PVC

STUDY ON WINDOWS

PVC. When it really counts.

"POTENTIAL TO SAVE ENERGY THROUGH THE USE OF MODERN WINDOW SYSTEMS IN EUROPE"

Presented by Marcus Hermes

ENORMOUS POTENTIAL TO SAVE ENERGY IN EUROPE

Study on windows: enormous potential to save energy

Sharp price increases in oil, gas and electricity require efficient energy-saving measures such as installing heat-insulating PVC windows. How much this is needed is shown in the study "Potential to save energy through the use of modern window systems in Europe" by engineer Marcus Hermes. The author operates the engineering office "hermes bauphysik und fenstertechnik" and the "institut für wärmebrückenanalyse." As a self-employed building physicist, his customers include international industrial and manufacturing companies, architects and planners, as well as residents and building owners. The study was commissioned by the European PVC Window Profile and Related Building Products Association (EPPA) together with PVCplus Kommunikations GmbH. In the process, these two institutions helped to foster commitment to the sustainable development of PVC window profiles.

Great opportunities for PVC windows

The results of the window study provide insight into the enormous potential for growth which is available to the European plastic window branch. The Turkish market alone for PVC windows, which the branch regards as a part of the European network, achieved 22 percent in growth last year. PVC is already the most important material for window frames in Europe and has gained top position with over 40 percent of the market share, e.g. in Germany, France and Austria almost more than 50 percent of all built-in windows are made of PVC profiles. In Great Britain it is more than 80 percent, in Scandinavia and Southern Europe less than 20 percent. Especially the markets for renovating old buildings are growing.

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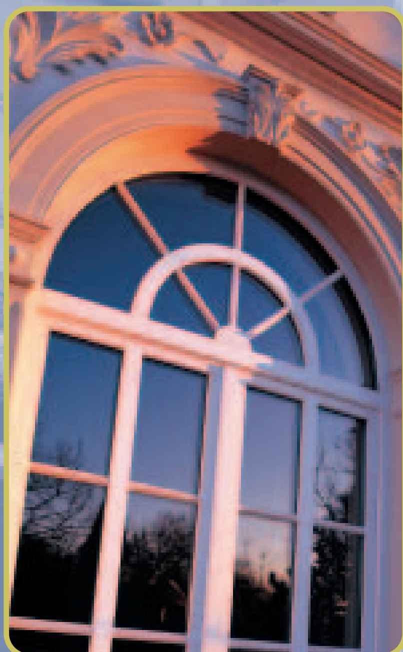


PVC. When it really counts.

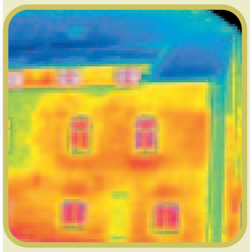
EPPA – European initiative for PVC window profiles

The EPPA, which was founded in March 2000, is a sector group of the European Plastic Converters in Brussels (EuPC) and represents on the European level the interests of the manufacturers of PVC window profiles and related building products made of rigid PVC. The members are comprised of the European manufacturers of window profiles and the respective national interest groups. Special emphasis is placed on the use of PVC window frames and related PVC applications such as roller shades, window sills, and window shutters. Additionally, there are accessories and secondary profiles necessary for plastic window production, and paneling for inside and outside walls (siding).

The main focus of the association's work is carrying out the voluntary commitment for the sustainable development of the European PVC branch (VINYL 2010 Voluntary Commitment) in respect to windows made of PVC and related building products. Through this 10-year plan, product management is continuously being improved during the entire life cycle of PVC. The EPPA therefore provides an incentive for establishing and operating national recycling initiatives for used PVC windows in Europe. Some of the tasks of the European association with its headquarters in Brussels involve calculating and controlling the flow of recycled materials. Furthermore, great importance has been given to the substitution of lead stabilizers by 2015 at the latest. The example of cadmium shows that the European PVC branch is achieving its goals. Since 2001 the branch has gone without using this stabilizer in manufacturing its products. In this respect, the European interest group EPPA has also made an important contribution to the sustainable development of PVC.

PVCplus – Marketing platform of the PVC branch

The marketing platform PVCplus with its headquarters in Bonn, Germany, is a service institution for the PVC branch. Its partners include chemistry companies which operate worldwide as well as medium-sized PVC processors. Special emphasis is placed on promoting the valuable plastic material in order to improve its image in speaking with the public, architects, designers and decision-makers. In doing so, PVCplus shows the technical strengths, the innovative potential, the profitability, and the sustainable development of the material. PVCplus also pursues these goals for the important building product PVC windows by revealing the energy-saving advantages of the plastic material and by publishing the most recent scientific findings. Furthermore, PVCplus supports PVC window companies through professionally designed sales promotion offers such as advertisements, fliers, and presentations in addressing customers. Additionally, there is also cooperation work with companies and associations from the PVC branch.



Enough wasting energy: PVC profiles with heat-insulating glass make energy saving possible

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Study

“Energy Saving Potentials from the Use of Modern Window Systems in Europe”

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on behalf of

EPPA, Brussels
European PVC Window Profile and
Related Building Products Association

and

PVCplus Kommunikations GmbH, Bonn
Marketing Initiative of the PVC Industry

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Introduction

The worldwide storm disasters of recent years have instigated an even more intensive discussion of the world's climate. The probable effect of environmentally harmful gases and the measures necessary to reduce harmful emission are to the fore in every climate conference. Moreover, the great dependency on fossil fuel raw materials from countries with unstable political systems causes an uncertainty that regularly results in surprises on the energy market. Together with the increasing inflation in recovering raw materials from ever deeper layers of the earth, this is leading to a constant price rise for energy. Extreme cost explosions for ongoing maintenance costs in the three main energy consumption sectors for industry, transport and buildings are the consequence that everyone can feel directly. Updated standards and laws [1;2] and many funding programmes [3] for energy-saving are designed to counteract this development in the building sector. In addition, the European directive on building energy efficiency [4] is enhancing awareness. A real energy-saving wave is developing appreciably, which will gradually include all those involved in building and all inhabitants. A buzzword in this context is the "energy pass" [5].

But which measures are proving to be really efficient for energy-aware building and the renovation of existing buildings? This reply is to be provided by object-related, well-founded energy planning that takes account of all aspects, such as surroundings, use, plant engineering, etc. The undisputed basis of this is an energy-saving design for the building shell. The "window" plays a key role in the interaction of the various components of a shell of this kind. With its many properties, from the ways of opening and transparency, to the design of buildings, it has always combined many unique advantages. But in terms of energy, the window also remains the component with the highest transmission heat losses. Modern window constructions with energy-saving frames and glazing with thermally improved edging have therefore become the standard in recent years. It is only the availability and use of these energy-saving elements that make energy-conscious building possible. The present study shows how high the energy-saving potentials of modern windows should be evaluated.

Windows and Thermal Insulation – The Basics

For a more precise calculation of the heat loss to be expected the window is divided into three energy elements [6]. Fig.1 shows a diagram of a window with its three building physical components involved in heat transmission.

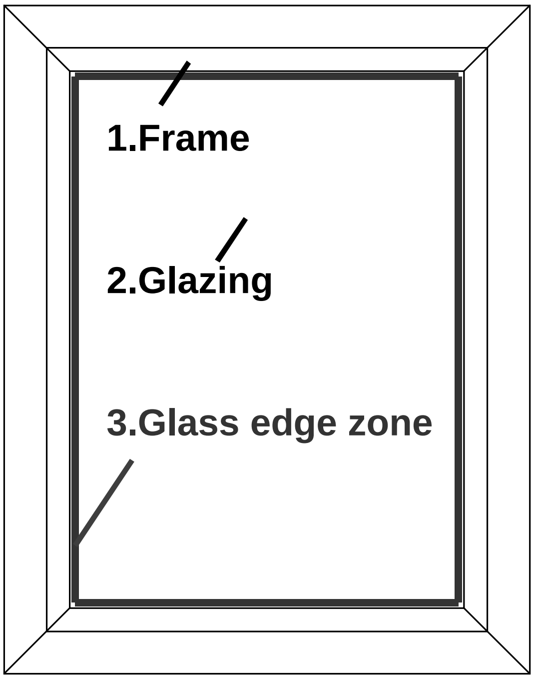

Fig. 1: Components of a window relevant to thermal engineering

The European fundamental standard DIN EN ISO 10077 Part 1 [7] contains all the basic formulae relevant to the calculation that are now standard in Europe.

In line with the following relation, it is clear that not only the glazing is key to the heat loss of a window, but also the frame and the edging with the spacer profile including all sealing and drying materials used in multi-pane insulated products. In the following this area is called "glass edge zone" for short.

The following applies:

$$U_W = (A_f \cdot U_f + A_g \cdot U_g + l_g \cdot \psi_g) / A_W \qquad (1)$$

with	U_W	Window heat permeability coefficient ("Window" index)	in W/(m²K)
	A_f	Visible surface of the frame (including casement, "frame" index)	in m²
	U_f	Heat permeability coefficient of the frame	in W/(m²K)
	A_g	Visible surface of the glazing ("glazing" index)	in m²
	U_g	Heat permeability coefficient of the glazing	in W/(m²K)
	l_g	Visible length of the glass edge zone	in m
	ψ_g	Linear heat permeability coefficient of the glass edge zone "Psi"	in W/(mK)
	A_W	Total area of the window ($A_W = A_f + A_g$)	in m²

Moreover, the U value calculation formula (1) clearly shows that window U values are heavily dependent on size. Fig. 2 clearly shows the energy proportions from frames, glazing and glass edge zone with windows of different sizes [8]:

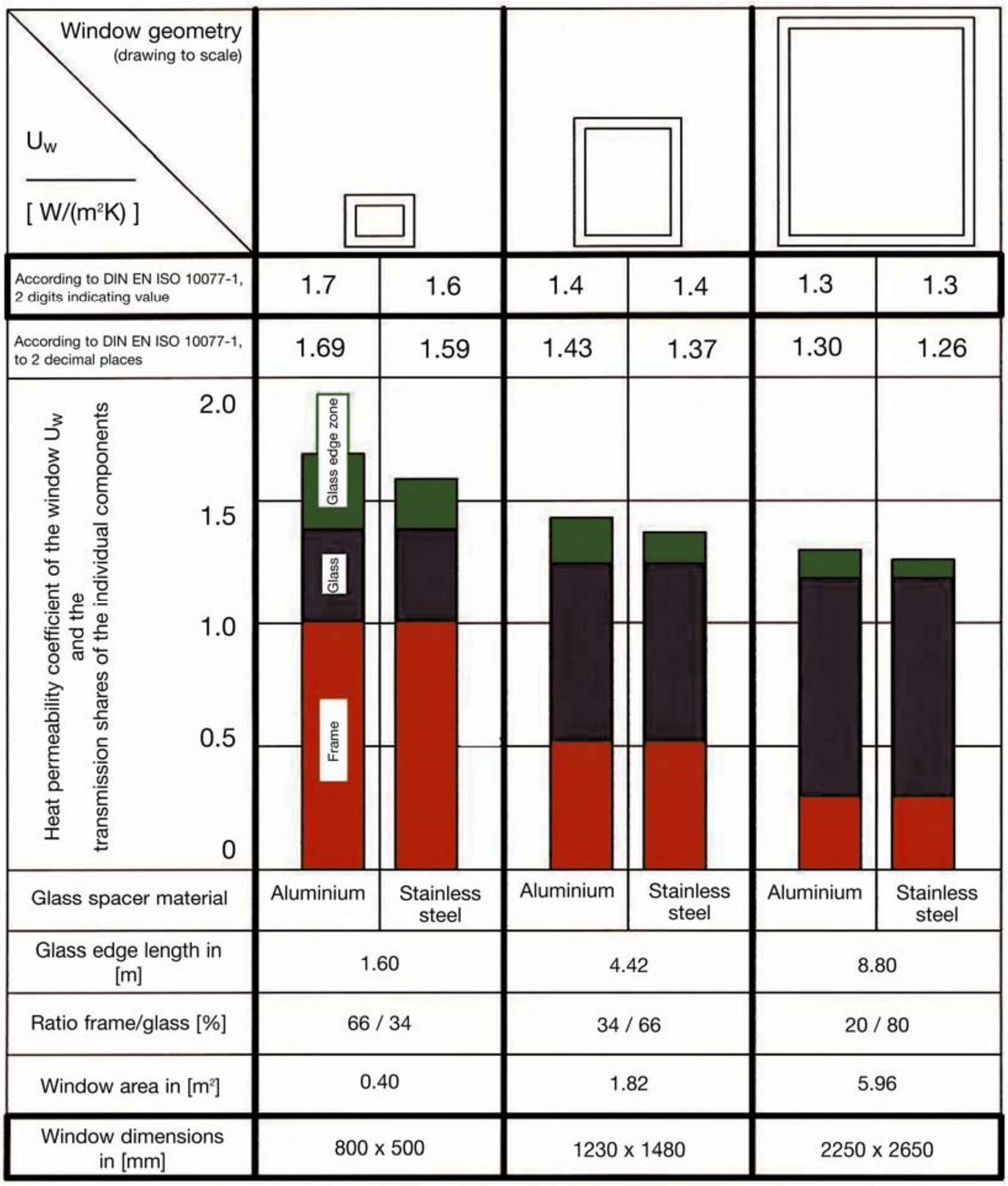

Fig. 2: Window U values depending on window size. Thermal input data: U_f = 1.5 W/(m²K), U_g = 1.1 W/(m²K), $\psi_{Aluminium}$ = 0.075 W/(mK), $\psi_{Stainless\ steel}$ = 0.050 W/(mK), geometry: Frame view width = 125 mm.

It can clearly be seen:

1. The smaller the window formats, the higher the window U value U_W.
2. The smaller the window formats, the higher the influence of the frame.

3. Even with a standard window size 1230 mm • 1480 mm, the proportion of heat transmission through the glazing is just 51%.
With the “window unit”, “WU” for short, with a size of 1.69 m² used as a basis in the publications, the proportion of thermal energy transmitted via the glazing according to Fig. 2 is even slightly below the 50% mark.
4. The influence of the frame combined with the glass edge zone is thus much more important in heat transmission than previously assumed. This fact in strengthened by the fact that it is the window frame itself that has the key thermal influence on the linking zone with the body of the building. Thermal bridge analyses of various window installation situations reveal an additional heat loss that can be compensated for only with well-planned and executed installation [9; 10].

Definition of the Thermal Technical Comparative Basis – New Windows

As a basis for comparison it appears to make sense to use two thermal insulation levels for new windows as a starting point for assessing the energy-saving potential.
They are based on the conventional market circumstances and consciously exclude the extremely high insulating constructions for passive houses. Because it can certainly be assumed that in the foreseeable future constructions of this kind will not be the general standard for all residential buildings in Europe, including eastern Europe, for very many reasons. These reasons include the very complex, expensive frame construction with frame installation depths of around 100 mm, the increased production expense, the resultant high cost level, bottlenecks in the availability of infra-red coated glazing for tripe insulation glass structures as well as insufficient experience in the long-term behaviour of such constructions in extreme climate regions.

Therefore, the two basic windows selected of the size 1300 mm • 1300 mm (corresponding to the window unit size WU = 1.69 m²) for identification of the energy-saving potentials in this study have the following thermal indices:

Window Type	Window U_W in W/(m²K)	Frame U_f in W/(m²K)	Glazing U_g in W/(m²K)	Glass Edge Zone ψ_g in W/(mK)
A good insulation level	1.2	1.2	1.1	0.040
B average insulation level	1.7	1.6	1.5	0.080

In addition to an outstanding frame structure with a building depth of at least 70 mm and at least 4 chambers for plastic windows, the well insulated window type of Class A thus has very good double glazing with coated glass, inert gas filling between the panes and a thermally separated spacer system, e.g. made of plastic. All values comply with the current European standards [7; 11; 12], are generally available commercially and realise a total window insulation value of $U_{W, A}$ = 1.2 W/(m²K).

Window type B with average insulating properties is comprised of a frame with a building depth below 60 mm, air-filled, but coated glazing and spacers made of aluminium. A window U value of $U_{W, B}$ = 1.7 W/(m²K) is reached in this way.

Definition of the Thermal Technical Comparative Basis – Existing Windows

The heat insulation properties for the existing windows that are usually installed as new windows with conventional building methods without particular heat insulation requirements or are exchanged and thus replaced when buildings are being renovated can also be divided into two types of window:

Window Type	Window U_W in W/(m²K)	Frame U_f in W/(m²K)	Glazing U_g in W/(m²K)	Glass Edge Zone ψ_g in W/(mK)
C low insulation level	3.0	2.4	3.3	0
D very low insulation level	4.6	2.4	5.7	0

Window type C with low insulating properties is comprised of a wooden frame with a building depth below 50 mm, with a compound glass construction made up of two single panes without spacers. A window U value of $U_{W, C}$ = 3.0 W/(m²K) is reached in this way.

Window type D with very low insulating properties is comprised of a wooden frame with a building depth below 50 mm, with glazing made up of only one single pane without spacers. A window U value of $U_{W, D}$ = 4.6 W/(m²K) is reached in this way.

Energy Saving when using Modern System Constructions (Type A and B) in Comparison to Conventional Window Construction Methods (Thermal Insulation Type C and D)

Because of the lower U value of window types A and B, less thermal energy is lost from the inside to the outside during the heating phase then with window types C and D with higher thermal energy consumption indices.

These window U values form the basis for the calculation of heat losses through transmission for a window unit (WU) per year. In this connection it is the case [13]:

$$Q_{WU} = 84 \cdot U_W \cdot A_W \quad \text{in kWh/a} \qquad (2)$$

This approximation formula takes account of a heating degree-day index [14] of 3500 Kelvin days per year (Kd/a) in climate factor 84, which is multiplied by the time conversion factor of 0.024. The value applies to the average climate conditions of central Europe. In particularly cold regions, heating degree-day indices of up to 4500 Kd/a are easily possible. In this case, the climate factor increases from 84 to 108. For simplicity's sake, the statements in this study refer to the basic climate factor of 84. However, the use of the higher value is recommended in separate individual considerations.
The thermal energy consumption is measured in kilowatt hours per year, kWh/a for short. Then, the following formula can be used to easily convert the energy consumption value into litres of heating oil and cubic metres of natural gas. The following applies:

$$10 \text{ kWh/a} = 1 \text{ l heating oil} = 1 \text{ m}^3 \text{ natural gas} \qquad (3)$$

Moreover, on this basis the amounts of exhaust CO_2 [13;15] can be calculated as follows:

The consumption of	results in approx.
1 litre of heating oil	2.7 kg CO_2
1 m³ natural gas	1.1 kg CO_2

With the help of equations (2) and (3) and the amounts of exhaust CO_2 the following annual energy consumption and exhaust gas quantities result for the individual window units A to D (with heating with heating oil being used as a basis initially) per window unit WU:

Window Type 1 WU = 1.69 m²	Annual energy Q_{WU} in kWh/a	Consumption in l heating oil	Quantity of exhaust gas CO_2 in kg
A good insulation level	170	17	46
B average insulation level	241	24	65
C low insulation level	426	43	115
D very low insulation level	653	65	176

These values refer to the single window unit, as considered in window market data. Even when considering 1 million window units, the values for consumption and CO_2 emissions rise tremendously:

Window Type 1 million WU = 1,690,000 m²	Annual energy Q_{WU} in GWh/a (Giga watt hours/a)	Consumpti on in million l heating oil	Quantity of exhaust gas CO_2 in t (tonnes)
A good insulation level	170	17	46 000
B average insulation level	241	24	65 000
C low insulation level	426	43	115 000
D very low insulation level	653	65	176 000

When using natural gas, the situation for 1 million window units is as follows:

Window Type 1 million WU = 1,690,000 m²	Annual energy Q_{WU} in GWh/a (Giga watt hours/a)	Consumpti on in million m³ natural gas	Quantity of exhaust gas CO_2 in t (tonnes)
A good insulation level	170	17	19 000
B average insulation level	241	24	27 000
C low insulation level	426	43	47 000
D very low insulation level	653	65	72 000

These basic values are now transferred to the number of window units in the European states and regions. In this connection, – where known – the mix of heating oil and natural gas of the individual states and regions is incorporated to roughly take account of the considerable deviations of CO_2 emissions between heating oil and natural gas combustion.

The 25 States in the European Community

The 25 states of the European Community are listed below: the overview contains information about the state area and the number of inhabitants. Moreover, the per-capita consumption of heating oil and natural gas are given [15; 16; 17] and the resulting total emissions of CO_2, also per person:

State	State area in km²	Population	Energy consumption Litres of heating oil per inhabitant	m³ of natural gas per inhabitant	Total CO_2 kg/inhabitant (only from oil and natural gas consumption)
Belgium	30528	10364388	3495	1496	11081
Denmark	43094	5432335	2011	972	6500
Germany	357021	82431390	1885	1208	6417
Estonia	45226	1332893	1088	953	3987
Finland	338145	5223442	2441	872	7550
France	547030	60656178	1971	693	6083
Greece	131940	10668354	2370	219	6640
Ireland	70280	4015676	2538	1046	8002
Italy	301230	58103033	1872	1225	6401
Latvia	64589	2290237	735	742	2800
Lithuania	65200	3596617	1436	767	4721
Luxembourg	2586	468571	6898	1846	20656
Malta	316	398534	2621	0	7077
Netherlands	41526	16407491	3254	3030	12119
Austria	83870	8184691	2029	954	6528
Poland	312685	38635144	715	298	2259
Portugal	92391	10566212	1793	241	5106
Sweden	449964	9001774	2231	105	6140
Slovakia	48845	5431363	763	1252	3437
Slovenia	20273	2011070	1500	517	4620

Spain	504782	40341462	2221	445	6486
Czech Republic	78866	10241138	1049	966	3896
Hungary	93030	10006835	778	1336	3569
United Kingdom	244820	60441457	1653	1536	6154
Cyprus	9250	780133	3868	0	10444

This overview clarifies the tremendous differences in energy consumption behaviour. In total, a **population** of around **457 million** in today's European Community need around **847 billion litres of oil** and **466 billion m^3 of natural gas**. Burning these raw materials generates around 2800 mega tonnes of exhaust CO_2. Assuming that the three consumption sectors of industry, traffic and buildings, this enormous quantity are roughly divided into equal thirds, meaning that around **930 Mt CO_2 is incurred by the building sector** including heat generation.

Five Other States of Eastern Europe

The following overview results for the five important eastern European states [17] including Turkey [17; 19] used in this study:

State	State area in km²	Population	Energy consumption Litres of heating oil per inhabitant	m³ of natural gas per inhabitant	Total CO_2 kg/inhabitant
Bulgaria	110910	7450349	833	779	3107
Romania	237500	22329977	611	828	2560
Russia	17075200	143420309	3702	2804	13080
Turkey	780580	69660559	596	324	1965
Ukraine	603700	47245336	493	1690	3189

Therefore, a population of a further **290 million** consume around **616 billion litres of oil** and **529 billion m³ of natural gas**, which in total cause CO_2 emissions of around 2250 mega tonnes. If the sectors here are also divided into thirds, an additional **750 Mt CO_2 emissions harmful to the climate** can be put down to the building sector each year. At this point, it must be pointed out that this high proportion is also due to the consideration of the whole of Russia. But as the existing sources of figures do not make a distinction between the European and the Asian part of Russia, Russia as a whole has been considered here.

The Window Market in Europe

With respect to the number of window units, the various market research companies [18; 19; 20] have cited the following figures for the European states concerned:

Windows-per-Inhabitant Rate

	Central Europe including eastern Europe within the European Community	Eastern Europe Five additional states Bulgaria, Romania, Russia, Turkey, Ukraine
Population	**457 000 000**	**290 000 000**
WU per inhabitant	**0.126**	**0.085**
No. of WU as a whole	**57.58 million WU**	**24.65 million WU**
Total window units	**82.23 million WU**	

Measured in terms of the task of assessing the energy-saving potential, this derivation of the total number of windows with the windows-per-inhabitant rate from [18] seems highly plausible compared with the other market figures from [20]. Finally, other European states, such as Switzerland and the Balkan countries, have not been considered in this overview for the time being. Further millions of window units must be added from these countries, meaning that a total figure of over 90 million WU in Europe appears realistic. Nevertheless, the present study continues to use the “lower limit” of the number of window units in order to obtain reliable findings about the energy saving potential without exaggerations.

Energy-Saving Potentials from Modern Windows

Scenario 1: Minimal Energy Saving

Instead of window type C (low insulating level) window type B (average insulating level) were installed, or window type B replaces window type C.

Window Type **82 million WU**	**Consumption in million l heating oil**	**Quantity of exhaust gas CO_2 in Mt (mega tonnes)**	**Consumption in million m³ natural gas**	**Quantity of exhaust gas CO_2 in Mt (mega tonnes)**
B average insulation level	1320	3,575	648	0.729
C low insulation level	2365	6,325	1161	1,269
Difference type C - type B = **Reduction of energy consumption and amounts of exhaust CO_2**	**1045**	**2.75**	**513**	**0.540**

In Scenario 1 a potential of 15580 million kWh per year are saved. This amount of heat loss corresponds to a heating oil equivalent of 1558 million litres of heating oil. Measured in terms of the German heating oil price of around € 0.65 per litre, this amount of energy corresponds to an equivalent value of over € 1 billion.

And the reduction of the exhaust CO_2 assumes a considerable order of magnitude at a potential 3.29 mega tonnes. Measured in terms of the total emissions of the European Community, however, this is just 0.3%.

Scenario 2: High Energy Saving

Instead of window type D (very low insulating level) window type A (good insulating level) were installed, or window type A replaces window type D.

Window Type **82 million WU**	**Consumption in million l heating oil**	**Quantity of exhaust gas CO_2 in Mt (mega tonnes)**	**Consumption in million m³ natural gas**	**Quantity of exhaust gas CO_2 in Mt (mega tonnes)**
A good insulation level	935	2.53	459	0.513
D very low insulation level	3575	9.68	1755	1.944

Difference type C - type B = **Reduction of energy consumption and amounts of exhaust CO_2**	**2640**	**7.15**	**1296**	**1,431**

In Scenario 2 a potential of 39360 million kWh per year are saved. This amount of heat loss corresponds to a heating oil equivalent of 3936 million litres of heating oil. This amount of energy would be enough to supply almost 984,000 (!) four-person households, i.e. just under four million people, with 20°C living space and running hot water in modern residential buildings in central Europe for a whole year.
Measured in terms of the German heating oil price of around € 0.65 per litre, this amount of energy corresponds to an equivalent value of over € 2.56 billion.
And the reduction of the exhaust CO_2 assumes much higher values than in Scenario 1, at a potential 8.58 mega tonnes. Measured in terms of the total emissions of the European Community this is nevertheless 1% of the estimate total amount of emissions for the building sector.

But since the installation of new windows usually continues to take effect for many years, it is worth looking at a slightly longer period, for example five years. Then, the results from the scenarios come up against another background. In Scenario 1, 3.29 mega tonnes of CO_2 are saved every year. After the fifth year, this amounts to 16.45 mega tonnes exhaust CO_2 per year. So, an annual 0.3% of the exhaust CO_2, after five years 1.5% of the total amount of exhaust gas have been saved from oil and natural gas combustion for future years. That pays for the consumer. After five years, € 5 billion are saved every year.

But these values can be easily exceeded, as an extended consideration on the basis of Scenario 2 reveals. Here, the reduction of exhaust CO_2 after five years is 5% per year. This corresponds to a reduction of around 43 mega tonnes CO_2 that no longer pollute our atmosphere. This is a quantity that easily exceeds the annual CO_2 emission from oil and natural gas combustion of Finland (39 Mt CO_2) or the Czech Republic (40 Mt CO_2). And consumers can count themselves lucky: after 5 years around € 13 billion have already been saved because they did not have to be spend on heating oil and natural gas – and with the same result: 20°C interiors and running hot water.

If really exciting energy saving programmes were launched politically to support accelerated CO_2 reduction (buzz word “funding programmes”) and if the public awareness were to bring about a greatly energy-saving basic attitude among subsequent generations through interest and education, the speed of window installation could double in a possible Scenario 3. With double window unit numbers this would also bring about double the saving potentials from Scenario 2.

Shutter Boxes as Additional Window Component with Energy-Saving Effect

Windows are increasingly being fitted with shutter boxes - not just in new buildings, but also in particular when buildings are being renovated. In the last few years in particular this additional component has developed into a high-tech solution that is even manufactured permanently attached to the window as a component. The great advantage of these combination window and shutter boxes is that, when closed, the shutter reinforcement locks in an air cushion between the inside of the reinforcement and the outside of the window frame and glazing. This air cushion acts as a thermal insulation layer and thus improves the U values of window type A by a further 20 to 25 % depending on the design of the shutter box. The window U values thus fall below the magic 1.0 threshold for night time, where the shutters are lowered automatically via a control and reach values of around 0.96 W/(m²K). This additional saving potential, extrapolated to the 82 million window units used as a basis, amounts to over 100 million litres of heating oil linked to the corresponding reduction of exhaust CO_2.

Summary and Prospects

Over 457 million people live in Europe; they live and work in buildings of many different types of construction. Each year, these buildings need over 82 million windows for new buildings and existing buildings. The choice of high-quality energy-saving windows presents the opportunity of drastically reducing heat losses through windows.

The biggest savings potential is achieved by the use of high-quality thermal insulating windows in comparison with the previously standard single-glazed system. But it is not just the glazing that is decisive here. In particular, a high-quality energy-saving frame construction lays the key foundation for a good heat insulating level. High-quality energy-saving frames also reduce the heat loss in the edge area of the joint between the building and the window.

Specifically, the use of four-chamber plastic systems or IV78 wooden systems should clearly be preferred over the simple earlier systems, such as 3-chamber single systems or IV68 components. This choice becomes essential if old box-type windows are to be replaced during renovations. They already have a U value of between 1.5 and 2.2 W/(m²K), depending on the design. The difference from the possible new modern windows is therefore not particularly great. The energy-saving potentials are therefore much lower. In these cases, a new box-type window is advised for a clear reduction of the heat losses from transmission. Combinations where the inner or outer old window is retained are also conceivable: a common solution in listed buildings. In particular, where masonry is very thick, the box-type window combination (two windows in one opening in the building) should be preferred over super highly insulated single windows, among other things for reasons of protection against damp.

From the point of view of thermal protection and in terms of stewardship of resources, the installation of high-quality windows in the boom regions of eastern Europe is especially important. Here, growth rates in double figures are expected in the years ahead [18]. As living standards rise, the amount of exhaust CO_2 will quickly reach western European levels with annual emissions of over 6000 kg per head of population. This must be counteracted with high-quality window systems. Not least in their own interest, otherwise there would be another, quicker cost explosion of raw materials because of their scarcity.

This study deliberately chooses the route of referring relevant data to head of population or window units. This makes the numerical values more tangible. With the results expressed in terms of a million window units, new window market data can be easily commented on with the additional energy consumption values and amounts of exhaust CO_2. This means that the results of the study can be used universally.

Market data, which could be especially revealing about the age structure of the building, currently do not exist for the majority of European countries, in particular for eastern Europe. Here, more detailed input data would make more precise energy calculations possible. Moreover, a more precise knowledge of the energy flow streams in the individual energy consumption sectors of the individual states would be very helpful. The division into thirds of the total energy quantities of oil and natural gas is very rough and probably results in great assumptions in the building sector. In terms of the energy-saving potentials and exhaust CO_2 reductions, higher percentages of savings probably already exist for the pre-calculated window data.

Acknowledgements

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PVC WINDOWS: THE RIGHT CHOICE

Effective heat insulation – to reduce energy costs

Modern PVC window profiles profit from continuous progress in window technology. Optimum multiple chamber profiles and specially coated high-performance glass with gas-filled chambers guarantee ideal heat insulation. Today the U-value in W/(m²K) for normal PVC windows is between 1.3 und 1.1. With special frames and heat-insulating glass, the value can be reduced to 0.8. In the process, plastic windows continuously gain in importance for extremely thrifty passive houses. Before 1995, the average U-value for insulated glass was at 2.8 and for single-pane glass at 5.8.

Economical from the very beginning – PVC windows

High-quality plastic windows last about 50 years since they are extremely weather resistant and durable. Constant troublesome painting and extensive maintenance are no longer necessary. Cleaning is also uncomplicated. Additionally, the purchase price is favorable. All of these factors make its use attractive and profitable in the long run. Through the use of PVC plastic windows, more energy is saved with the same investment than with other materials.

PVC profiles – the perfect solution for any façade

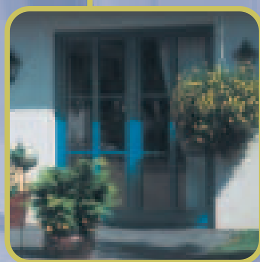
A further advantage is the variety of design possibilities since PVC window profiles are offered in almost all colors, styles, and settings. They match the genuine details of any architecture. For this reason, window frames made of PVC are not only suitable for designing the façades of modern office buildings, but also for renovating historical buildings. Practically all your wishes can be fulfilled with thin or curved profiles.

High-tech windows – living comfort in order to feel good

An increase in living comfort is guaranteed by installing modern PVC windows because they improve room temperature and provide effective protection against noise. They are available in various noise reduction categories depending on the individual level of noise. Additionally, special glass and fittings guarantee effective protection against theft. And last but not least, the use of high-quality PVC frames makes possible effective fire protection.

PVC recycling – advantages for the environment

Across Europe large amounts of PVC waste have become part of a material cycle thanks to large-scale collecting and recycling systems for all important PVC building products such as windows, flooring, roofing membranes, and pipes. Removed PVC windows are converted into new high-tech profiles. Unmixed recycled PVC is used for the core of the profiles, and the outer covering of the frame consists of new PVC. This saves resources and protects the environment.



Recycled PVC for the production of new plastic windows

PVC

STUDY ON WINDOWS

"POTENTIAL TO SAVE ENERGY THROUGH THE USE OF MODERN WINDOW SYSTEMS IN EUROPE"

Presented by Marcus Hermes

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