might have been installed in Poland. We cannot wait passively for Ecodesign regulations and, as in other EU countries, we should establish national emission standards. In the Czech Republic, it was concluded that corrective action should be implemented now so as to reduce people's exposure to excessive concentrations of pollutants in the air as soon as possible.

The establishment of national emission standards for low-power boilers is a necessary step towards improving air quality and increasing energy efficiency. Such standards would be a stimulus for the development of new technologies in Poland.

Another area requiring urgent intervention is to define quality standards for solid fuels. Boiler emission-intensiveness does not only depend on the boiler itself and the manner in which it is used, but also on the quality of coal it is fed with. **Since 2004, in Poland there have been no standards for solid fuels – the worst quality coals, including coal mud**, which should not be burned in domestic boilers (and which were formerly treated as a by-product of coal processing and used only in the energy sector) can now be bought by house owners. Experts estimate that in 2012 almost 800 thousand tons of coal mud* was used by individual households, small companies and workshops. Its use in the household sector over the last decade resulted in a dramatic increase in emissions of particulate matter, benzo[a]pyrene and other PAHs, volatile organic compounds, soot, carbon monoxide, dioxins and heavy metals.

* PhD, Eng. Krystyna Kubica, The Faculty of Thermal Technology at the Silesian University of Technology; "Koniecznie wycofać"; Ekologia; No 1/65/2013, 2013

Introduction of fuel quality standards and the withdrawal of low-quality coal from the individual consumer market are therefore prerequisites in the fight for clean air in Poland.

Without emission standards, public funding for the elimination of low--stack emission (i.e. KAWKA – a programme to reduce air pollution in cities run by the National Fund for Environmental Protection and Water

Management, with a budget of PLN 800 million) will not bring the expected improvement of air quality. On the one hand, the elimination of low-stack emission sources is subsidised in municipalities, and on the other, the growing availability of new sources (resulting from the lack of emission standards) means that the air quality is not getting better, and public resources are used inefficiently.

Without setting emission standards for low-power boilers and fuel quality standards, the achievement of national and EU air quality standards will not be possible. Urgent action must be taken by the government (the Ministry of the Economy and the Ministry of the Environment) and members of parliament in order to adopt the necessary package of legal solutions. A further delay in this area would push the prospects for clean air in Poland back and bring us closer to the EU's multi-million Euro penalties for significant violation of air quality standards.

ENERGY CONSUMPTION AND ENERGY SOURCES IN NEW BUILDINGS IN POLAND

AN ANALYSIS OF DATA OBTAINED FROM ENERGY PERFORMANCE CERTIFICATES ISSUED BY BUILDDESK

PIOTR **PAWLAK**
BUILDDESK POLAND, ROCKWOOL POLAND

MAREK **ZABOROWSKI**
INSTITUTE OF ENVIRONMENTAL ECONOMICS

This analysis utilises a database of technical information on certified buildings, collected by means of the BuildDesk system. It includes data on the structure, elements and systems of the buildings' construction. As a result, the statistical analyses are based on actual numerical data which refer to the technical characteristics of the buildings. This information has been being gathered in the system for five years now (since 2009), which allows us to carry out an initial analysis of trends in the Polish construction sector.

The data collected in the BuildDesk system come from over 65,000 buildings constructed in Poland (new, rendered for use, sold, modernised, etc.). Due to the extensive data volume it was possible to obtain objective, statistically verified information. The buildings that are analysed here were certified between 1 January 2009 and 31 December 2013. As a system of obligatory certification has not been effectively implemented on the resale market, the data refer mainly to new buildings (existing buildings that are sold, rented or extended account for only 20% of certified buildings). Given that the Directive on the Energy Performance of Buildings clearly defines an obligation to certify buildings on the primary as well as the resale market, this lack of certification for the resale market should be seen as a failure in implementing the Directive in Poland. The lack of reliable information about buildings at the resale market impedes effective state policy in this area.

When interpreting the data obtained from the database of energy performance certificates, it should be taken into account that certain errors might occur. One of the reasons for this is the fact that architects and constructors are still learning about the certification system – as a result, information entered into the database is getting clearer and more coherent every year (hopefully, it is also more and more reliable). Therefore, there is a risk that the comparison of data obtained during the initial period of system

PIOTR **PAWLAK**

BuildDesk Poland, Rockwool Poland – graduated from the Lodz University of Technology, at the Faculties of Civil Engineering and Management. Has spent over 15 years working in the field of insulation materials and actively promoting energy efficiency in the construction sector. Manages a new department of Rockwool Poland – Technical Advisory and Brand Specification. The department provides expertise in the optimisation of building design in order to maximise energy performance, taking into account the financial viability of such measures. Created the BuildDesk system, which provides support for auditors, designers and energy advisors.

MAREK **ZABOROWSKI**

Vice-President of the Institute of Environmental Economics, expert in energy efficiency. Graduated from the Faculty of Chemical Engineering and Technology at the Krakow University of Technology with postgraduate studies in environmental economics at the University of Minnesota. Active in the field of energy efficiency for over 15 years. A consultant to numerous state and international institutions and companies, e.g. the European Commission, OECD, ARUP, ECORYS, Scott-Willson. In 2000–2009 a member of the Board and the President of the Małopolska Energy and Environment Agency. In 2005–2007 a member of the Board of Trustees at the National Fund for Environmental Protection and Water Management.

operation with data from 2013 may lead to us to draw some false conclusions. Bearing in mind these imperfections in the system, we may now analyse the data derived from energy performance certificates issued for new buildings between 2009-2013.

MAIN CONCLUSIONS

Based on the information acquired from the BuildDesk database containing data from around 65,000 buildings certified in the period 2009–2012, we can conclude the following.

1. The insulation of buildings is systematically improving, thereby reducing their energy intensity.
2. A trend still exists for substituting gas heating with coal heating in single-family buildings. This is highly detrimental, not only due to increased greenhouse gas (GHG) emissions but also due to the negative impact of coal combustion on air quality in urbanised areas. The replacement of comfortable gas heating with much less convenient coal heating proves that coal is extremely competitively priced. As far as CO2 emissions are concerned, coal heating reduces the positive effect obtained from better insulation of the building fabric.
3. The high declared use of biomass for heating most probably results from the fact that energy certifiers just want to achieve the best Ep parameter (primary energy) instead of really increasing the share of energy from renewable sources. It does not contribute to any real improvement in energy parameters for newly erected buildings.

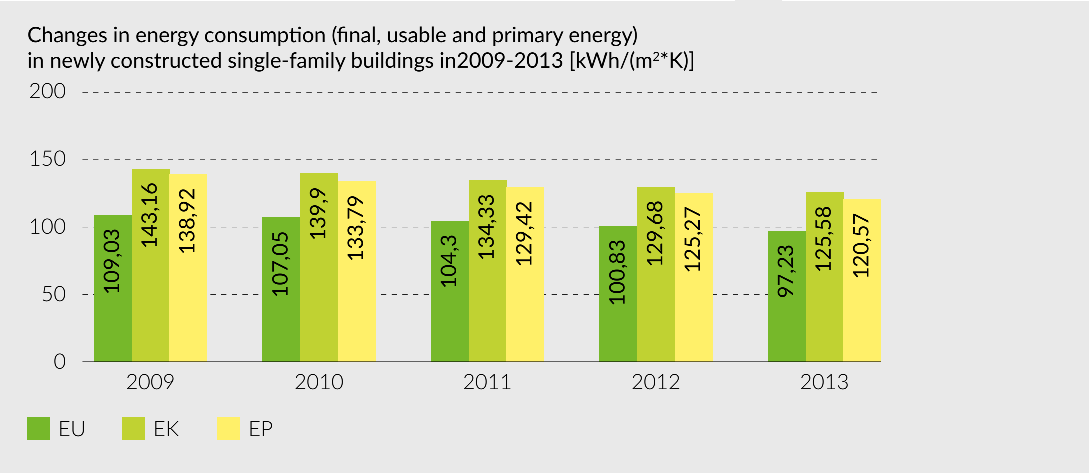
RECOMMENDATIONS FOR 2014 AND THE FUTURE YEARS

Based on this analysis we propose the following recommendations.

1. Promotion of energy-efficient technologies – the reduction of energy demand provides an effective solution for decreasing emissions (of carbon dioxide, particulate matters, benzo[a]pyrene and other pollutants) regardless of the fuel.
2. Focusing media activities on the remaining technologies – not only on insulation, which is already relatively popular.
3. An explanation of the growth in the popularity of biomass – the Polish government should immediately introduce remedial measures aimed at a real increase in RES use for heating.
4. The possible introduction of a ban on solid fuels (biomass and coal) in new buildings within areas with air quality problems – in particular when district heating and gas networks are available.

DATA ANALYSIS

We might call it a success – the consumption of energy in new buildings is systematically decreasing. In 2013 the Ep standard of single-family buildings in Poland reached 120 kWh/(m²*K). The energy efficiency of newly constructed single-family buildings has increased by around 13% over the last four years.



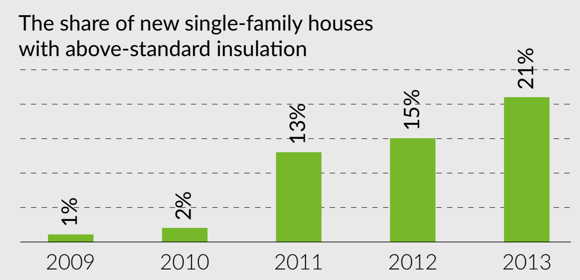
Source: BuildDesk database

Changes in energy consumption (final, usable and primary energy) in newly constructed single-family buildings in2009-2013 [kWh/(m2*K)]

	2009	2010	2011	2012	2013
Usable energy – Eu	109.03	107.05	104.3	100.83	97.23
Final energy – Ef	143.16	139.9	134.33	129.68	125.58
Primary energy – Ep	138.92	133.79	129.42	125.27	120.57
Sample – N	16 575	13 381	12 603	11 822	9832

Source: BuildDesk database

The use of above-standard insulation seems obvious – adding an extra centimetre of insulation during the construction phase does not cost much and the effect remains there for years. In other words, a small investment delivers relatively large benefits for decades. Why then did so few investors decide to use an additional insulation layer in 2009? It is probably a result of the outdated ideas represented by the "old school of construction", which focused on strict adherence to standards at the lowest possible cost. According to a new approach, buildings should be designed as well as possible – therefore, construction designers try to optimise both investment and maintenance costs. A significant improvement can be observed in this area. It is worth pointing out that the quality of insulation specified in ready-to-go projects is much higher – which has a significant impact on investor behaviour.



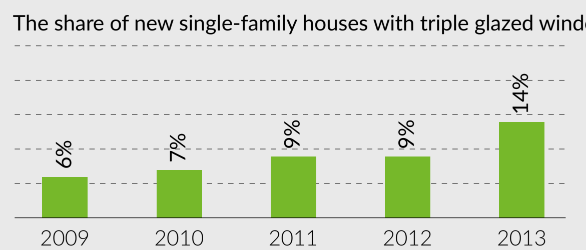
Source: BuildDesk database

The number of new single-family houses with above-standard insulation

	2009	2010	2011	2012	2013
The number of houses with above-standard insulation	186	320	1696	2111	2064
The number of analysed houses	16 041	13 698	13 116	13 628	9832
Share	1%	2%	13%	15%	21%

Source: BuildDesk database

Newly constructed buildings are more energy efficient mainly due to the fact that their insulation is systematically improving. More frequent use of above-standard insulation proves that architects and construction designers are really gaining more knowledge and skills. A similar trend can be observed on the triple glazed window market, whose share has also been systematically growing year by year.



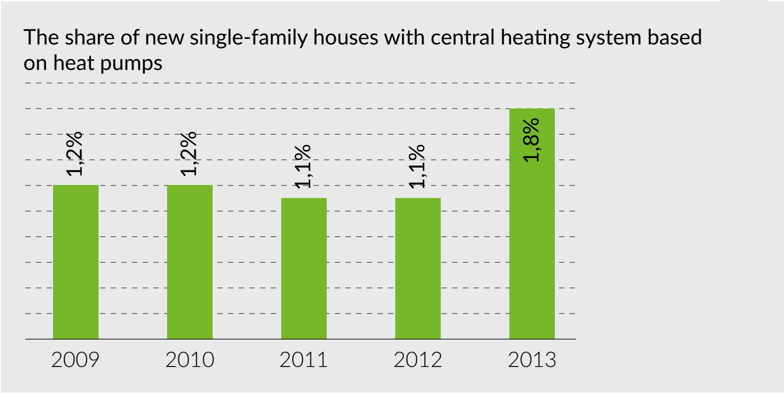
Source: BuildDesk database

The number of new single-family houses with triple glazed windows

	2009	2010	2011	2012	2013
The number of houses with triple glazed windows	955	962	1219	1285	1376
The number of analysed houses	16 041	13 698	13 116	13 628	9832
Share	6%	7%	9%	9%	14%

Source: BuildDesk database

Biomass is often indicated as a source of heat by Polish investors whereas solar power or heat pumps are rarely used for that purpose.



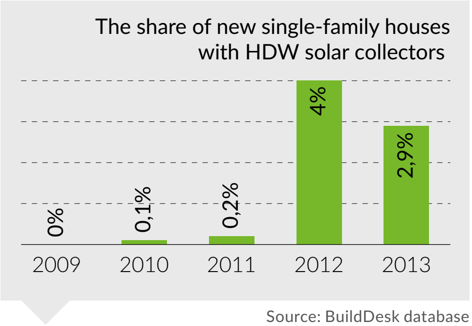
Source: BuildDesk database

The number of new single-family houses with central heating system based on heat pumps

	2009	2010	2011	2012	2013
The number of houses with heat pumps	**185**	**167**	**147**	**148**	**175**
The number of analysed houses	16 041	13 698	13 116	13 628	9832
Share	1,2%	1,2%	1,1%	1,1%	1,8%

Source: BuildDesk database

Heat pumps are not so popular in Poland, which is obviously related to the high investment cost (the price of equipment and installation cost) and the lack of preferential electricity tariffs. It also seems fully justified from the environmental point of view. In Poland, heat pumps are powered by electricity, which is mainly generated from coal. The efficiency of the Polish energy system is about 30–35%, so only one unit of electrical energy is obtained from three units of chemical (thermal) energy stored in the fuel. A heat pump converts electricity back into thermal energy with the efficiency of about 3/1 – hence, to put it simply, in Poland the final outcome is zero. This situation may change if we see an increase in the share of renewable energy sources in electricity generation.



Source: BuildDesk database

The number of new single-family houses with HDW solar collectors

	2009	2010	2011	2012	2013
The number of houses with HDW solar collectors	**0**	**8**	**24**	**551**	**289**
The number of analysed houses	16 041	13 698	13 116	13 628	9832
Share	0,0%	0,1%	0,2%	4%	2,9%

Source: BuildDesk database

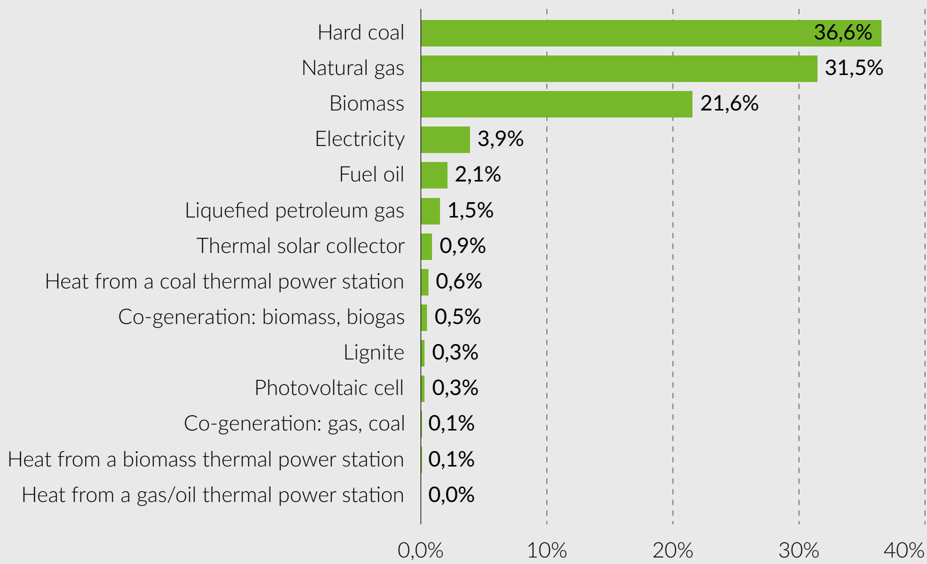
DECLARED FUEL USE
IN SINGLE-FAMILY BUILDINGS

Information from the BuildDesk database can be used as the basis for determining the "energy mix" for newly constructed buildings – both single and multi-family ones. The data being analysed shows that coal is still growing in popularity as a source of heat in single-family buildings. This is a result of the attractive price of coal and increasing foreign competition – on the retail market, Polish coal is being defeated by the cheap Russian coal*.

It is difficult to make conclusive interpretations where biomass is concerned. It is very likely though that the figures are highly over-estimated. We can assume that some investors declare biomass use while in fact they will be using other types of fuel for heating purposes (mainly pea coal) – in this way the primary energy value is lowered by the purely formal procedure of declaring the combustion of a renewable fuel, which will not be verified in the future. It is impossible to determine how many buildings will actually be heated with biomass and how many with other fuels.

* In 2013, coal mining in Poland was unprofitable – the average cost of extracting 1 tonne of coal was PLN 298.91, the average net selling price decreased by almost 15% to PLN 298.33. The average price of a tonne of Russian coal imported by sea was PLN 269, and by railway – PLN 293. http://www.pb.pl/3652697,97687,rosyjska-presja-na-polski-wegiel

Fuels used for heating in newly-constructed single-family buildings in 2013



Source: BuildDesk database

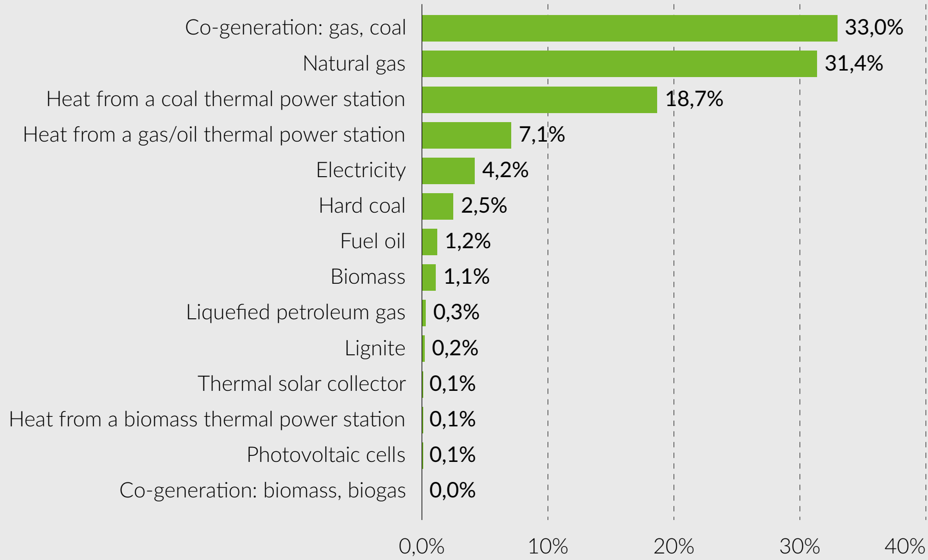
Changes in the utilisation of the main energy carriers for heating newly constructed single-family buildings in 2009–2013

	2009	2010	2011	2012	2013
Hard coal	29.9%	32.8%	34.1%	35.2%	36.6%
Natural gas	38.1%	34.3%	33.3%	33.0%	31.5%

Source: BuildDesk database

The relative share of final energy derived from gas consumption is steadily declining – since 2009 it has fallen by about 6 percentage points. A downward trend can also be observed in the case of fuel oil and liquefied petroleum gas.

Changes in the utilisation of the main energy carriers for the heating of newly constructed multi-family buildings in 2009-2013



Source: BuildDesk database

Changes in the utilisation of energy carriers for the heating of newly constructed multi-family buildings in 2009–2013

	2009	2010	2011	2012	2013	Average
Co-generation: gas, coal	31.3%	34.3%	46.9%	47.1%	33.0%	38.5%
Natural gas	37.8%	45.6%	27.6%	28.2%	31.4%	34.1%
Heat from a coal thermal power station	19.7%	9.2%	13.7%	10.6%	18.7%	14.4%
Heat from a gas/oil thermal power station	2.0%	2.3%	2.8%	3.6%	7.1%	3.5%
Electricity	3.7%	2.5%	3.6%	3.6%	4.2%	3.5%
Hard coal	2.7%	3.5%	2.1%	4.0%	1.2%	2.7%
Fuel oil	2.2%	0.9%	0.7%	0.7%	0.1%	0.9%
Biomass	0.2%	1.1%	1.3%	0.1%	1.1%	0.8%
Liquefied petroleum gas	0.0%	0.1%	0.3%	0.0%	2.5%	0.6%
Lignite	0.0%	0.4%	0.3%	0.8%	0.3%	0.3%
Thermal solar collector	0.1%	0.0%	0.5%	0.8%	0.2%	0.3%
Heat from a biomass thermal power station	0.1%	0.0%	0.0%	0.6%	0.1%	0.2%
Photovoltaic cells	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
Co-generation: biomass, biogas	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%

Source: BuildDesk database

In newly constructed multi-family buildings heat is mainly derived from co-generation, natural gas and local coal thermal power stations. It is difficult to determine a trend on the basis of the data collected – annual average values vary greatly.

DEFINITIONS*

SINGLE-FAMILY BUILDING – a detached, semi-detached, terraced or grouped building, constructed to satisfy residential needs, constituting an independent entity from the constructional perspective and representing one residential unit.

MULTI-FAMILY BUILDING – a building with more than one residential unit as well as hotels and similar buildings.

RESIDENTIAL UNIT – a complex of residential and auxiliary quarters, with a separate entrance, separated into permanent space divisions, fulfilling the conditions for permanent residence and an independent household.

USABLE ENERGY (EU) – takes into account heat loss through the building fabric, the energy necessary for heating water, the energy used for ventilation and air conditioning.

FINAL ENERGY (EF) – the value for usable energy increased by the loss resulting from the efficiency of systems for heating rooms and water.

PRIMARY ENERGY (EP) – final energy multiplied by a relevant primary resource factor characteristic for each final energy carrier; the factor defines the conventional impact of a particular energy source on CO_2 emissions.

* Regulation of the Minister of Infrastructure of 6 November 2008 on the methodology for the calculation of the energy performance of buildings and residential units or parts of buildings constituting a technically and functionally independent unit and on the manner of preparation of energy performance certificates and their models, Dziennik Ustaw (Polish Journal of Laws) No 201, item 1240

UNDERESTIMATED THERMAL MODERNISATION

MARIA **DREGER**
ASSOCIATION OF MINERAL AND GLASS WOOL MANUFACTURERS

Around 105,000 buildings are rendered for use in Poland every year, of which 75,000 are single-family houses. They are mainly heated with gas or coal, the former being very convenient to use and the latter relatively cheap, also due to political preferences. For example, in 2009–2010 gas heating was used in around 40,000 new buildings, whereas the remaining 35,000 were equipped with coal-fired boilers. Around 2,530 m^3 of gas or 4,800 kg of coal per year must be used to heat each of these buildings. This means that over a period of 30 years 76,000 m^3 of gas and more than 145 tonnes of coal will be used to heat them.

Could this be less? It would be enough if each of those relatively new houses were better insulated during the construction phase. Using the optimal thickness of insulation, instead of the minimal required one, would result in lower energy consumption. One house could save each year 550 m^3 of gas or 800 kg of coal with full thermal comfort maintained. Similar savings or losses would be delivered over every heating season that followed. Therefore, every new building can be perceived as a well-used opportunity or a missed chance. In the latter case, instead of generating savings, new houses will remain a constant source of unnecessary heat losses over the next few decades.

MARIA **DREGER**

Graduated from the Krakow University of Technology with postgraduate studies at the Warsaw University of Technology. Holder of an engineering degree with all licenses. For several years Standards & Norms Manager at Rockwool Polska Sp. z o.o., has extensive experience in various areas of the construction industry. A member of several technical committees of the Polish (PKN) and European (CEN) Committee for Standardization, and of work teams in Polish and European (EURIMA) trade organizations. She actively contributes to the development of standards relating to thermal insulation, fire protection and energy efficiency for the modern construction industry.

The application of energy saving measures in the construction sector would generate annual savings of 18 million m^3 of gas and 26 thousand tonnes of coal even if we only take into account buildings rendered for use in one year. If someone believes that the savings that can be achieved by increasing energy efficiency of single-family houses are small, it is easy to identify a source of much larger ones.

According to data obtained during the National Census of Population and Housing, conducted by the Central Statistical Office in 2011, there were over 6.1 million buildings in Poland, almost 98% of which (i.e. around 5.97 million) were residential buildings. Among them, there were as many as 5.5 million single-family houses. Most of these houses were built years ago, according to energy efficiency standards that were binding at the time. Requirements used to be much less stringent back then. Therefore, fuel savings which can be achieved by optimising the insulation of such

Heat demand for 1 m^2 of space – E [$kWh/m^2/year$]

Year(s) of construction	E [$kWh/m^2/year$]
up to 1966	350
1967–1985	260
1986–1992	200
1993–1997	160
1998–2013	120
Optimal	80
Passive	15

buildings, and thus minimising the total investment and maintenance costs, are greater than in the case of buildings which were erected recently. Let us just compare the levels of requirements and the corresponding levels of energy consumption in houses built in various periods of time.

A REAL LIFE EXAMPLE
THERMAL MODERNISATION OF A TYPICAL SINGLE-FAMILY HOUSE FROM THE 1970S

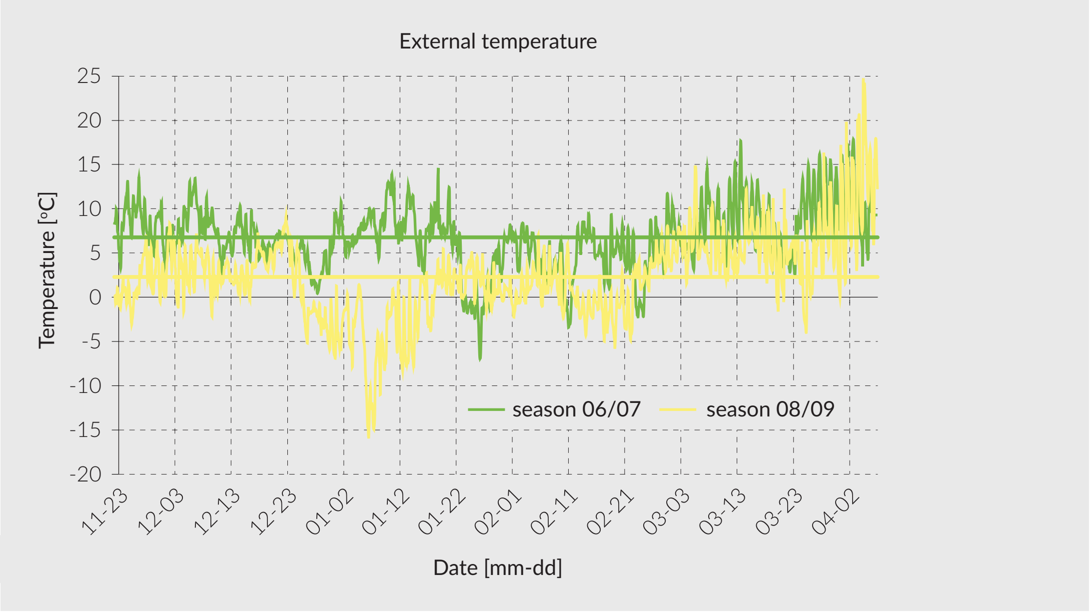
Here is a true story from a few years ago. A house in Zielona Góra, Poland, inhabited by a family of four, was subjected to comprehensive thermal modernisation. Before launching the project all the parameters of the house were measured in order to compare the actual effects of thermal modernisation with the pre-modernisation condition of the house as well as with its expected and planned condition.

Before thermal modernisation

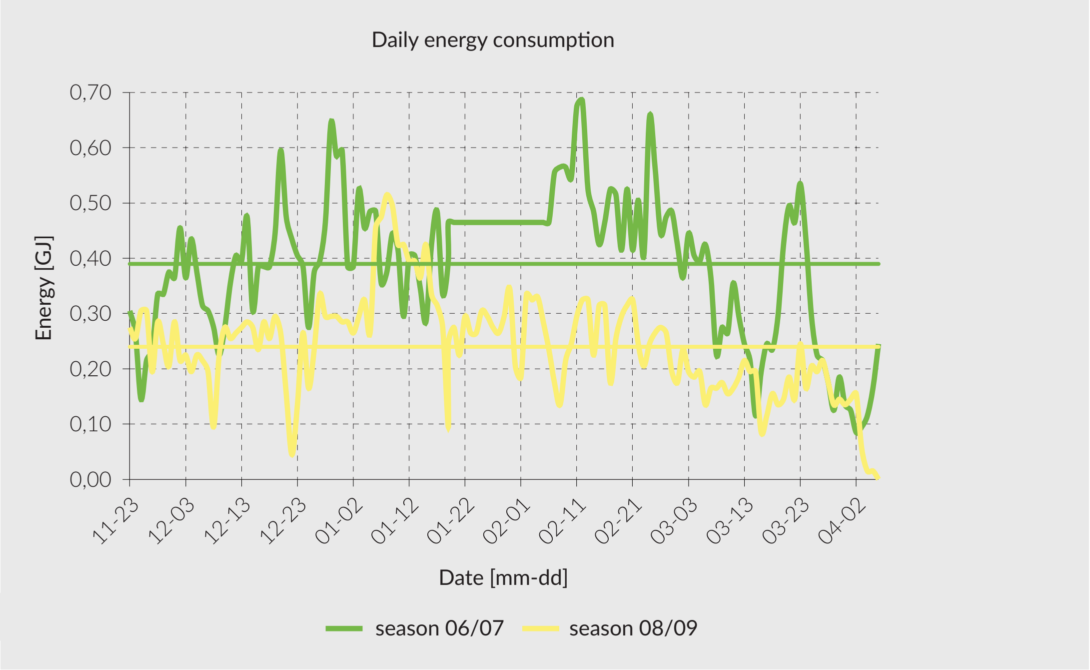
After thermal modernisation

The scope of the works was planned on the basis of energy audit results. However, improvements in the aesthetics of the building were also taken into account. Thermal modernisation included insulating the building envelope: roof, external walls, above-ground basement walls – with 15-centimeter thick mineral wool panels, underground basement walls – a 12-centimeter layer of mineral wool, and the balcony floor above the garage – a 5-centimeter layer of mineral wool. Thermal bridges were eliminated. The heating system was adapted to heat demand, which was significantly reduced thanks to the insulation.

The results were better than expected: seasonal heat demand was reduced by almost 50%, gas consumption and heating costs decreased accordingly.



External temperature before and after thermal modernisation



Daily energy consumption before and after thermal modernisation

Although the average outdoor temperature during the heating season after thermal modernisation was lower by as much as several degrees, the indoor temperature remained higher by 1°C. Moreover, the temperature in the rooms proved to be stable, regardless of the very low temperatures outside the building. The total cost of all the work was a little more than PLN 80,000, but only part of that amount can be classified as expenses related to improving the energy standard, i.e. as expenses strictly related to thermal modernisation. A significant amount of money had to be spent on refurbishment works that were necessary after so many years (new roof cladding, facade restoration and additional fittings suggested by the architect to improve the aesthetics of the building). As a result, by investing 25% of the cost of a new house, the owners gained an attractive, comfortable and conveniently located house with a modern form, built to an excellent standard. Critical success factors included: a professional energy audit and construction design, fine workmanship, high quality materials, adherence to technological regimes and an eye for detail.

The effect of reducing energy demand and gas consumption by around 50% is important not only for house owners or users. It also has a positive effect on the country's energy balance.

AND WHAT ABOUT MODERNISING THE MAJORITY OF OLD SINGLE-FAMILY HOUSES?

It would be enough to insulate 3.5 million of single-family buildings in Poland in order to generate annual energy savings of over 995 million m^3 of gas and over 1.6 million tonnes of coal.

It is worth comparing these figures with a huge project planned for the years 2016–2020, which involves the expansion of gas storage facilities by 1,030 million m^3. This project, carried out as part of the Operational Programme Infrastructure and Environment, is going to consume enormous amounts of resources, not only from EU funds. The investment is supposed to improve energy security by increasing gas stocks. Its side effects will include a price increase, which is necessary for the construction and storage costs to be recouped. Meanwhile, as the above mentioned example and statistics show, reducing heat losses in single-family houses by subjecting them to thermal modernisation would have the same effect in terms of improving the country's energy security. **Moreover, instead of bearing the burden of higher costs resulting from increased gas prices, house users would pay less for heating.** Widespread thermal modernisation would improve the lives of millions of Polish families and reduce the phenomenon of energy poverty. If living in well-heated homes is to be no longer a privilege but a standard, energy efficiency must also become a standard in all buildings: in old ones as well as new.

INSULATION OF SINGLE-FAMILY HOUSES = GAS AND COAL SAVINGS = ENERGY SECURITY AND CLEANER AIR

What is more, if less energy were necessary to heat houses, stoves and boilers would not be fired with cheap, but inappropriate fuels. This would result in a significant reduction of air pollutant emissions. Poland would no longer be, together with Bulgaria, one of the countries with the most polluted air in Europe. The very poor air quality in our country contributes to an increased incidence of asthma, cancer, and other respiratory, nervous and cardiovascular diseases.

Comprehensive thermal modernisation could have a significant positive impact on the whole economy. Just by comparing the number of big and small buildings we can observe that **small houses – being so numerous – provide the main savings potential**. Even the most spectacular thermal modernisation projects meant for large buildings cannot be as effective in terms of energy savings and economic benefits as a high number of small projects. **Additionally, the implementation of a number of small projects stimulates the development of the construction services sector**. Jobs in this field do not require large expenditures. Being in high demand, they are created, quite importantly in this case, in all parts of the country. They cannot be exported or outsourced to cheaper regions of the world. They contribute to improving the living conditions of both service providers and recipients. Thermal modernisation has many other positive effects too. It could also be a great boost to the market for construction materials and products. The potential of the insulation market alone is estimated to be around 1.5 billion m2, not to mention windows, roof cladding, finishing components and installation materials. Thermal modernisation and, more generally, energy efficient homes, promote the development of renewable energy sources because if just a small amount of energy can satisfy the demand for heat in a building, the cost of applying them is relatively low. Therefore, energy from modern installations based on renewable sources becomes competitively priced compared with traditional systems based on fossil fuels.

WHAT AMOUNT OF ENERGY RESOURCES CAN BE SAVED BY ONE SINGLE-FAMILY HOUSE? AND BY 5 MILLION OF SUCH HOUSES?

While implementing the objectives of the climate and energy package, it is advisable to take the most cost-effective measures first. The package provides for a reduction of energy consumption and fuel demand, which is supposed to increase Europe's competitiveness and guarantee its independence from external suppliers. One of those measures, proven on many occasions, is to invest in energy efficient construction and improve energy parameters in existing buildings by subjecting them to thermal modernisation. It was stated as long ago as 2005 in the European Commission's Green Paper that energy efficiency investments provide 3–4 times as many jobs as investments in increasing production capacity.

Thermal modernisation needs a common sense approach. What counts most is a good plan. It would be best not to focus on selected, individual projects but to subject buildings to extensive and deep thermal modernisation following the Trias Energetica model: first reduce heat loss to the minimum level and then optimise the heating system with the use of clean or renewable sources of energy. Thermal modernisation understood and implemented in this way can become an inestimable, and no longer underestimated, means of improving the energy balance of the country with all the positive effects it entails.