Through the looking glass

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Content

INTRODUCTION

Buildings should be built to last. What is still typical today, despite all the new technology, is after all that architecture is a genuinely unwieldy, slow medium that requires major resources for its creation. For this reason the robust is important if architecture is to be taken seriously and contribute to the development of a sustainable community. The robust is an alternative to the architecture that is mainly based on visual features. The really significant qualities of a building are complex and not always visually accessible. They quite simply demand a different commitment, or even presence, if they are to be judged. Johan Celsing, 'The Robust, the Sincere' 2008

'Robust – Reflections on Resilient Architecture', is a scientific publication following the conference of the same name in November of 2017. Researches and PhD-Fellows, associated with the Masters programme: Cultural Heritage, Transformation and Restoration (Transformation), at The Royal Danish Academy of Fine Arts, School of Architecture, are presenting their latest research in this publication encompassing an approach to architecture consistent with the field of research at the programme. This research characterizes how an architecture of Resistance, Resilience and Robustness is at the core of the heritage discourse.

Peer review has taken place prior to publication by reviewer Héctor Fernández Elorza, Professor PhD at *Escuela Técnica Superior de Arquitectura de Madrid.* The peer review has taken place in an open review, in which the reviewer knew the identity of the authors, and the editors of the publication knew the identity of the reviewer. The reviewer is not affiliated with the authors or KADK as an institution, and has no monetary gain as a result of the review.

All articles in 'Robust – Reflections on Resilient Architecture' are original works by the authors and are not previously published. The peer review process is conducted to guarantee, that all research published in the publication, is presented with transparency, honesty, and in an accurate way, consistent with correct research ethics.

The realization of this publication has only been possible thanks to Realdania. In 2014 Realdania generously founded the research project 'Bæredygtig Bygningsarv' [Sustainable Building Heritage]. The research conducted within this project is presented in this publication. During these last three years, other research projects has been started up at Transformation, and the research unit has expanded in regard of both people and projects. These newer projects are also included in this publication with articles presenting their current status and direction.

In this sense, 'Robust – Reflections on Resilient Architecture' summarises the outcome and marks the finalisation of the research project 'Bæredygtig Bygningsarv'. It is at the same time a possibility to present the ongoing research at Transformation and an opportunity for the researchers to point out directions for further investigation.

THROUGH THE LOOKING-GLASS

TEXT: THOMAS KAMPMANN

ENERGY LOSS THROUGH WINDOWS REPRESENTS A SIGNIFICANT PART OF THE TOTAL ENERGY LOSS FROM BUILDINGS, AND IS THEREFORE DEALT WITH IN THE CURRENT BUILDING CODE, BR 2015. HOWEVER, AS THIS ARTICLE LAYS OUT, THE RULES ARE COMPLICATED AND DISCRIMINATORY AGAINST SECONDARY GLAZING WINDOWS COMPARED TO WINDOWS PROVIDED WITH ENERGY PANES. THIS ARTICLE STUDIES HOW TRADITIONAL WINDOWS, USED IN HISTORICAL BUILDINGS, COMPARES TO MODERN WINDOWS ON A NUMBER OF PARAMETERS, AND HOW THESE PARAMETERS CORRELATE TO CURRENT LEGISLATION.

PREFACE

This arcticle presents an examination into the application of energy loss calculations in the Danish Building Regulation, BR 2015, regarding windows. Further the article offers an investigation of traditional windows, built with several frames and secondary glazing, and whether these are unfairly evaluated compared with similar energy-pane windows.

The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation, Master´s Programme of Architectural Heritage, Transformation and Conservation (KTR), has previously examined the proposal for the Danish Building Regulation 2015 (BR 2015) and made a consultation response. (Trafik-, Bolig- og Byggestyrelsen, 2015) This was done in response to former regulation, BR 2010, as this regulation was highly problematic with regard to small and/or multi framed windows. The consultation response, which was done as a proposal for the BR 2015, was based on the rules of BR 2010, except for a simple reduction of the limits for energy loss and there was a risk that the problems would be even bigger in the final version.

The goal with this examination was to give building advisors and authorities, manufacturers and students a tool to understand the pitfalls and the rather complex field regarding BR2015, specifically in relationship to energy consumption around small and/or multi framed windows.

Traditional windows are usually designed with several frames and often with glazing bars, but the problems concerning multi framed windows are the same for new windows, if they are divided into several frames. The hope it is that this article will also aid in the design of windows in new buildings. Therefore it was obvious to make a careful investigation of the final edition of BR 2015 , which was the original purpose of this article.

During the investigation on the subject, it became clear that this work was already outdated by the fact that consultation on new BR 2018 was held during the summer of 2017. The hearing period is now over and the objections are being processed. It is said that BR2018 is structured in a completely different way, therefore thorough investigation of BR2015 in its entirety is not deemed relevant. As a result of these conditions, this paper explain the conditions for how windows are constructed in Denmark, explaining general definitions concerning energy loss through windows and give a brief introduction to the problems concerning regulation of energy loss through windows in the BR 2015, and probably also in the following regulations.

INTRODUCTION

In modern time, up until the energy crises in 1970s, Denmark's energy supply was mainly based upon imported oil. As a consequence of that, Denmark at that time, had nearly no oil or natural gas production and no hydro- nor nuclear power. The energy crises therefore amplified the need for necessitated energy savings in order to achieve certainty for maximum energy supply security. Approximate 40% of all energy consumption in Denmark is used in buildings. About one third of that energy consumption is lost through windows, and as such a topic of great importance in terms of total energy consumption.

Until and including The Building Regulations of 1995, all windows were treated equally using the very simple rule, that the U-value for the whole actual window being used should be lower than 1,8 kWh/m2. In subsequent Building Regulations the rules are much more complicated. There is now a division between new windows with sealed units, and secondary glazing windows, where the secondary glazing windows, mostly used in traditional housing, which has been subject to stricter regulation, than the insulating glass unit (IG-unit) windows. A reason for the introduction of this new regulation could be that many new windows, used as replacements in traditional buildings, with more than one frame and possible glazing bars, did not fulfil the earlier simple legal requirements.(Kampmann, 2002)

BACKGROUND

Former building regulations

In BR 2010 windows with insulating glass IG-units are treated completely differently from traditional secondary glazing windows. Secondary glazing windows are rated in relation to the U-value of the whole window in its actual form, size and actual panes used, whereas windows with IG-units are rated according to the combined U-value and the added solar energy during the heating season, the so-called energy gain (E). Furthermore all windows with IG-units should be specified based on the energy gain of a reference window Eref, as though they were designed with only one single framed window in a standard size of 1.23 x 1.48 m. This is regardless of the actual size of the window being used, the number of frames, if it has mullions, transoms and glazing bars, and if it is fitted with noise reduction or solar control panes. The problem is that all the different parameters have a huge impact on the total energy performance, which makes it very hard or impossible to select the most energy efficient windows, both according to the rules of BR 2010 and the implemented BR 2015. This indicates that new windows provided with energy panes are favored. It is feared that BR 2018 will still be based on the same poor conditions.

Up to BR 2008, a minimum U-value regarding windows was in effect. But that requirement disappeared with BR 2010 – except for windows inside houses facing rooms heated to more than 5 Kelvin below the temperature in the room concerned. It is hard to see the logic in having rules for windows placed indoors, but not for exterior windows facing the outside.

Traditional windows

Traditional Danish windows are often designed with more than one framework. If so, it is normally necessary to divide the casement with a mullion if you need two frameworks and maybe a nogging if you need four frameworks. This can be extended to various combinations. Thus, mullion and noggings are at part of the casement/window jamb. If a window has more than one frame it is referred to as a multi framed windows in this article. If one needs to divide the glass in the framework, it is done by glazing bars. See Apendix IV

Secondary glazing windows

Traditional windows were normally only fitted with one layer of glass. In order to insulate against energy loss and noise, windows have been subsequently fitted with secondary glazing, , at least this has been the case in Denmark since the early 1700s. Whereas Danish windows nearly always open outwards, the secondary glazing opens inwards. Thus one has to remove the potted plants!

Around 1900 the linked frames became widespread, where the second pane is linked to the framework and opens together with it – with no need of removing the potted plants.

The description of the construction of a window, in short, specifies each pane in a window with secondary glazing, numbered from the outer and inwards. Thus a window with only one layer of glass is called (1) and secondary glazing windows (1 + 1).

The pane in the secondary glazing was traditionally just ordinary glass, but today is almost always an energy pane. An energy pane is referred to as one layer of glass with an hard energy coating. The coating will limit the long-wave radiation between the two layers of glass, and thus limit the heat loss by nearly half. The hard coating is stronger than the glass, and therefore can be treated as normal glass.

To improve insulation, the secondary glazing can be provided with a sealed unit, with e.g. two layers of glass. This is referred to as (1 + 2). One of the drawbacks of a window with secondary glazing is the cleaning of each surface, and that one has to open two frames in order to let in fresh air. On the other hand it is possible to clean all the surfaces contrary to sealed units, where one has to replace the whole unit if the sealing is broken. In addition, secondary glazing windows provide far better soundproofing, especially if there is ample distance between the two glass panes(Kampmann, 2004).

Sealed units windows

Today almost all windows are provided with sealed units where two or three panes are joined together with a spacer. This is briefly called (2) or (3). Are one or more of the glass surfaces coated with an energy coating they are called insulating glass units (IG-units). The benefits of the sealed units are that there is no need of cleaning the glass surfaces facing the cavity, but on the other hand, when the sealing is broken and the insulating gas evaporated, it is impossible to fix and the whole unit has to be replaced. Another benefit with IG-units is that, because it is impossible to touch between the glasses, one can use a very sensitive coating, the so-called soft coating, which is very effective. On the other hand, this construction is not as soundproof, as one of the most important parameters is the distance between the glass panes, which is not very large.

Glazing bars in windows with IG-units can either be built up with a continuous glazing bar, which are very clumsy (due to the thick IG-units) and very ineffective with regard to insulation, or with a so-called fake glazing bar where the glass actually continues over the whole pane with several profiles glued or clipped to the class. The fake glazing bar is much more energy efficient but still has some problems. Of course they are much less visible than the through glazing bar, especially seen directly perpendicular to the window, but when seen obliquely, the fake construction is obvious. Another problem with the fake glazing bar, is that it can very easy simply fall off.

As many new buildings are well insulated, there is often a problem with overheating. In order to reduce this problem many windows with IG-unit are provided with solar control coatings in order to reduce overheating. As this is a permanent construction, it also prevents the energy gain from the sun when needed during the cold season, thus this solution is problematic in climates with a heating season.

PROBLEM STATEMENT

The original purpose of this article was to investigate whether BR 2015 met the targets described in BR 2015 chapter 7. Energy consumption:

> *Buildings must be constructed so as to provide satisfactory conditions in terms of function, safety, sustainability and health. Buildings must be constructed in accordance with best practice, using materials which are appropriate for the purpose.*
> *- 4.1 Provision, (Trafik-, Bolig og Byggestyrelsen, 2015)*

The same applies to conversions and any other significant alterations to buildings covered by 7.4.

Proclaimer

The investigation only covers a specific field concerning energy consumption of windows, with special focus on multi framed windows. This article only examines section 7, energy consumption including BR 2015 appendix 6, concerning windows with focus on dwellings. As previously stated BR 2015 is already going to be replaced with a new BR 2018, which is still pending publication. This article, therefore focus on the description of the preconditions for understanding the design of different Danish windows and how the design influences energy consumption. The thesis is that BR2015 does not provide the necessary balance of tools to properly enable advisors, authorities, manufacturers and consumers to choose the most energy efficient solutions.

As such the competition parameter to be set aside for the spread of energy efficient windows in traditional buildings, as well as new buildings provided with multi framed windows. Part of this includes investigation into whether the requirements for secondary glazing windows and windows with IG-units are different. The study has been done by collecting data from window manufacturers and then comparing this data from different typical window designs to the provisions of BR 2015.

The study only deals with the energy consumption of windows in Denmark described in the Danish legislation, but should be extended for examination of possible legislation in the European Union.

WINDOW DATA

Data from window manufactures

As part of this investigation, an updated schedule of energy consumption for typical Danish windows, in different typical variants was prepared. Unfortunately, it has not been possible to find a single manufacturer of IG-unit window windows that have an energy calculator on their website. Only a few years ago it was custom for all manufacturers to disclose the values. All manufacturers claim that they will share the relevant data upon receiving an order. The Danish window manufacturer Velfac was so kind as to provide partial window data when asked, whereas Rationel referred to sourcing a local carpentar for the information.

Therefore, there has not been sufficient data to design a new energy scheme. In the cases where it has been possible to get window data, the manufacturers in question now produce windows with better energy performance than before.

Previously collected data

The traditional wooden windows, fitted with secondary glazing (green curves), have almost the same energy performance regardless of the window design, see Appendix III. The curves are rather horizontal meaning that they are relatively poor for Eref, with only one frame, compared to windows with IG-units, but much better for divided windows with mullions, noggin and transom – and for noise reducing panes. The main reason why the numbers are slightly worse with mullions, is due to the shadows cast by the mullions, meaning less g-value. On the other hand the IG-unit windows have good energy performance for Eref, and with a three layer IG-unit even are excellent A-labelled positive energy windows (Eref > 0). However for the windows with two casements or more, the energy performances are poorer than windows with secondary glazing. It can be seen that the Rationel Aura + (3, three layers) is even poorer than a simple (1+1 layers) secondary glazing for multi paned windows. In fairness it should be mentioned that the producer of Aura + said that it was not possible to produce such a window. It seems that it might be a problem using three layer panes for small casements, especially if they are provided with mullions. The recently introduced A-labelled triple pane Velfac Classic (3, three) has 75 % greater energy loss than the (1+2 layers) secondary glazing with double coating (energy gain ÷32 compared to ÷18.2), and has only ÷25.7 kWh/m2 year better energy gain than the traditional secondary glazing with one hard coated energy pane ÷57,7 (1+1). The C-labelled Velfac Classic double paned (2) has an energy gain of only ÷61.

EXAMINATION OF BR 2015, CHAPTER 7

Chapter 7 deals with energy consumption in buildings, and therefore also energy consumption through windows. Windows, together with external doors, roof lights, skylight domes, glazed external walls, glazed roofs and hatches facing the outside are often treated in a different way, than the rest of the climate screen. That is presumably because these building components are the weak point, much lesser in thickness, than walls and roofs, and they contain thermal bridges. For building components containing glass, the extra challenge also being the energy gains from the sun itself.

It reads in the opening provision of BR2015, Chapter 7.1:

> *Building must be constructed so as to avoid unnecessary energy consumption for heating, hot water, cooling, ventilation and lighting while at the same time achieving healthy conditions. The same applies to conversions and any other significant alterations to buildings covered by 7.4*

This first provision is very easy to understand and has a clear purpose. Unnecessary energy consumption, of course, should be reduced as must as possible. The lower the consumption, the lower the demand for energy. The regulations continues in Chapter 7.2:

Any Cold bridges in building elements which face the outside including windows and doors, must be insignificant. The energy implications of cold bridges must be factored into calculations of heat loss from each building element.

Note there is particular mention that cold bridges in e.g. windows are to be factored into the calculations of heat loss – but meanwhile most of them are ignored according to rules applying windows. Apparently, windows and doors are mentioned specifically, because presumably there are major problems with said bridges in windows.

BR2015, Chapter 7.2 also describes that when calculating the total energy performance frameworks for a building it is necessary to take into account the total requirements for energy supplied for heating, ventilation, cooling, domestic hot water and, where appropriate, lighting. It is describes what is included in the total energy performance for new buildings and how it should be calculated in order to prove that a given building satisfies the requirements of BR 2015.

Again, it is a clear and logical requirement, and it seems obvious that one should use the actual energy data from the windows in use, and not data from the reference window. You need to know the exact energy performance of a window to make a correct energy performance framework for a building. The problem is that this is a reference to BR 2015 Appendix 6. The rules concerning windows in new buildings are rather confusing. The total energy performance framework of the whole building should be calculated, and in guidance 7.2.1 (Trafik-, Bolig og Byggestyrelsen, 2015), it is specifically mentioned that the calculation must take into account the envelope of the building, the location and orientation of the building, including sunlight entry (which mainly appears through windows. These rather clear rules indicate that it is important to calculate as accurately as possible to get the right result, in order to design buildings with as little energy demand as possible where e.g. sunlight entry through windows should be taken into consideration.

On the other hand, section 2 in BR 2015 appendix 6(Trafik-, Bolig og Byggestyrelsen, 2015) states that calculations should be made for a reference window. There is a big difference in the energy performance of windows, depending on the size, shape, design and panes of windows. Since all window manufacturers are obliged share the actual energy data when they deliver the windows (and therefore ought to be able to make the calculations), there should be no problem in asking for the same for IG-unit windows as well.

Windows in existing buildings

Chapter 7.4.2 deals with energy consumption in connection with conversions and other building alterations. Thus also for renovation or replacement of windows. It appears that the requirements for windows designed as secondary glazing windows should apply the U-value of the actual window size. There is no explanation for the difference in this respect, incomprehensible discrimination. Furthermore it is clear that secondary windows should only be labelled according to their U-value, and not take into account the solar gain through the windows. As the gain of solar energy through a secondary glazing window tends be greater than through an IG-unit window, this seems to be discriminatory.

If one takes into account that the energy loss through secondary glazing windows will change relatively little from the reference window to at multi framed window with many frames and panes, this is even more amazing.

New secondary windows are defined as new (1 + 2, layers) windows, which means that the outer part of the window has one layer of glass, whereas the pane in the secondary glazing should be fitted with an energy pane. Otherwise it is not possible to reach a U-value less than 1.40. This type of window actually has a U value slightly less than 1.40. Worse though is that the energy gain for the actual window is less than a 1 + 1 solution, with only one energy pane in the secondary glazing.

The far most energy efficient window with secondary glazing, is achieved with a 1 + 2 solution with an energy pane with two coatings. This design is actually better than equivalent new three layer energy panes – except for the reference window!

Here it should be mentioned that some producers have experienced problems with thermal bridges using energy panes with two coatings. There are assigned requirements for a renovated secondary windows, but they are defined as windows (old secondary windows) dismantled, renovated and reinstalled in another building. This is very seldom or never done, and would be better labelled recycled windows. The provisions continue with specific mention that there are no requirements for secondary window frames, which are fitted on existing, permanent windows. This is really bizarre, as one of the most common and cost effective ways to reduce energy consumption, is to install an energy glass on the secondary frame. This solution reduces energy consumption by half, and is even allowed in protected buildings. The only case where it would be wrong to replace with energy glass is if there is original drawn glass panes in the secondary casements, but there could be a simple exception in these cases.

If one installs an energy pane with two coatings, the total energy consumption will fall to one sixth compared to ordinary glass in the secondary frames.

DISCUSSION

Windows with secondary glazing are much better at noise reduction, than IG unit windows, due to the greater distance between the glass layers(Kampmann, 2004). As the majority of existing buildings are provided with multi framed windows it seems far more important to make them as energy efficient as possible, and not, as the practice has been the last 35 years, to replace with new windows. This might have a big impact on the total energy consumption, and it is probably far more sustainable to improve energy efficiency of existing houses, than building new ones. Furthermore one could fear that the Danish way of using a reference window might be used as an inspiration for former EU legislation, and therefore be widespread in the whole region(Avasoo and Andersson, 2003), (Kragh et al., 2008). The lack of energy calculators on manufacturers websites, is a major problem. Today, manufactures are obliged to present data, but only when you ask for it in connection with an estimate or order. As it is so cumbersome to find the most energy efficient solution, it is feared that it does not happen in practice.

CONCLUSIONS

The BR 2015 can be of good use for choosing between different single light windows with IG-units which correspond to the reference windows, but if the windows have more than one frame it is not suitable. Therefore, the BR 2018 should be changed concerning windows, not in the least due to the fact that 50 % of the windows being used are multi framed. The use of Eref should stop while all windows, including windows with secondary glazing, should be rated from the energy gain of the actual window in the actual design. Furthermore energy labelling should follow the same rules, versus the current situation, where windows with secondary glazing cannot be labelled, and where they are using the Eref for labelling IG-unit windows. All window manufacturers should have a public energy calculator in order to achieve the energy label, so one can find the correct energy data before asking for an offer. There should be a minimum U-value limit of 1,80 W/m2K for exterior facing windows , and not as today where there are only limits for interior facing windows heated to 5 K less than the heated room - but with no limits in relation to the outside. All future analyses should include windows with secondary glazing. There needs to be an independent website regarding sustainability, maintenance, noise reduction, total economic and energy performance of windows in typical design and sizes.

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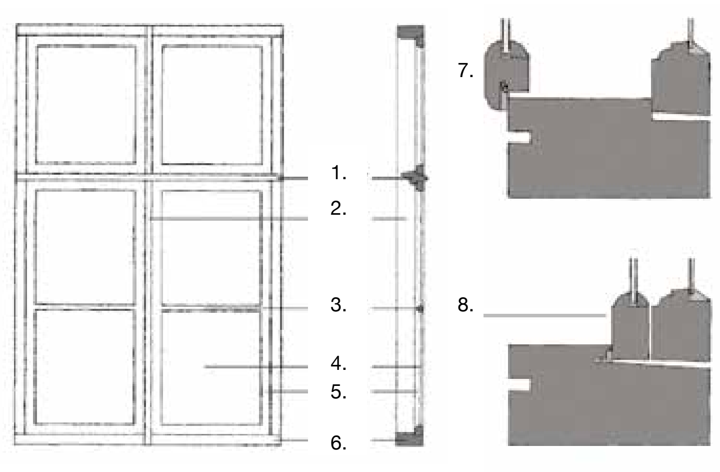
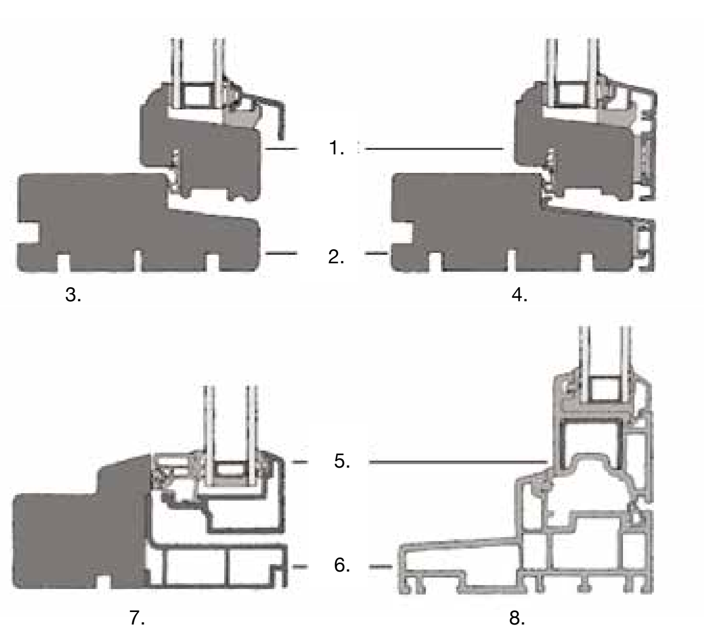
Title page:
Assistant Professors of KTR measuring a window in Villa Garbald by Gottfried Semper, on a study trip to Castasegna, Switzerland.



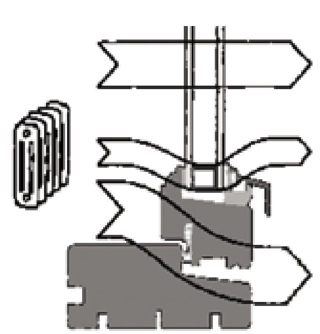
Review of relevant window terms

1. Nogging
2. Mullion
3. Glazing bar/Muntins (US)
4. Pane
5. Framework/sash
6. Casement/window jamb
7. Secondary glazing
8. Linked frames



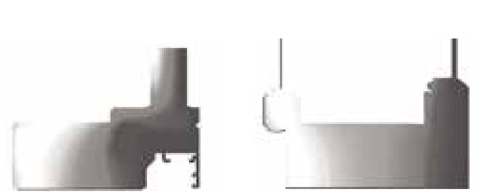
Sealed unit windows

1. Framework
2. Casement
3. Wood
4. Wood/Alu.
5. Framework.
6. Casement
7. Combined materials
8. Composite

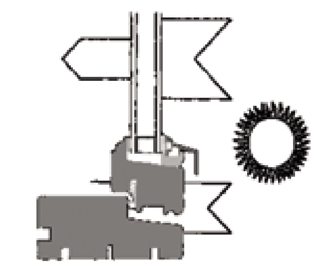


Energy loss through windows

The U-value, thermal transmittance, is the rate of transfer of heat through a structure per temperature difference across the structure, and is measured in W/ m2 K.
For windows the U-value (Uwindow or Uw) is divided into the energy loss through:
the panes, the upper arrow, which depends on the area of the panes (U glass)
the casement/ mullion/ noggin/ glazing bars, the lower arrow, which depends on the area of the casement/ mullion/ noggin/ glazing bars
The edges of the pane (only for IG-unit as windows with secondary glazing has no spacer) the middle arrow, which depends on the length of the edges of the panes (Y, the Greek letter psi) and thus is relatively much bigger for a multi framed window than for a big, approximately squared, window.
As the U-value of the IG-units today is lower than the U-value of the casement/ mullion/ noggin/ glazing bars, the ratio between the different "arrows" of course will change dramatically dependent of the design of the window. Hence a circular window with no glazing bars will have the highest share of the energy efficient panes and relatively shortest length of edges of the panes, being a little lower for a nearly square/rectangular windows, and much lower share for a window provided with mullions, noggins and glazing bars. The share of the area of the panes will typically fall from 75 % to 48 % from a single framed window 123 x 148 cm, to a window in the same size but with four frames and 20 panes.
Whereas it is rather simple to get the U-value of the panes (from the glass producers[manufacturers]) it is rather complicated to calculate the U-value of the casement/ mullion/ noggin/ glazing bars.

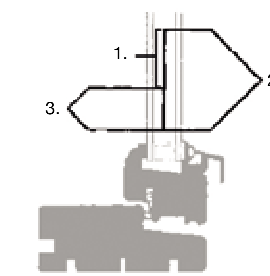


The two figures show a result of a calculation of respectively a IG-unit pane window with two layer of glass upper, and a secondary glazing window fitted with one layer of energy glass lower.
If the colours in the "gradient" are narrow, it indicates a thermal bridge and if the colour on the inside of the window, to the left, has dark colours there could be problems with internal condensation.



Energy gain through windows

As the sun shines a certain percentage of the energy from the sun will pass through the window. The quantity of energy passing through the casement/ mullion/ noggin/ glazing bars is negligible and is omitted in the calculation of the total energy balance.
The energy gained through the panes is referred to as the g-value, and is the percentage of the solar energy that hits the panes in an average reference year and is radiated into the interior, g glass.
If the g glass.is multiplied with the ratio of the area of the panes to the whole window (Ff) one gets the g window.



1. Energy suplement
2. Combined heatloss
3. Solar gain

Total energy balance through windows

The total energy balance of a window is found by calculating the energy gained through the window during the heating season, minus the energy lost through the window in the same heating season, and is referred to as E window.
As the energy gained through the window, of course, changes a lot depending on the orientation of the window, it is normally specified as a weighted average of the distribution of areas of windows to the orientation to the south.
The unit is in kWh/m2 year, and it is very simple to calculate the yearly energy loss just by multiplying the energy balance with the total sum of the area of the windows. Calculating the annual costs is done by multiplying the total energy loss with the relevant energy price.
As the total energy balance depends very much on the design of the window, the Danish Energy Agency has chosen to use a reference window consisting of only one frame, E ref measuring 1230 x 1480 mm in size.
As the energy balance is highly dependent on the design of the window, E ref cannot be used for calculating the energy loss, as will be explained in this article.

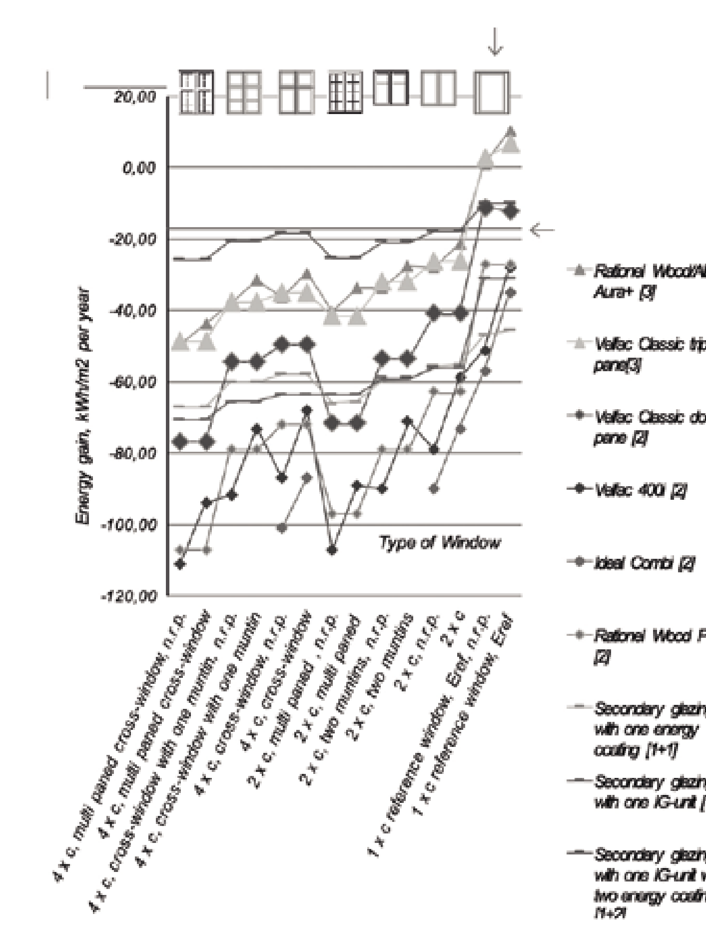
Energy calculation

The Danish window manufacturer Bøjsø offers the following information:
Energy Calculation of Bøjsø Windows - How It Works:
When you receive estimates and / or order confirmation from Bøjsø, we also specify the precise energy statistics for the specific window or door, where you also get a comprehensive calculation of the entire specification average u-value.
We can also send an energy fact sheet with the total energy calculation.
It has only been possible to find a single website with an energy calculator, namely that for manufacturers of secondary glazing windows: www.energiforsatsgruppen.dk

APPENDIX II - Energy loss defined in BR 2015

Up to BR 2006 windows where only rated for their ability for insulation, specified by the U-value, with no regards to the fact that windows also gathers energy as the sun´s rays get through the glass and into the rooms. As the amount of energy gathered through the windows during the heating season for well insulated windows can be higher than the energy lost, it is a very reasonable action to take this contribution into account. The rules are described in BR 2015 Appendix 6.2 and are the same as when they were first introduced in BR 2010.
The problem is that the calculations should be based on a so-called reference window using a single-light opening and not the actually window used in each case. This is probably due to the fact that the energy performance is changing very much according to the number of light openings, muntins, type of glass, special noise reducing and solar control glass.
Furthermore the rules only applies for windows designed with IG-units, for windows with secondary glazing the rules are completely different.

APPENDIX II - Energy performance of typical Danish windows



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