

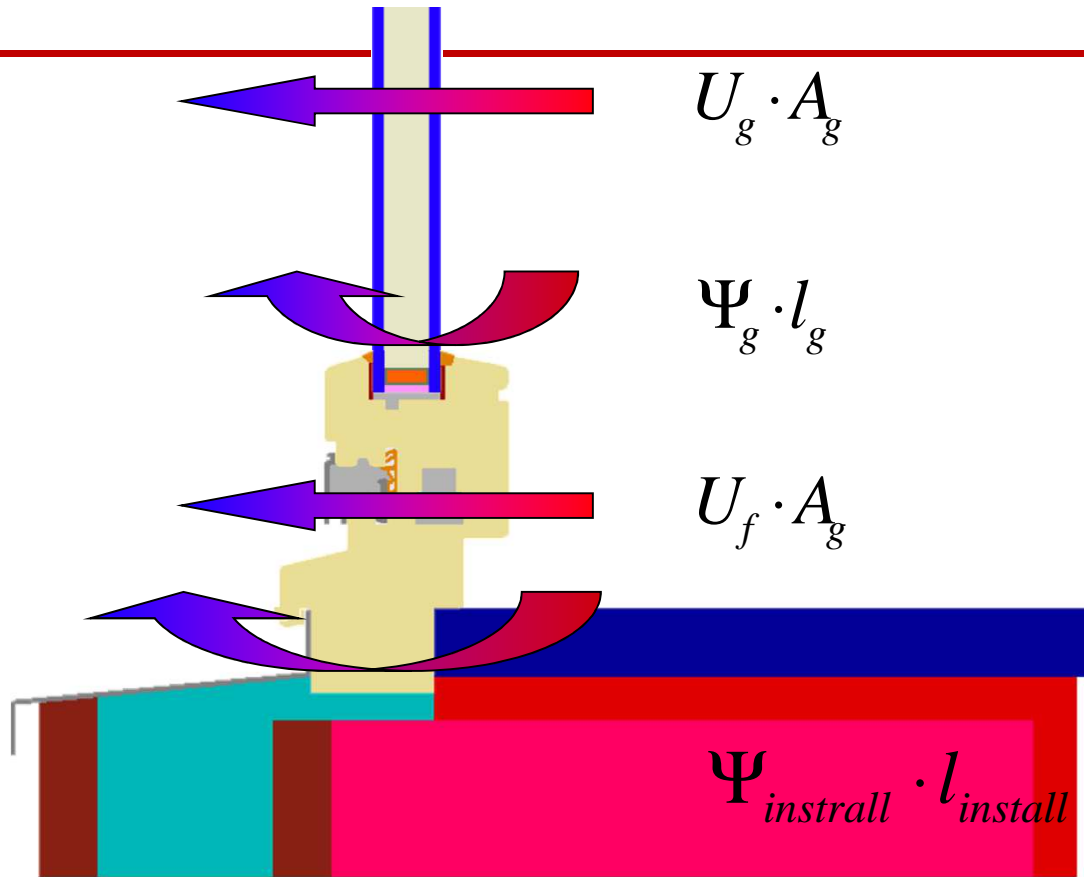


# Deep renovation with Passive House Windows of the newest generation - useful across the globe?

franz freundorfer passivhaus consulting

the launch pad  
or  
the absolute basics

# Thermal performance of windows



$$U_g \cdot A_g$$

$$\Psi_g \cdot l_g$$

$$U_f \cdot A_f$$

$$\Psi_{install} \cdot l_{install}$$



**Certification criteria**  
(cool temperate):

**R7.1**  $U_w \leq 0.80 \text{ W}/(\text{m}^2\text{K})$

**R6.7**  $U_{w,installed} \leq 0.85 \text{ W}/(\text{m}^2\text{K})$

with  $U_g = 0.70 \text{ W}/(\text{m}^2\text{K})$ ,

dimensions: 1.23m \* 1.48m

R7.1  
R6.7  
R8.1  
4\*4.9ft

$$U_{w,installed} = \frac{U_g \cdot A_g + U_f \cdot A_f + \Psi_g \cdot l_g + \Psi_{install} \cdot l_{install}}{A_g + A_f}$$

**Not part of ISO 10077-1**

# The Passive House Institute



## Efficiency class

- phC** certifiable component
- phB** basic component
- phA** advanced component
- phA+** very adv. component

*540 components certified*



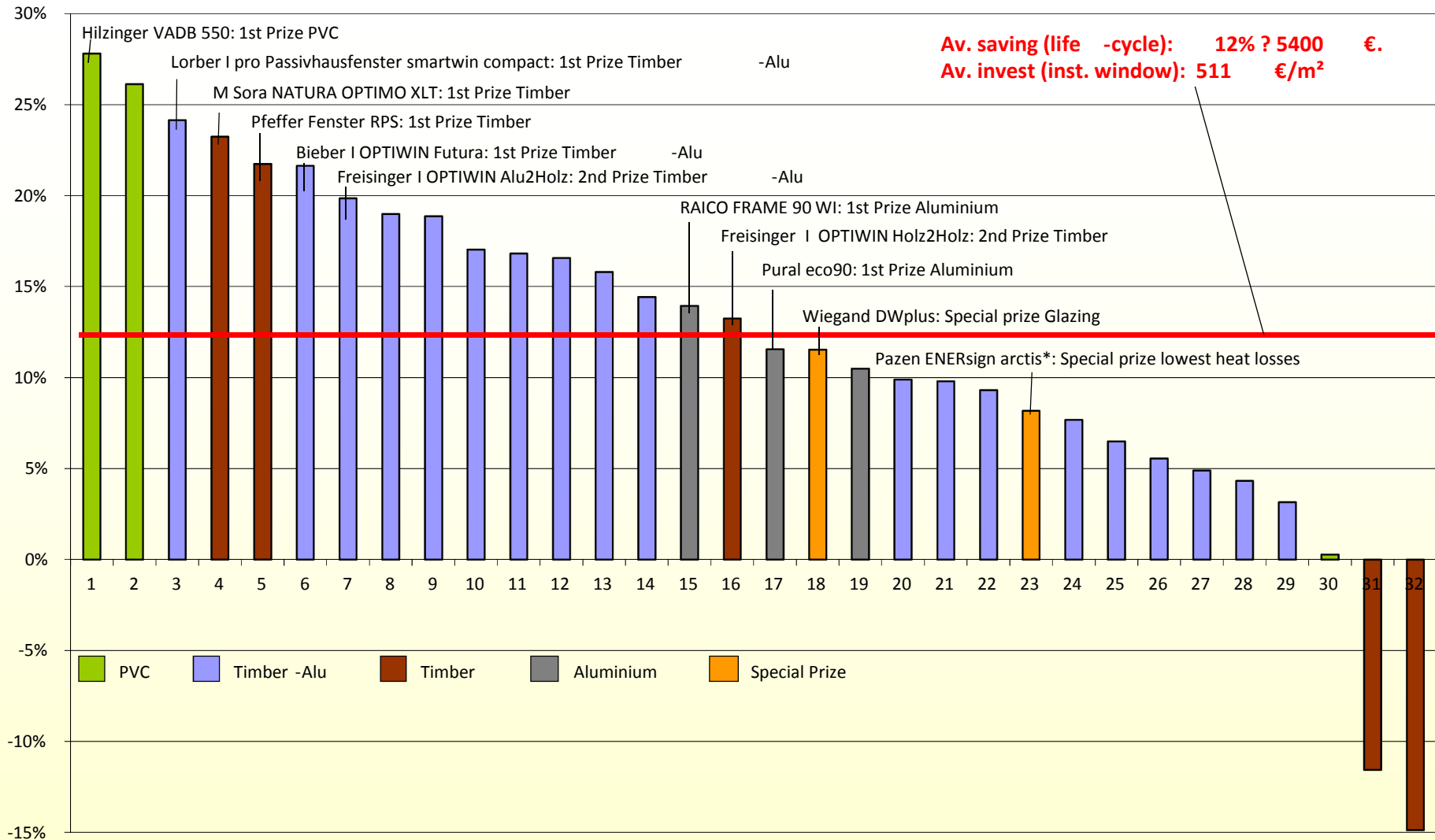
## Climate region

- Arctic
- Cold
- Cool, temperate
- Warm, temperate
- Warm
- Hot
- Very hot

## Category

- Opaque envelope
- Transparent envelope
- Building services

*The PHl component seal*



**Passive house windows are profitable for building owners**



**COMPONENT  
AWARD  
2014**

Passive House Institute

**EuroPHit**

**RESULTS: Savings to reference**

|              | Standard window*           | Passive House window** |
|--------------|----------------------------|------------------------|
| Investment   | ~ 16.920 €                 | ~ 18.600 €             |
| Credit       | 2% real interest, 20 years |                        |
| Annual rate  | ~ 1.035 €/a                | ~ 1.137 €/a            |
| Energy costs | ~ 250 €/a                  | ~ 3 €/a                |
| Total        | ~ 1.285 €/a                | ~ 1.140 €/a            |

**Savings: ~ 145 €/a (11%)**

**After 20 years: 250 € - 3 € = 247 € (99%)**

\* Average over the standard windows of all categories.

\*\* Average over all winners except special prizes.



**COMPONENT  
AWARD  
2014**

Passive House Institute

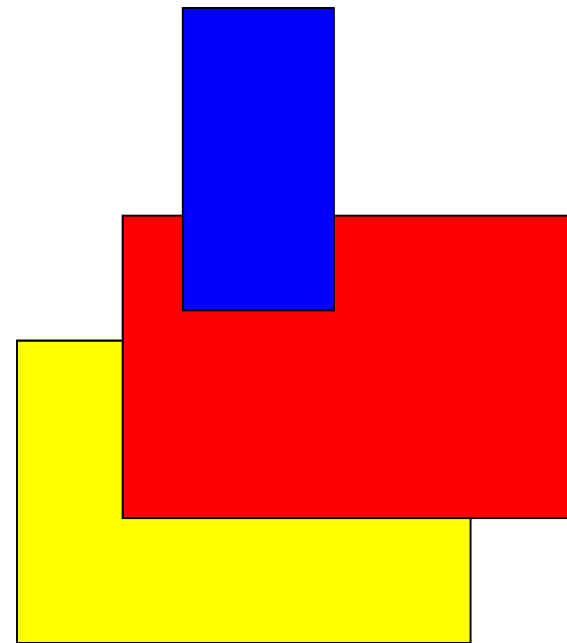
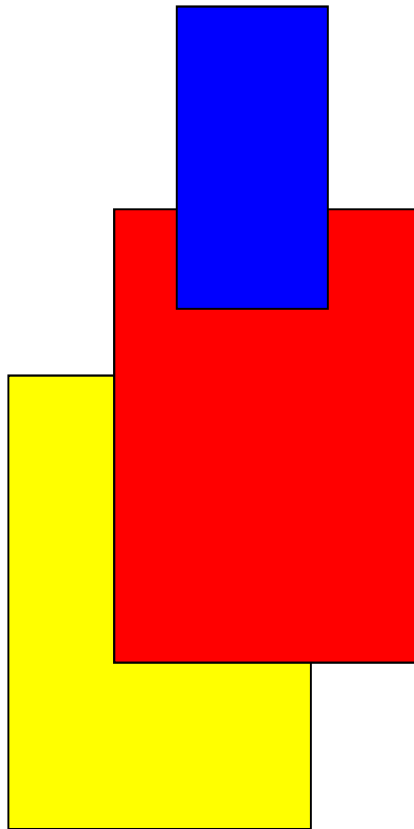
**EuroPHit**

**RESULTS: Profits right from the start!**

# The Passive House Windows in the class phA

# The Passive House Windows in the class phA

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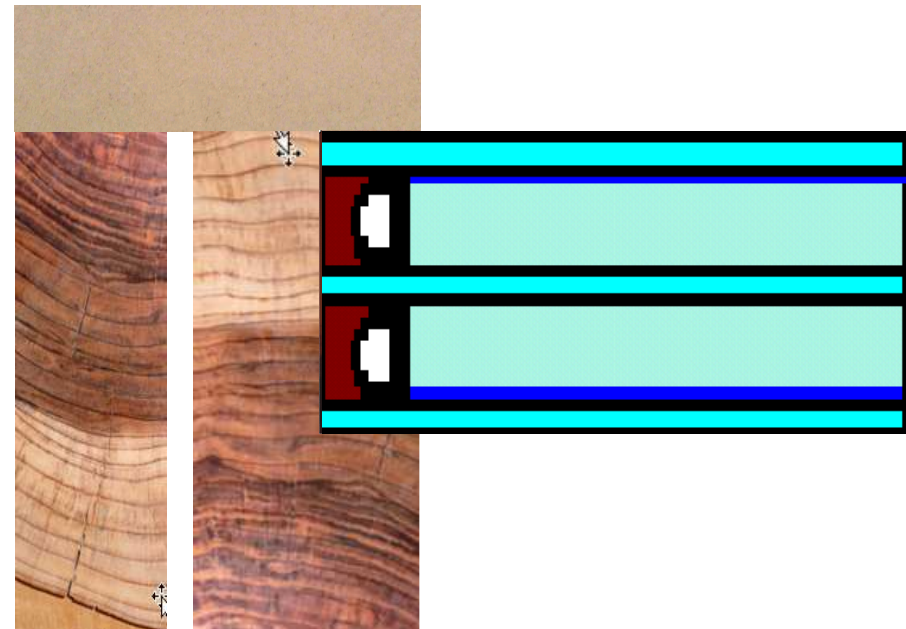
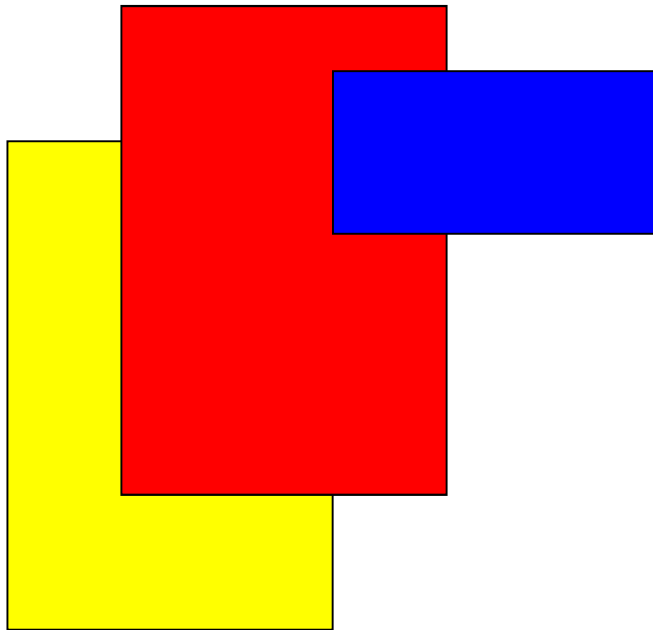




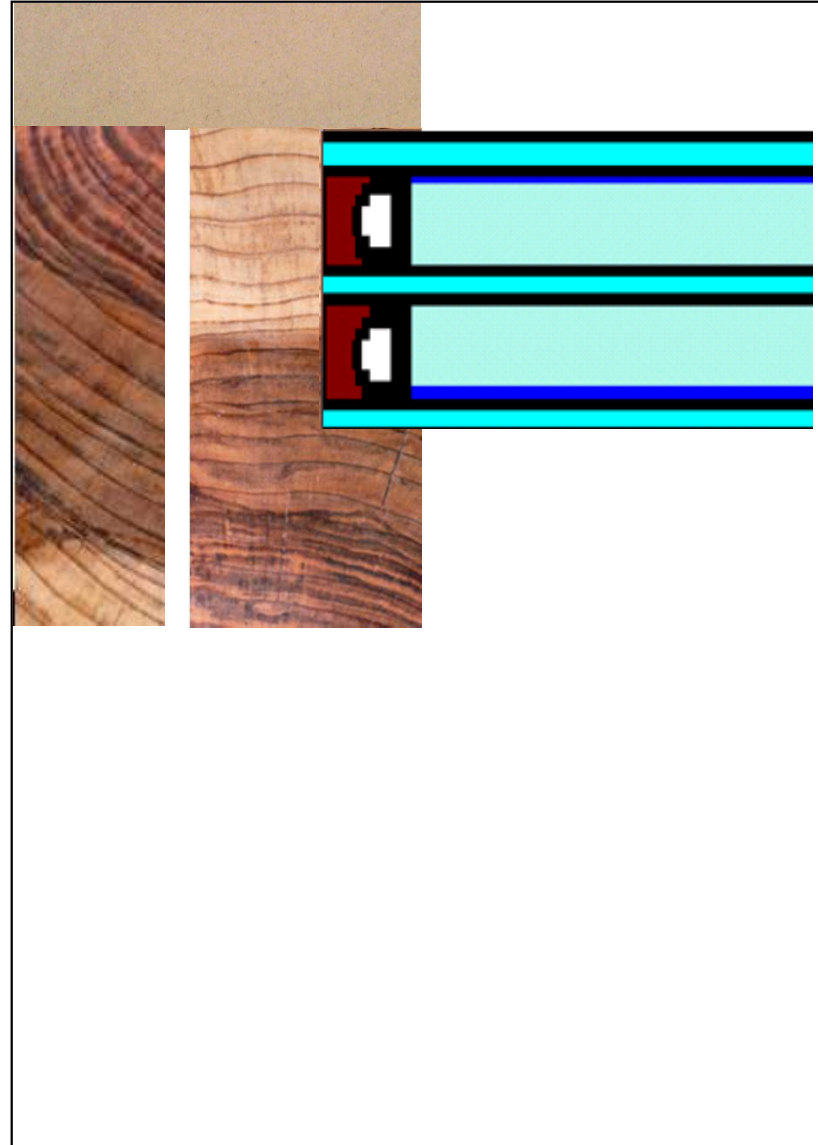
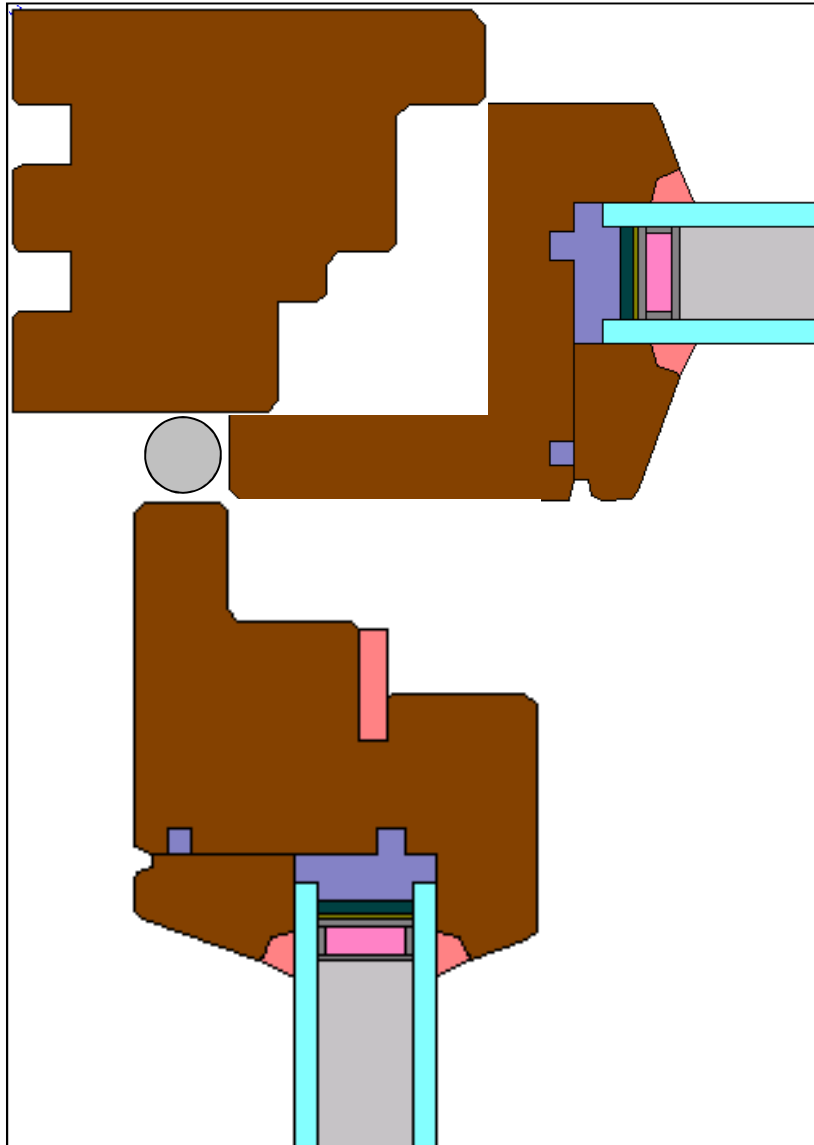
# The first idea



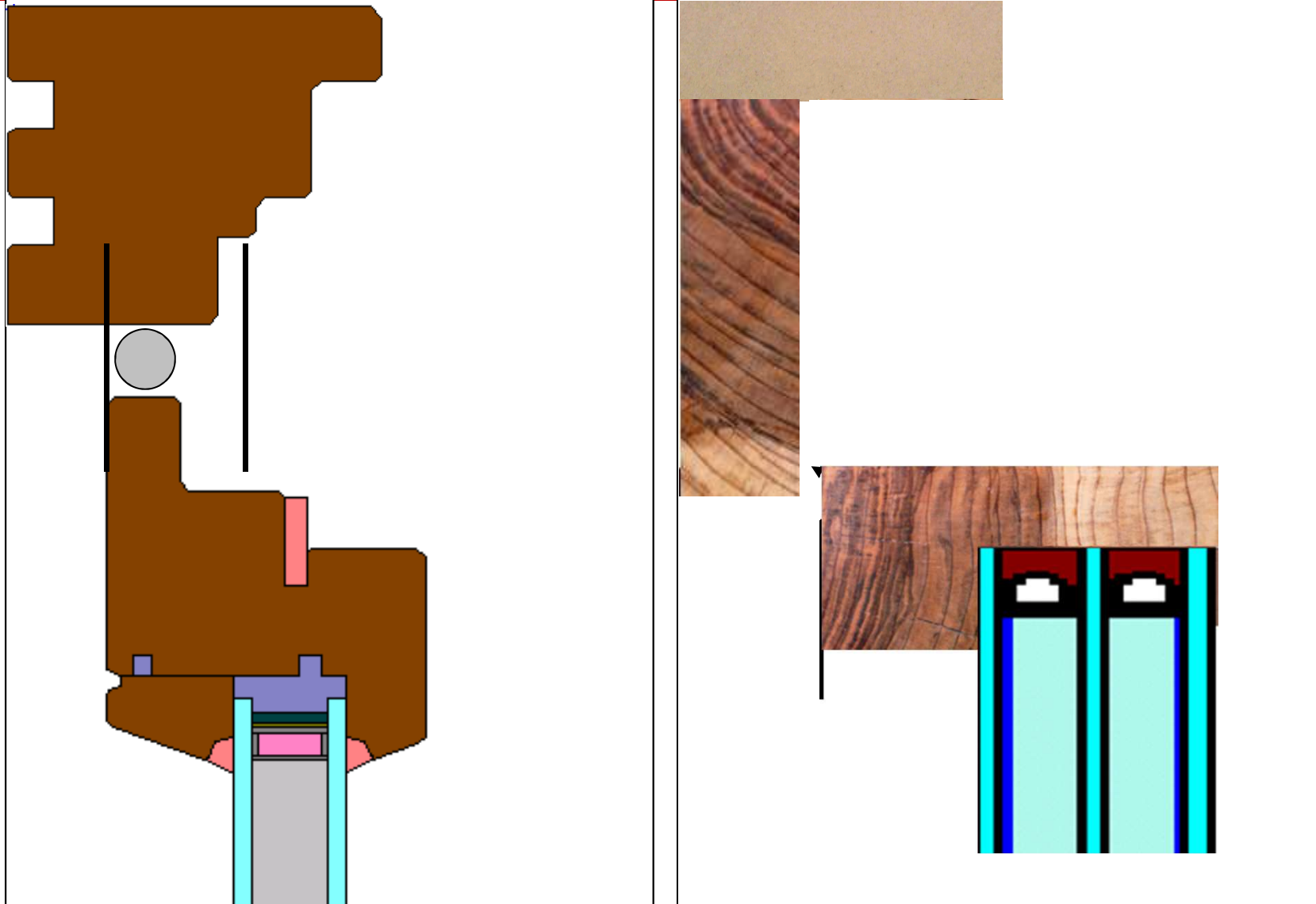
1 board + 1 panel + 1 blank =  
the window of the future



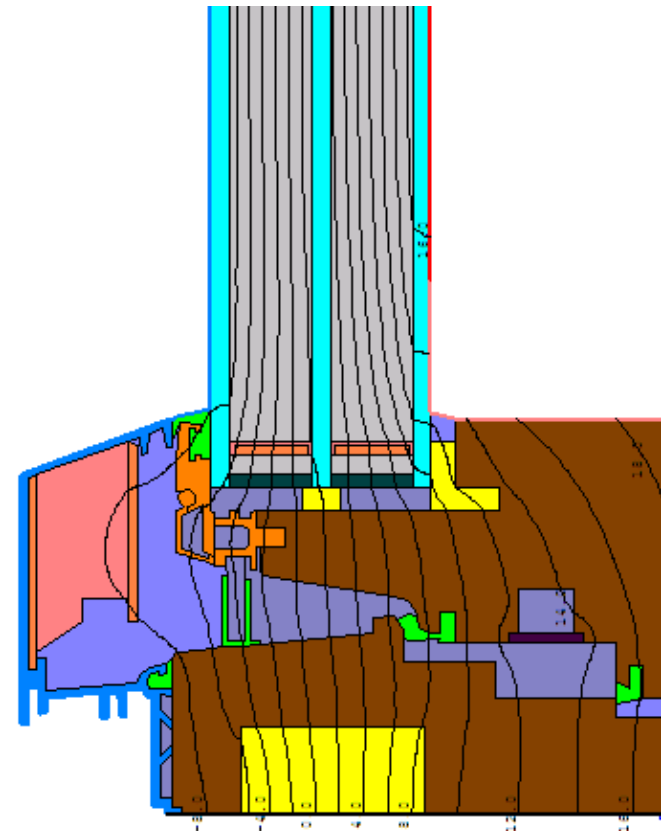
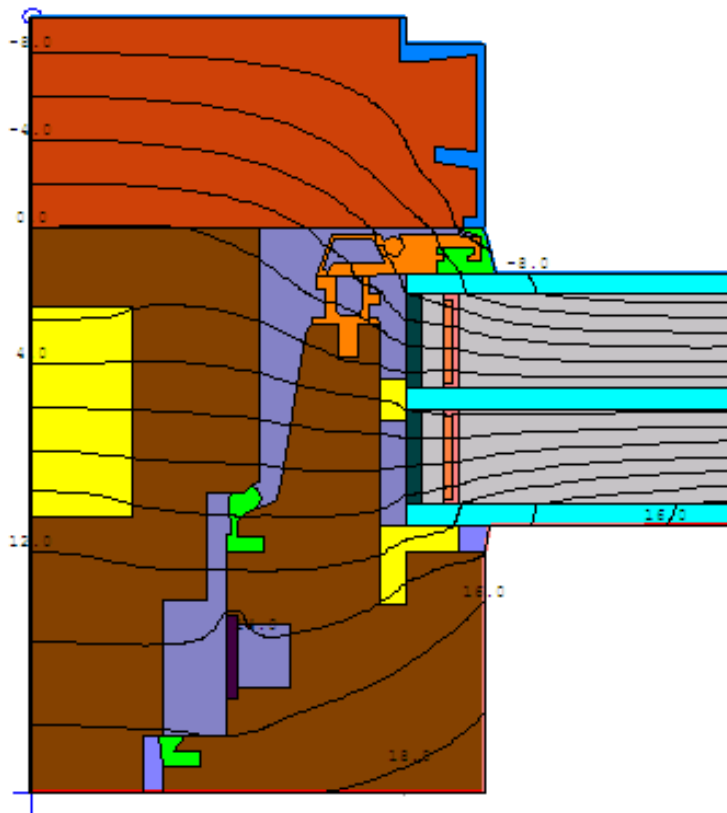
# Why are the window frames so wide?



28mm smaller

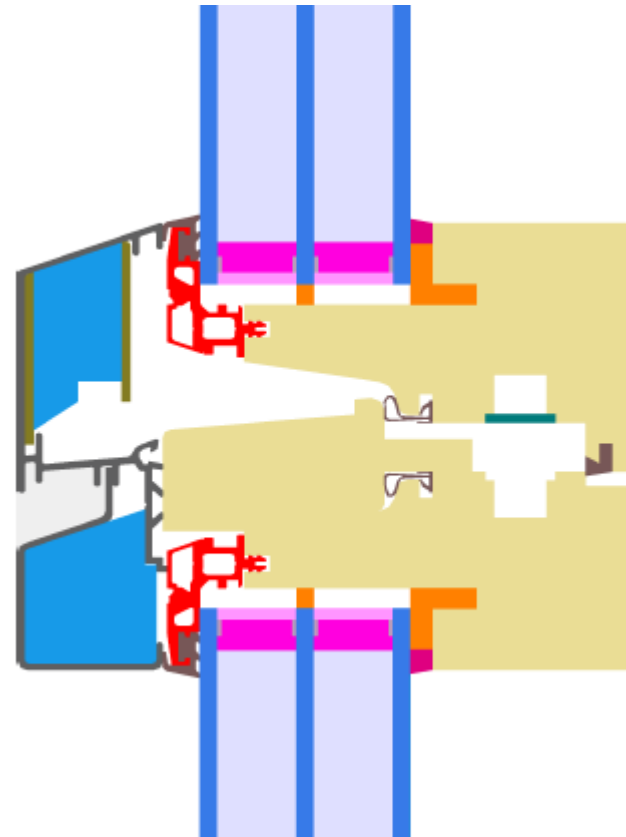
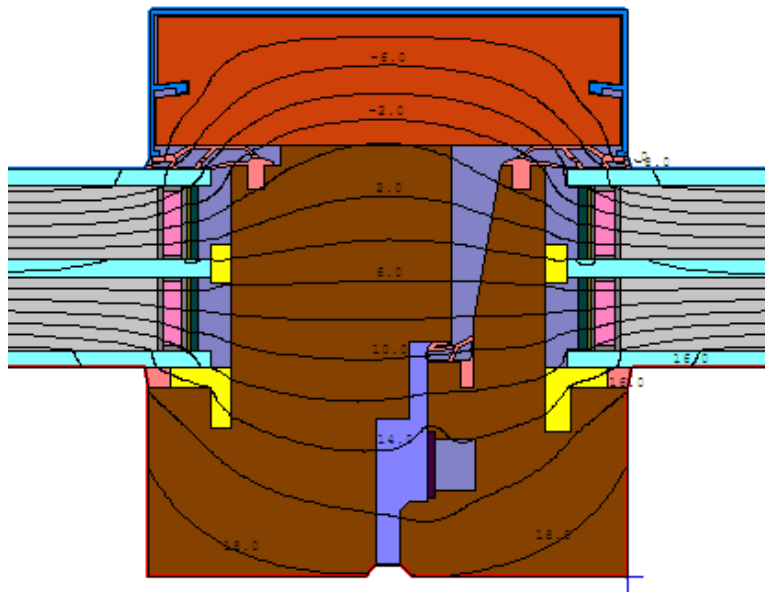


# Technical issues



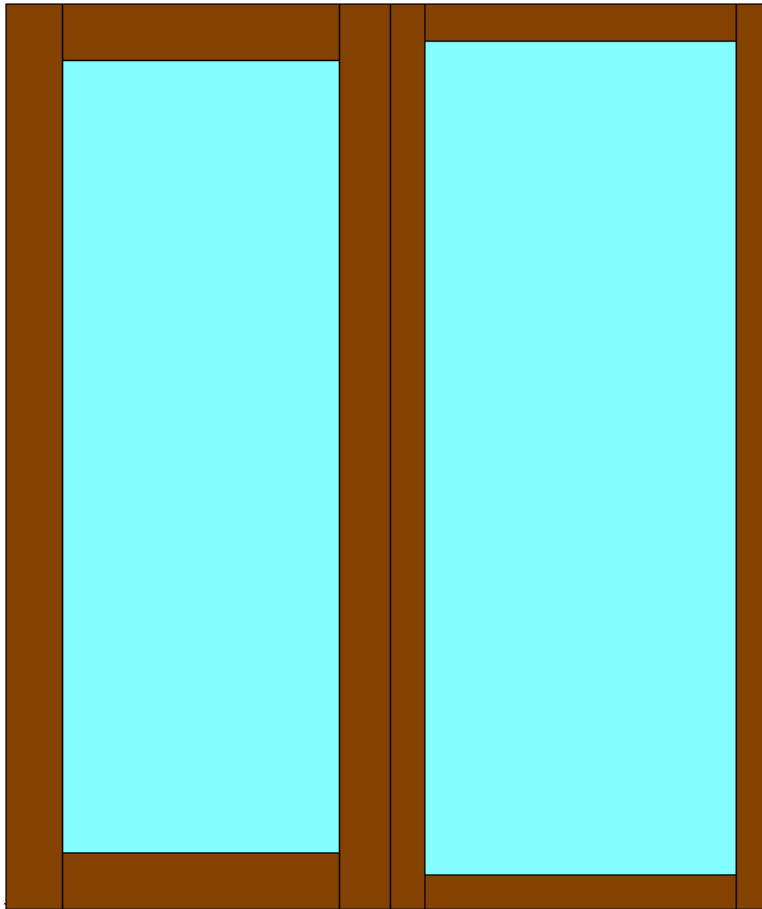
Frame 86mm wide,  $U_w = 0,66 \text{ W/m}^2\text{K}$  with  $U_g = 0,54 \text{ W/m}^2\text{K}$ ,  
 $U_{f \text{ st}} = 0,70 \text{ W/m}^2\text{K}$ ,  $U_{f \text{ bottom}} = 0,91 \text{ W/m}^2\text{K}$

# Post

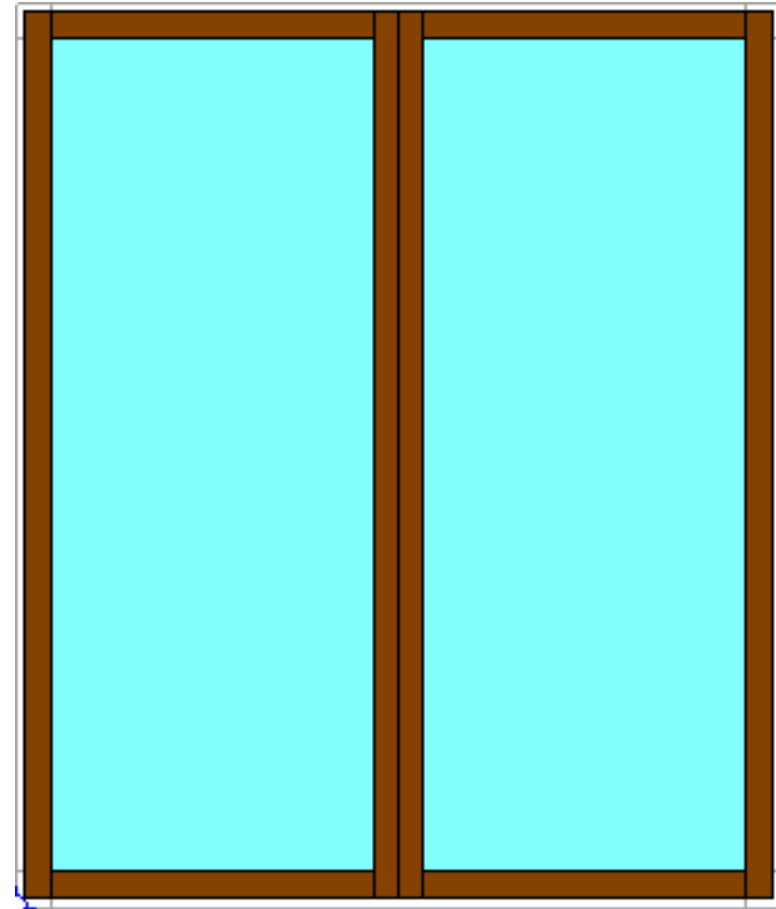


110mm wide,  $U_f=0,822$  or  $1,058$  W/m<sup>2</sup>K

# View from inside

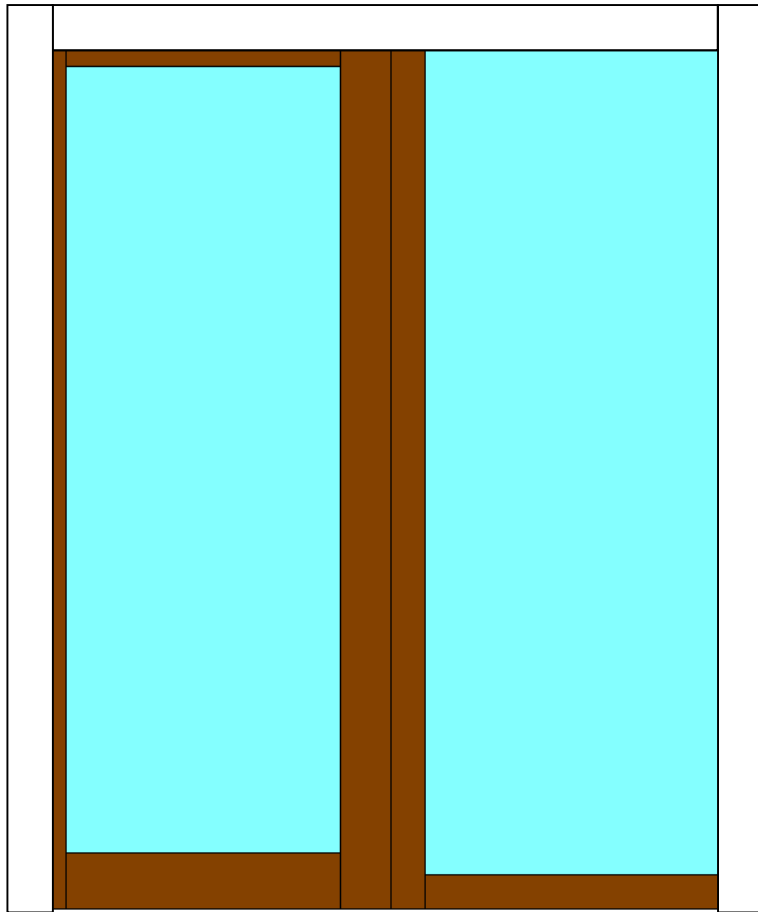


135mm wide frame

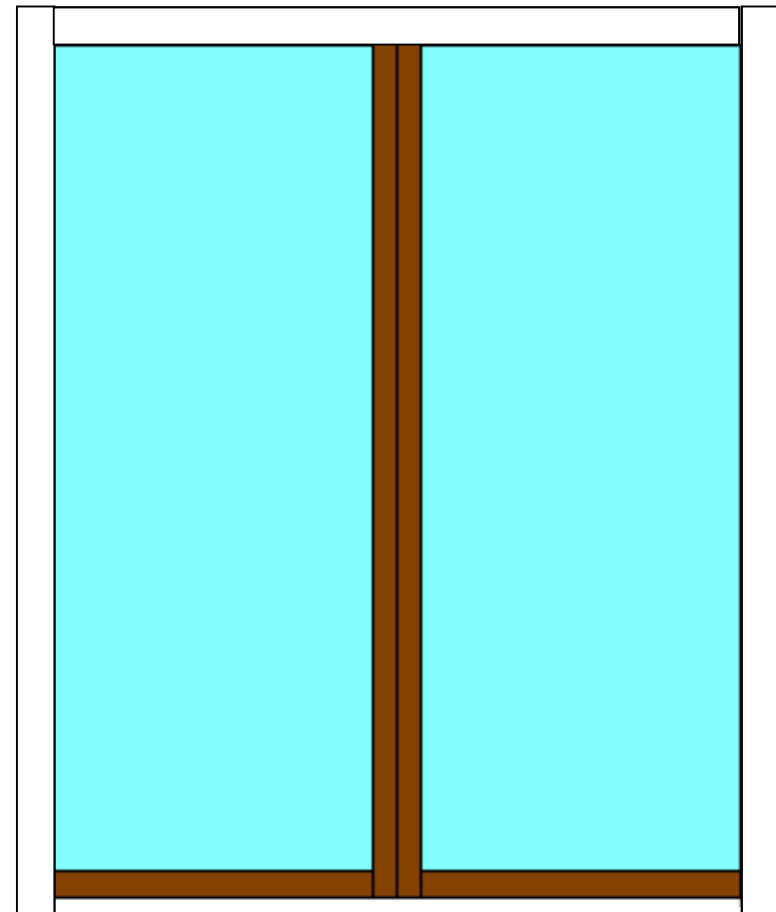


86mm wide frame

# View from outside



135mm wide frame



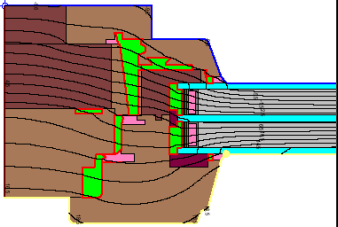
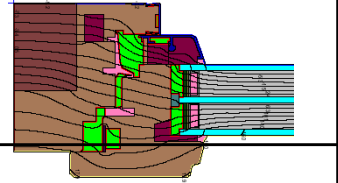
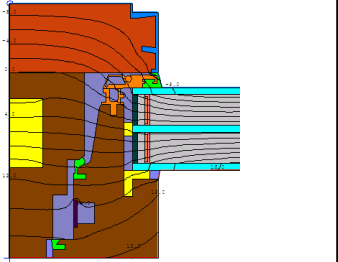
86mm wide frame

# With strong solar heat gains



Heat demand  
[kWh/m<sup>2</sup>a]



|                                                                                     |            | HD   | $Q_{solar}$ | $Q_{Twindow}$ | HD   | $Q_{solar}$ | $Q_{T window}$ |
|-------------------------------------------------------------------------------------|------------|------|-------------|---------------|------|-------------|----------------|
|    | $U_f=0,73$ | 14,2 | 3749        | 3170          | 14,6 | 3693        | 3289           |
|   | $U_f=0,95$ | 14,4 | 4034        | 3452          | 14,8 | 3885        | 3547           |
|  | $U_f=0,71$ | 9,8  | 4171        | 3066          | 10,4 | 3964        | 2966           |



# Windows are key to ...

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Passive house in cold regions

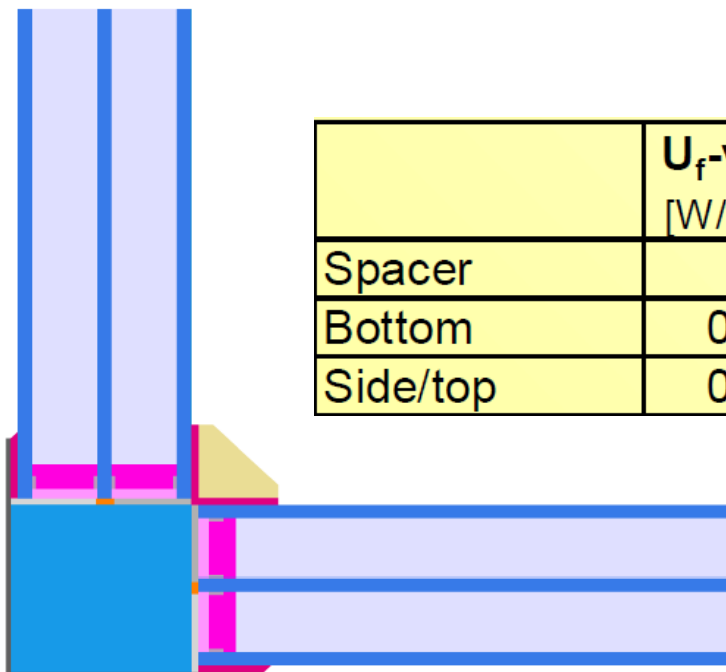


Cheaper passive houses



Achieve the passive houses standard in the renovation sector more easily

# Fixed window



|          | $U_f$ -value<br>[W/(m <sup>2</sup> K)] | Width<br>[mm] | $\Psi_g$<br>[W/(mK)] | $f_{R_{Si}=0.25}$<br>[-] |
|----------|----------------------------------------|---------------|----------------------|--------------------------|
| Spacer   |                                        |               | SwisspacerV*         |                          |
| Bottom   | 0.77                                   | 86            | 0.027                | 0.72                     |
| Side/top | 0.54                                   | 86            | 0.028                |                          |

$U_f=0,260 \text{ W/m}^2\text{K}, f_{fR_{Si}}=0,70$

## Certificate

**Passive House suitable component**  
for cool, temperate climate, valid until 31.12.2014

Category: **Frame for fixed glazing**  
Manufacturer: **pro Passivhausfenster GmbH**  
83080 Oberaudorf, GERMANY  
Product name: **smartwin fix**

Passive House Institute  
Dr. Wolfgang Feist  
64283 Darmstadt  
GERMANY

**Passive House Efficiency Class**

phA  
advanced component

phB  
basic component

phC  
certifiable component

not suitable for Passive Houses

**Thermal data of the window frame**

|          | $U_f$ -value<br>[W/(m <sup>2</sup> K)] | Width<br>[mm] | $\Psi_g$<br>[W/(mK)] | $f_{R_{Si}=0.25}$<br>[-] |
|----------|----------------------------------------|---------------|----------------------|--------------------------|
| Spacer   |                                        |               | SwisspacerV*         |                          |
| Bottom   | 0.77                                   | 86            | 0.027                | 0.72                     |
| Side/top | 0.54                                   | 86            | 0.028                |                          |

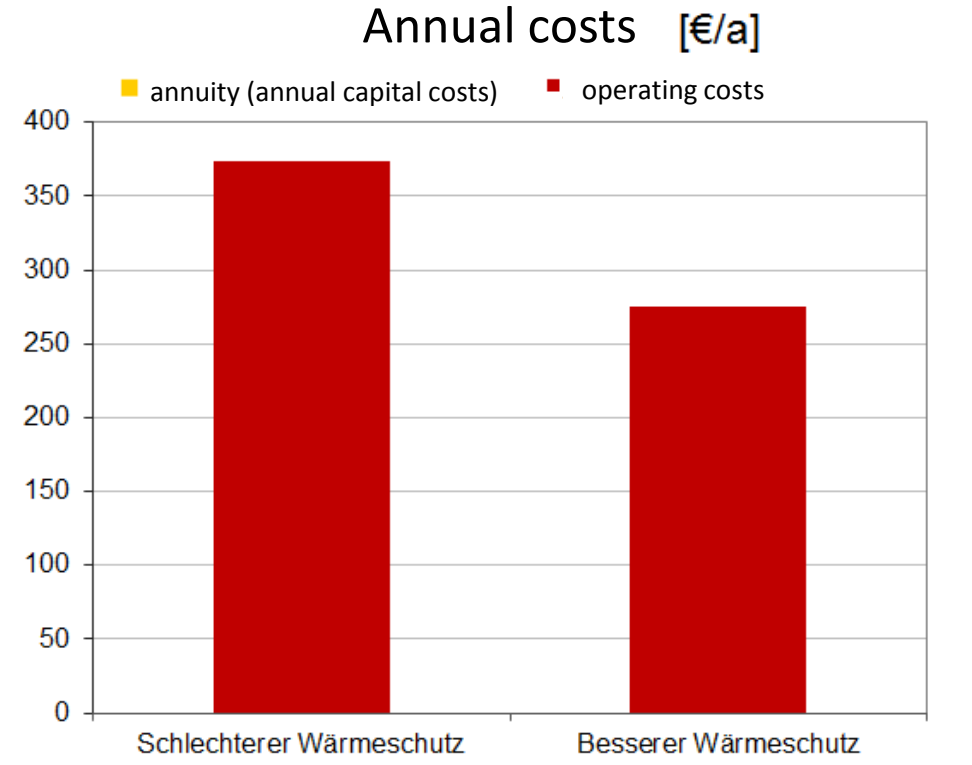
\*Spacers of lower thermal quality, especially those made of aluminium, lead to significantly higher thermal losses and lower temperature factors.

Further information see data sheet

www.passivehouse.com 0122fx03

Passive House Institute

# Less energy saves more



Thermal window quality

Better but not good

phA

Maximum for higher investment:

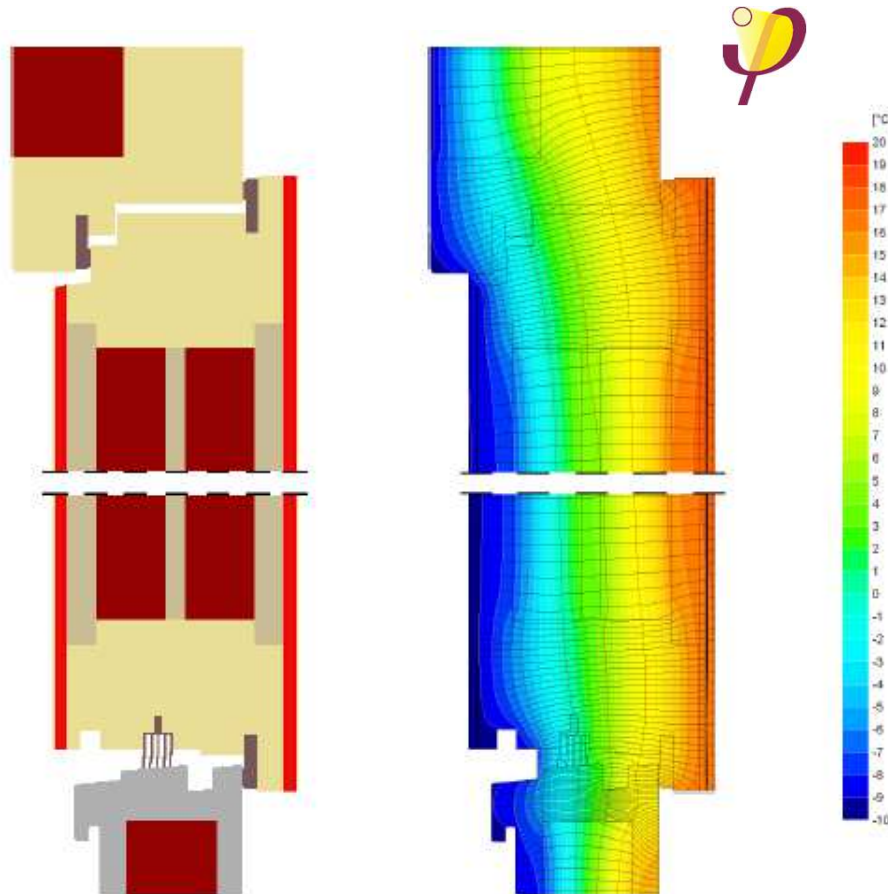
3129,-

Higher investment EneV to phA from Award2014:

1680,-

# The Passive House entrance door newest developments

# Outdoor: airtight and thermal bridge free



Same requirement as windows

Thermal bridge free threshold!

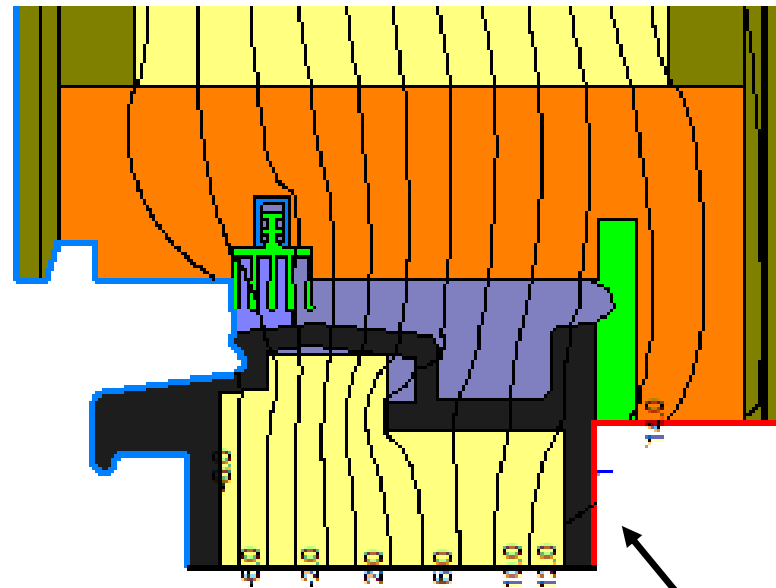
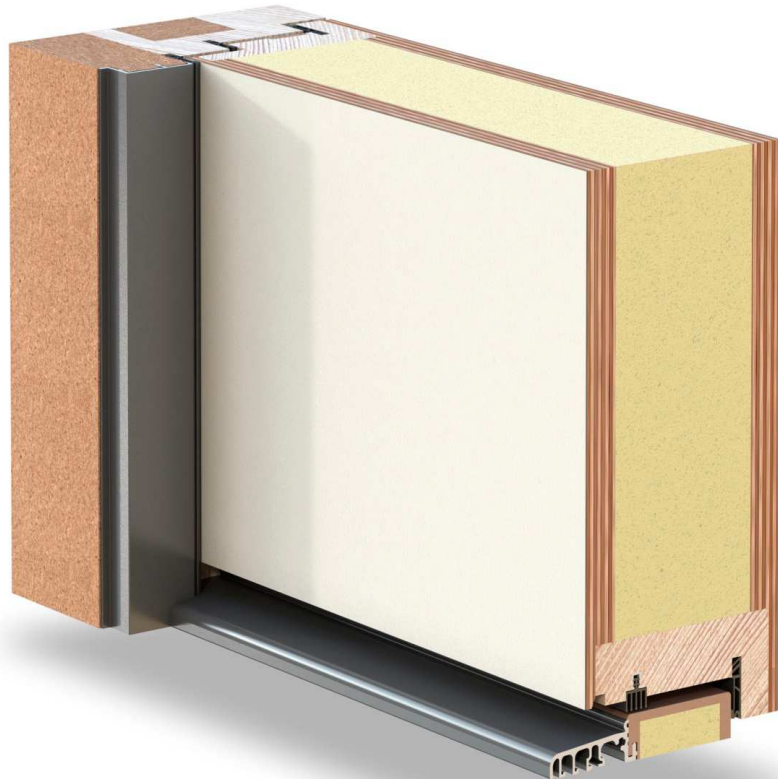
Additional climate test:  
Stability, airtightness  
 $Q(100 \text{ Pa}) \leq 2,25 \text{ m}^3/\text{hm}$

Easy handling

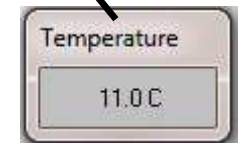
$$U_{D,\text{fitted}} \leq 0,80 \text{ W}(\text{m}^2\text{K})$$

# Today's best off

$$U_{D,installed} = 0.52 \text{ W/(m}^2\text{K)} \leq 0.80 \text{ W/(m}^2\text{K)}$$



20 degree interior  
-10 degree



# Today's best off



## Certificate

**Certified Passive House component**  
For cool temperate climates, valid until 31 December 2015

Category: **Entry door**  
Manufacturer: **pro Passivhausfenster GmbH**  
83080 Oberaudorf, Germany

Product: **smartwin entrance**

This certificate was awarded based on the following criteria:

Heat losses through the installed entry door:

U-value of the installed door (1.10 m wide by 2.20 m tall):  
 $U_{D,installed} = 0.52 \text{ W/(m}^2\text{K)} \leq 0.80 \text{ W/(m}^2\text{K)}$

Provided that the installation is carried out according to the certification report, available from the manufacturer.  
U-value before installation:  $U_D = 0.45 \text{ W/(m}^2\text{K)}$ .

The  $U_D$  and  $U_{D,installed}$  values apply to a door with no glazing.

Airtightness:

Airtightness class 3 according to EN 12207.

The airtightness criterion has been fulfilled.

The airtightness test according to EN 1026 was carried out taking into account a maximal deformation of the door leaf, as per EN 1121.

**U-value entry door:  $U_D = 0.45 \text{ W/(m}^2\text{K)}$**

For further information, please see data sheet.

[www.passivehouse.com](http://www.passivehouse.com)

0634ed03

Passive House Institute  
Dr. Wolfgang Feist  
64283 Darmstadt  
Germany



vertical section



**CERTIFIED COMPONENT**  
Passive House Institute

## Certificate

**Certified Passive House component**  
For cool temperate climates, valid until 31 December 2015

Category: **Entry door with glazing**  
Manufacturer: **pro Passivhausfenster GmbH**  
83080 Oberaudorf, Germany

Product: **smartwin entrance**

This certificate was awarded based on the following criteria:

Heat losses through the installed entry door:

U-value of the installed door (1.10 m wide by 2.20 m tall):  
 $U_{D,installed} = 0.73 \text{ W/(m}^2\text{K)} \leq 0.80 \text{ W/(m}^2\text{K)}$

Provided that the installation is carried out according to the certification report, available from the manufacturer.  
U-value before installation:  $U_D = 0.67 \text{ W/(m}^2\text{K)}$ .

The U-values were calculated based on glazing with  $U_g = 0.64 \text{ W/(m}^2\text{K)}$  in accordance with EN 673 and the spacer "Dwispacer V". The glass pane should have a maximum area of 1.534 m<sup>2</sup> (79.8 x 192.2 cm) or a maximum circumference of 5.44 m (79.8 x 192.2 cm).

Airtightness:

Airtightness class 3 according to EN 12207.

The airtightness criterion has been fulfilled.

The airtightness test according to EN 1026 was carried out taking into account a maximal deformation of the door leaf, as per EN 1121.

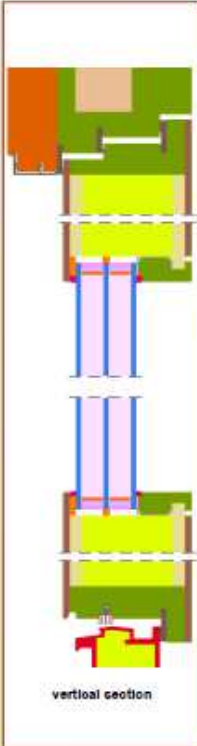
|                                                                                                              |                                      |
|--------------------------------------------------------------------------------------------------------------|--------------------------------------|
| <b>U-value entry door</b><br>including the above mentioned glazing with $U_g = 0.64 \text{ W/(m}^2\text{K)}$ | $U_D = 0.67 \text{ W/(m}^2\text{K)}$ |
|--------------------------------------------------------------------------------------------------------------|--------------------------------------|

For further information, please see data sheet.

[www.passivehouse.com](http://www.passivehouse.com)

0690ed03

Passive House Institute  
Dr. Wolfgang Feist  
64283 Darmstadt  
Germany



vertical section



**CERTIFIED COMPONENT**  
Passive House Institute

Let us implement the shading

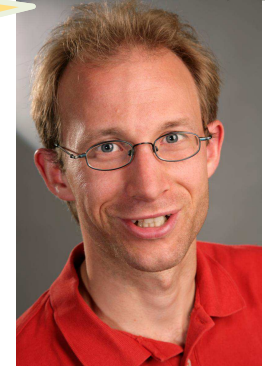


# Energyefficient shutters window-integrated



*After smartwin and smartwin compact there is no big chance to improve the cost efficiency further on, **around the window is a lot of potential.***

*(Benjamin Krick-Franz Freundorfer ,Passiv House Window Talk Gouda 2014)*

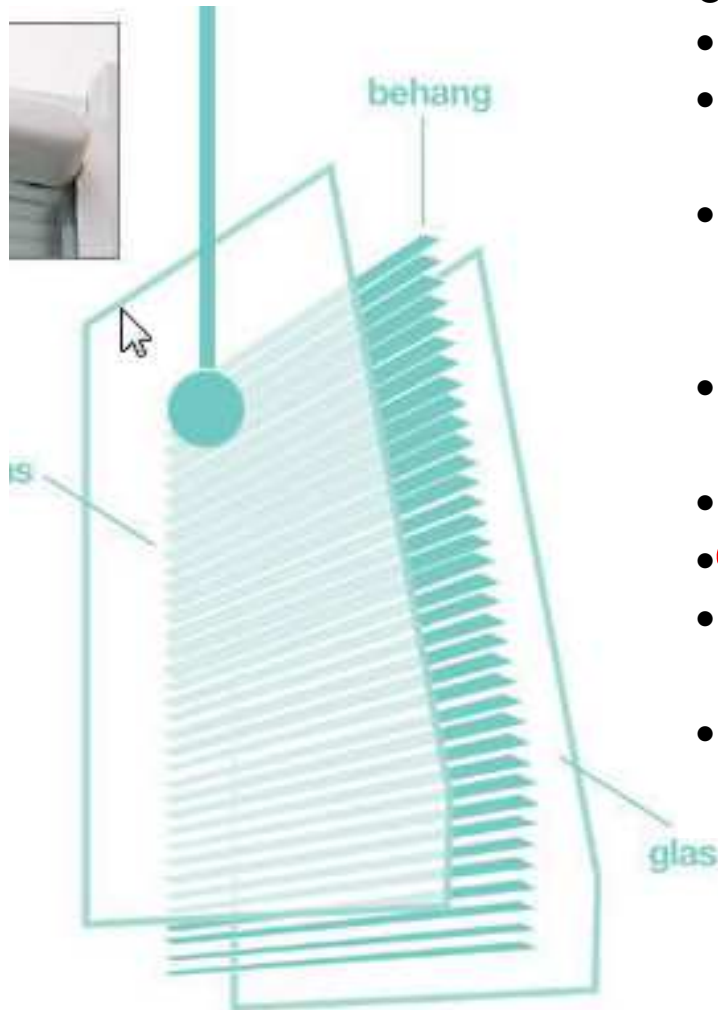


*I don't think, that you are able to invent something, that is more costly than the shutters we use now.*

*(Christoph Hartmann Rosenheim 2014)*



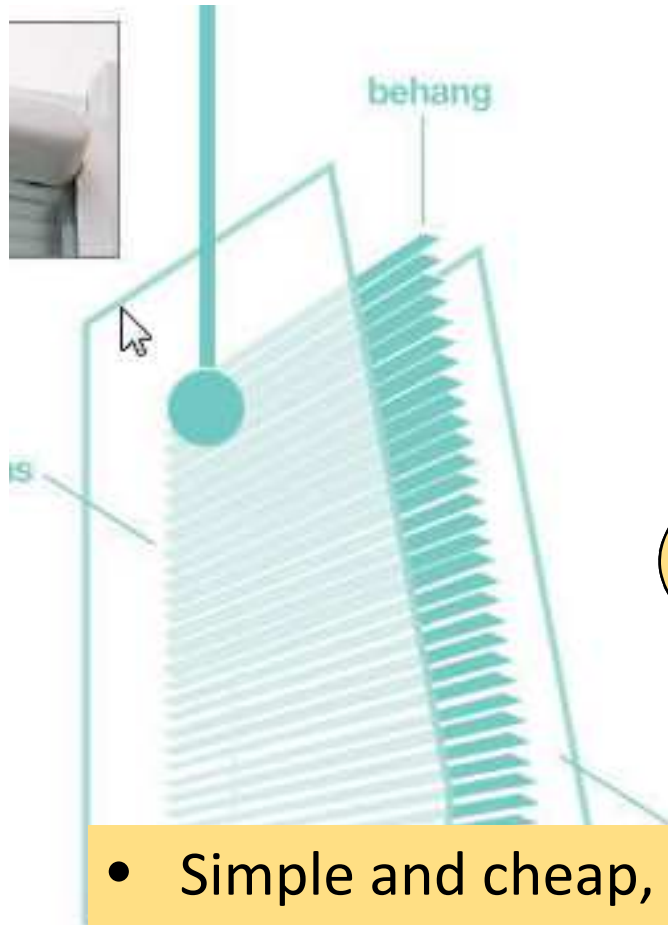
... but one unbelievable disadvantage



### 8 benefits of screenline

- manually operated for precise control
- blinds can be raised or lowered to suit the weather conditions
- blinds can be tilted to regulate precisely the level of light and heat entering the home
- unbeatable protection against glare and build-up of heat
- cannot get dirty or dusty
- **endless lifetime**
- can be combined with a range of toughened glass
- choice of coloured slats available - white, cream and silver

... but one unbelievable disadvantage



### 8 benefits of screenline

- manually operated for precise control
- blinds can be raised or lowered to suit the weather conditions
- blinds can be tilted to regulate precisely the level of light and heat entering the home
- unbeatable protection against glare and heat

*Shutter broken = pane faulty  
that is unacceptable for us!!*

- choice of coloured slats and -  
white, cream and silver

- Simple and cheap, because it is like an interior shutter
- No wind protection necessary

# Window integrated shutters repairable and exchangeable

---



*The necessary thickness of sealed air cavities exceeds all possible limits  
 $2 \times 18 \text{mm} + \text{minimum } 24 \text{mm} = 60 \text{mm}$*



# Window integrated shutters repairable and exchangeable

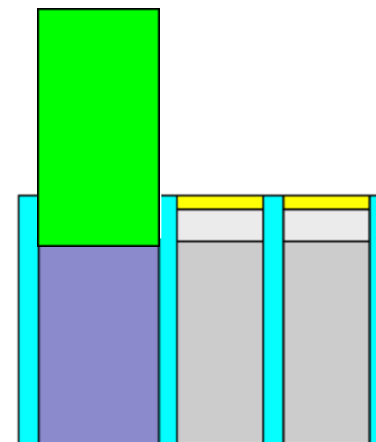
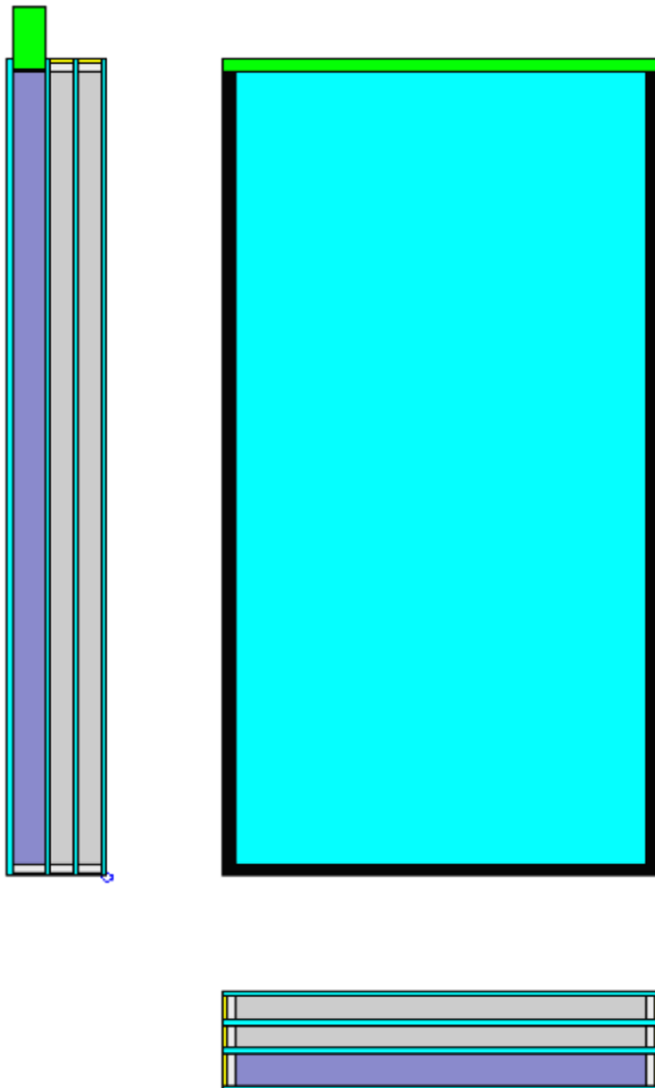
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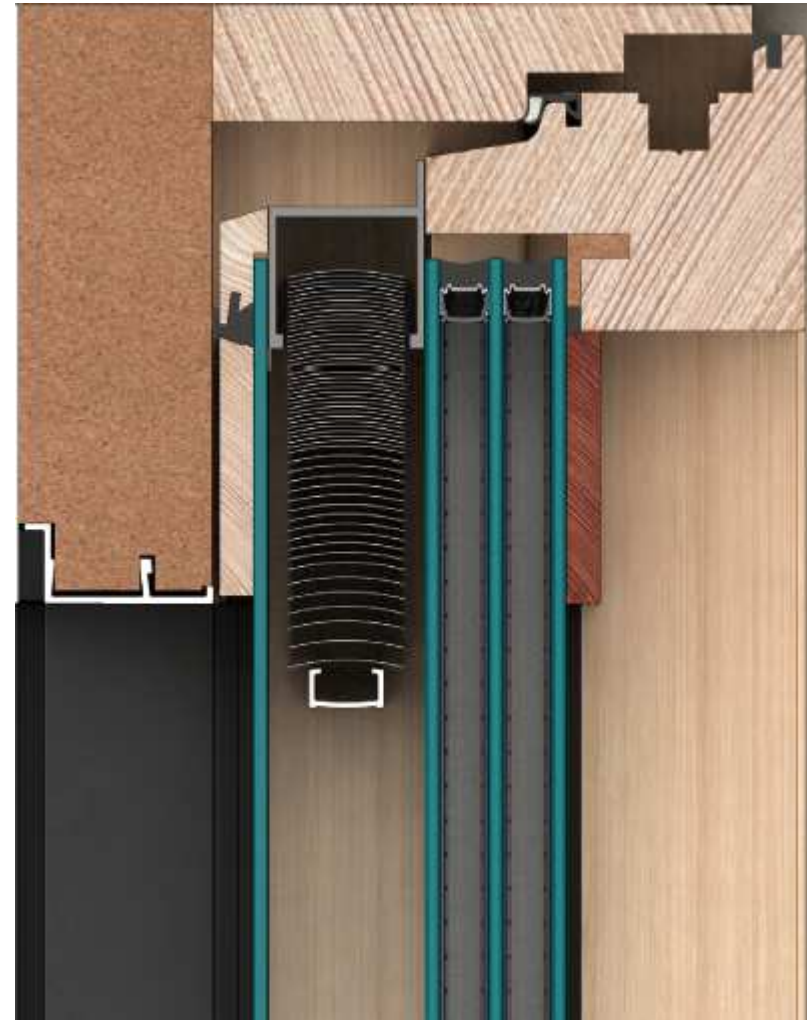
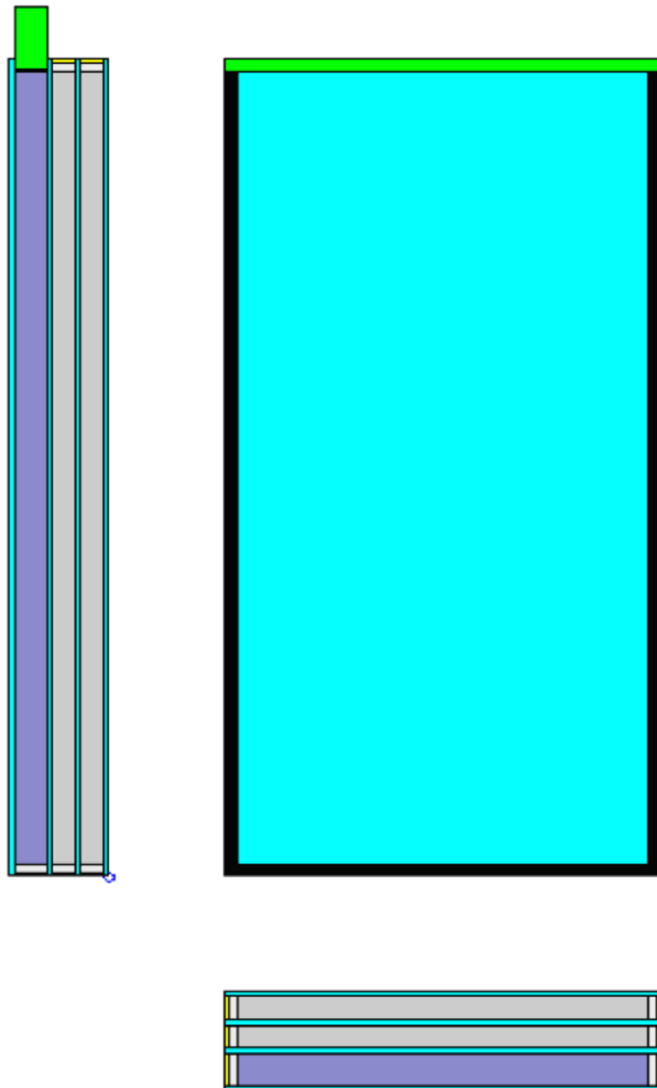
*Let us put a fourth pane in front of the triple glazing.  
The spacer at the top stays open to house the shutter*

# Integrated shutters repairable and exchangeable

---



# Integrated shutters repairable and exchangeable



# Glazing industry and calculation of premium products

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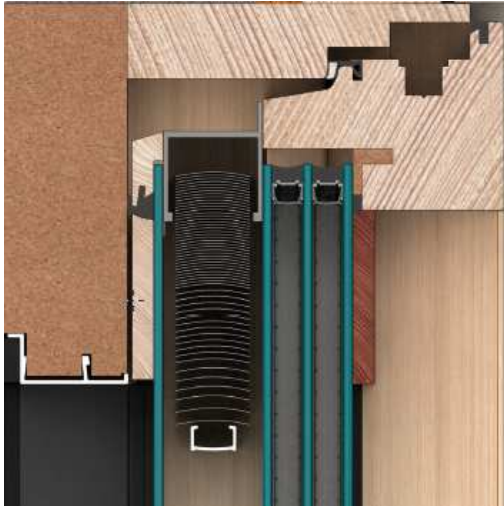
They calculate reverse

|                               |                            |
|-------------------------------|----------------------------|
| Conventional solution (slats) | 450,- EUR/m <sup>2</sup>   |
| – Costs of shutter            | - 150,- EUR/m <sup>2</sup> |
| – fitting of the shutter      | - 60,- EUR/m <sup>2</sup>  |
|                               | <hr/>                      |
| = price for window producer   | 240,- EUR/m <sup>2</sup>   |



# Not with us!

## Of course we changed the construction

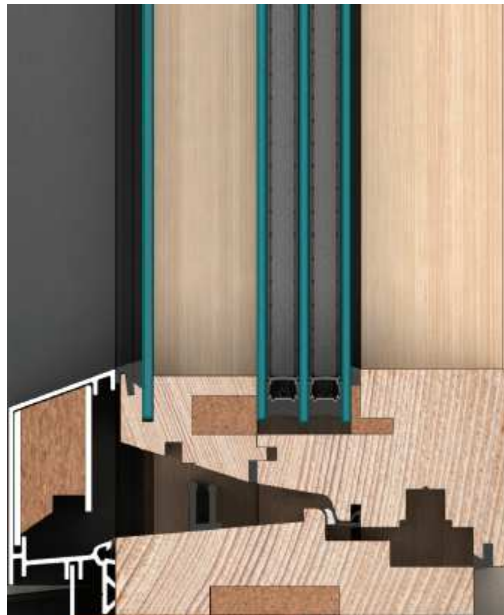


We take a triple glazing and a single pane.  
The single pane is fixed on three sides in a groove.

The shutter is included in the window factory.

So the construction gets even easier.

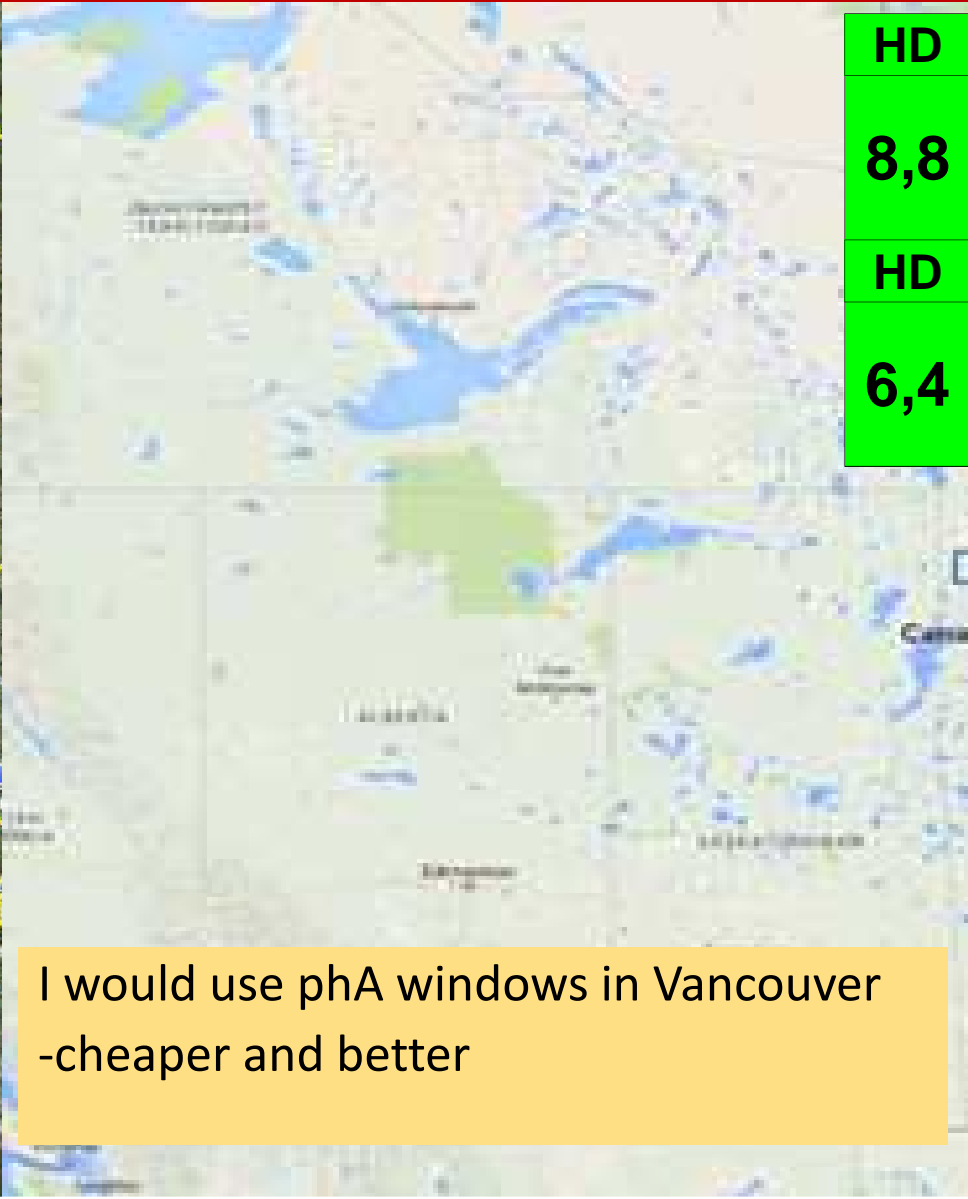
Possible to have the outer pane of glass openable.



# Franz's House in Vancouver



HD  
11,6



HD  
8,8  
HD  
6,4

I would use phA windows in Vancouver  
-cheaper and better

# Franz's House in Edmonton



**HD**  
**11,6**



**HD**  
**24,8**



# Franz's House in Edminton



**HD**  
**11,6**



**HD**  
**24,8**

I would recommend smartwin compact (phA window) in Edminton

**HD**  
**17,3**

better ventilation machine  
(better airtightness also possible)

**HD**  
**14,9**



# Franz's House in Yellowknife



# Franz's House in Yellowknife

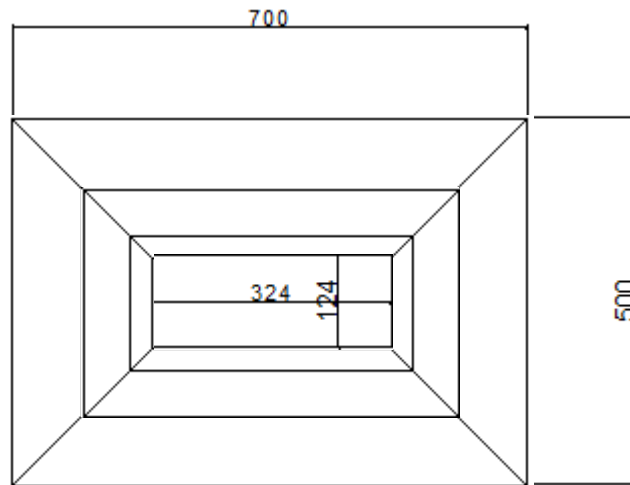


|      |                                                           |                                                          |      |    |
|------|-----------------------------------------------------------|----------------------------------------------------------|------|----|
| HD   |                                                           | HD                                                       | HD   |    |
| 11,6 |                                                           |                                                          | 60,4 | HD |
|      |                                                           | We need for shure phA+                                   | 47   | HD |
|      |                                                           | with quadruple glazing                                   | 41   | HD |
|      |                                                           |                                                          | 33   | HD |
|      | <p>better ventilation machine<br/>better airtightness</p> | <p>Windows phA+ would be<br/>again the game-changer!</p> |      |    |

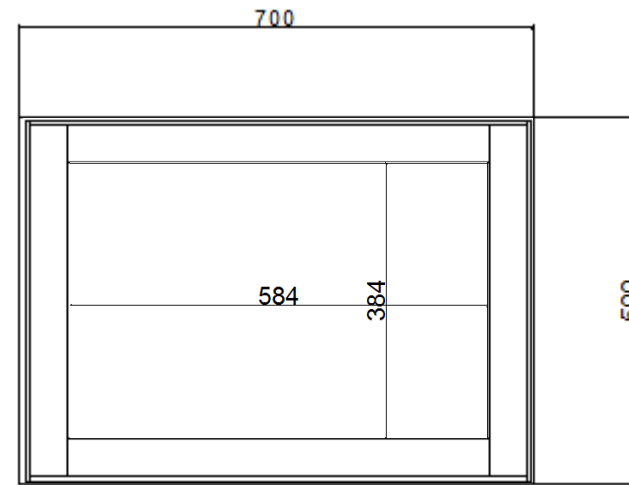
For cold and arctic climate our  
Passive Windows are still not  
good enough.

phA+ certified for cold climate  
shouldn't that get reality?

People say, that the windows are the eyes of a house.



*The chunky frame of class phC  
(188mm)*



*The slimest frame in class  
phA+ (58mm)*

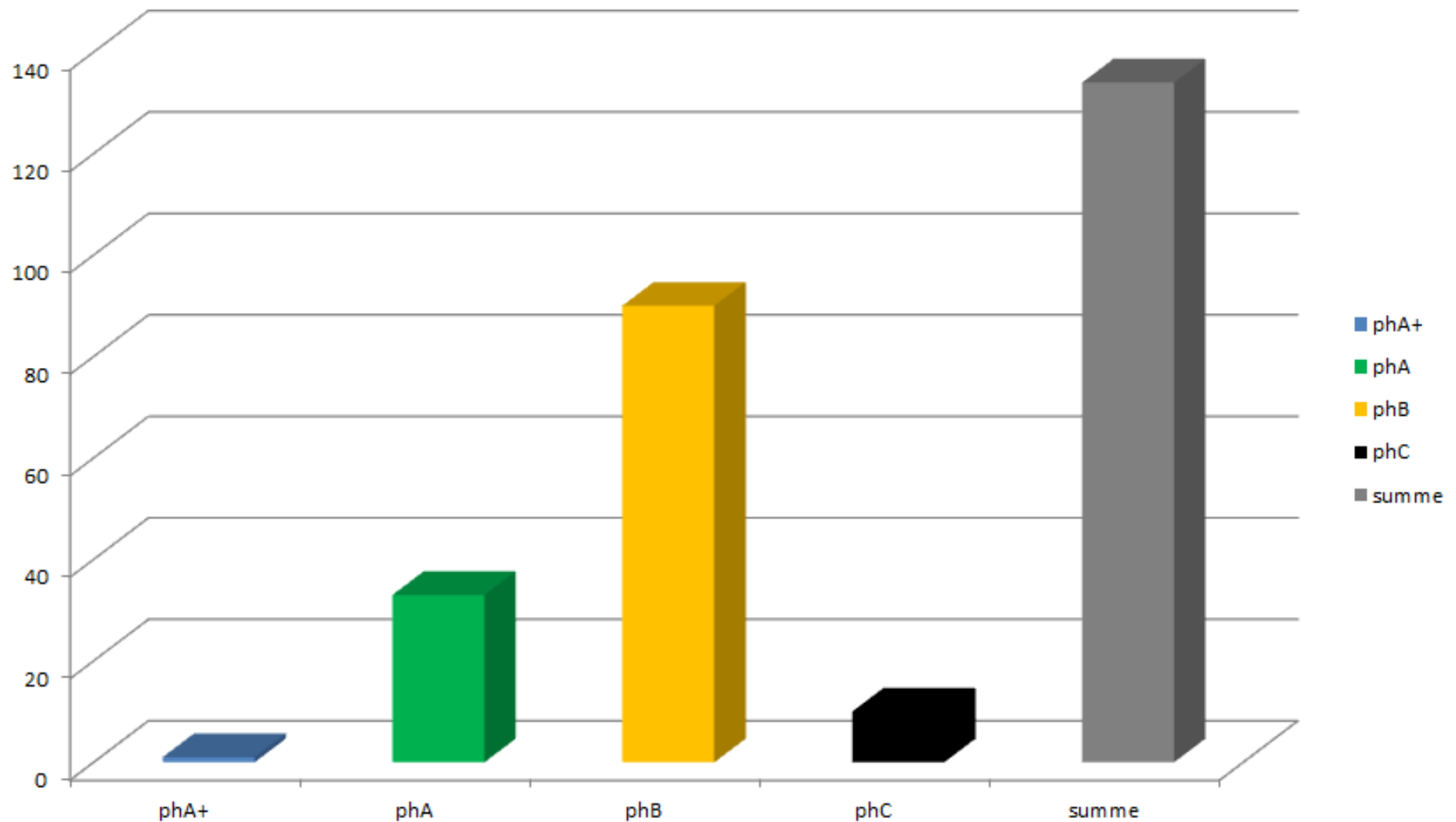
*Proportions and esthetics are  
sometimes a mismatch ...*



# Why windows in efficiency class phA+



Number of certified windows (27.03.2015)



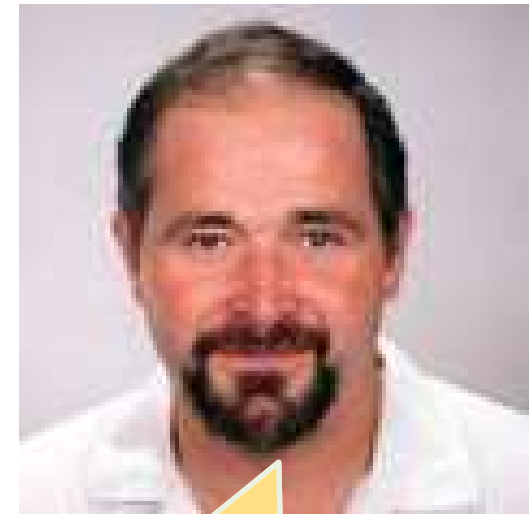
# What was the real kick-off?

---



*Class phA+ is only for not openable windows. You can't achieve that with an openable one.*

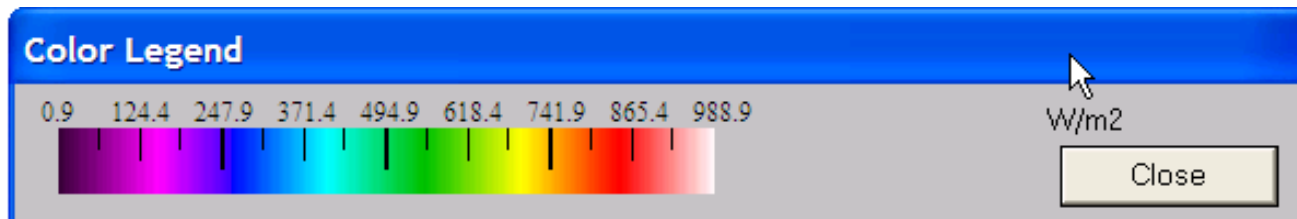
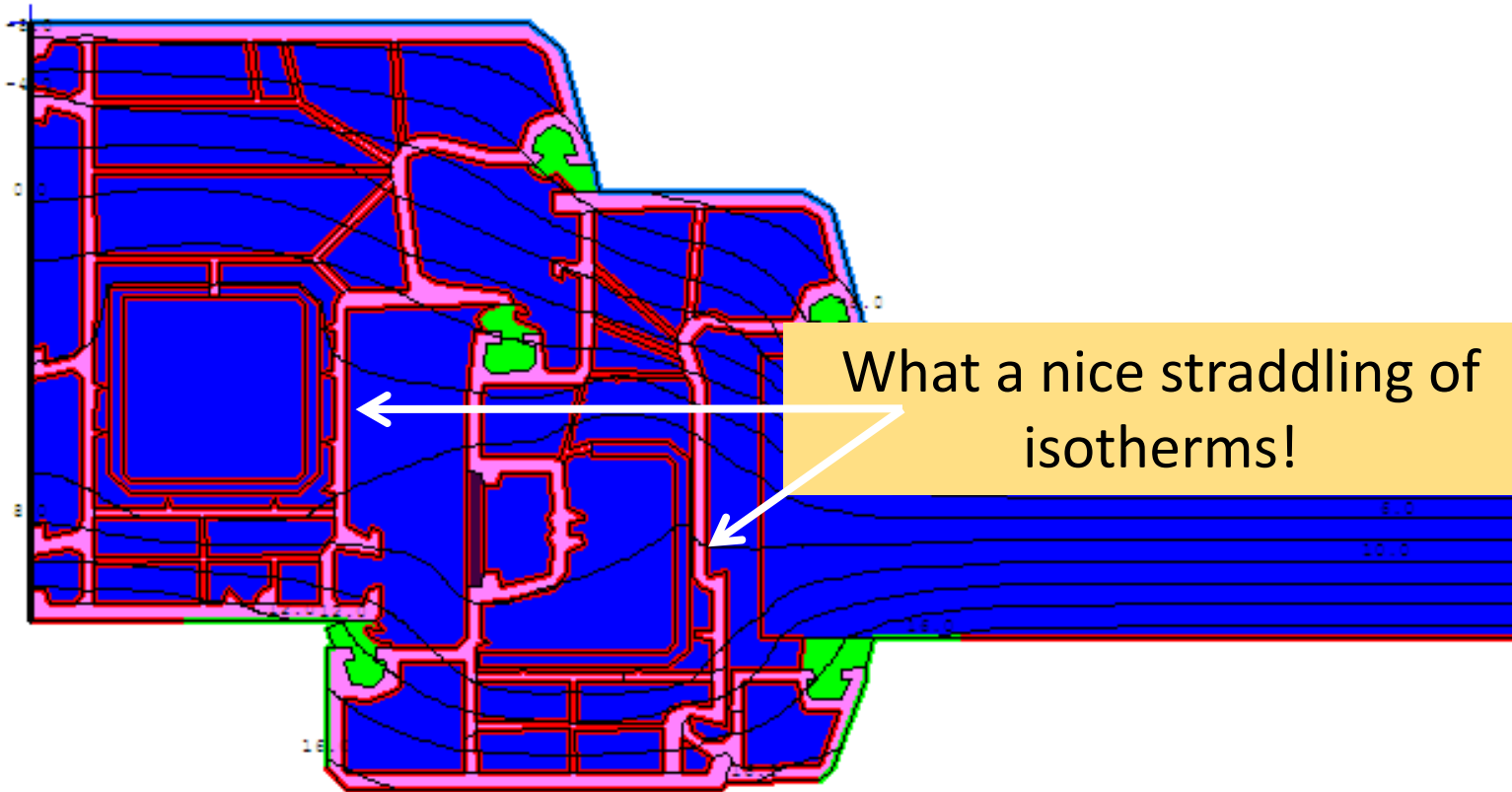
*(Dr. Benjamin Krick, Partnermeeting 2012)*



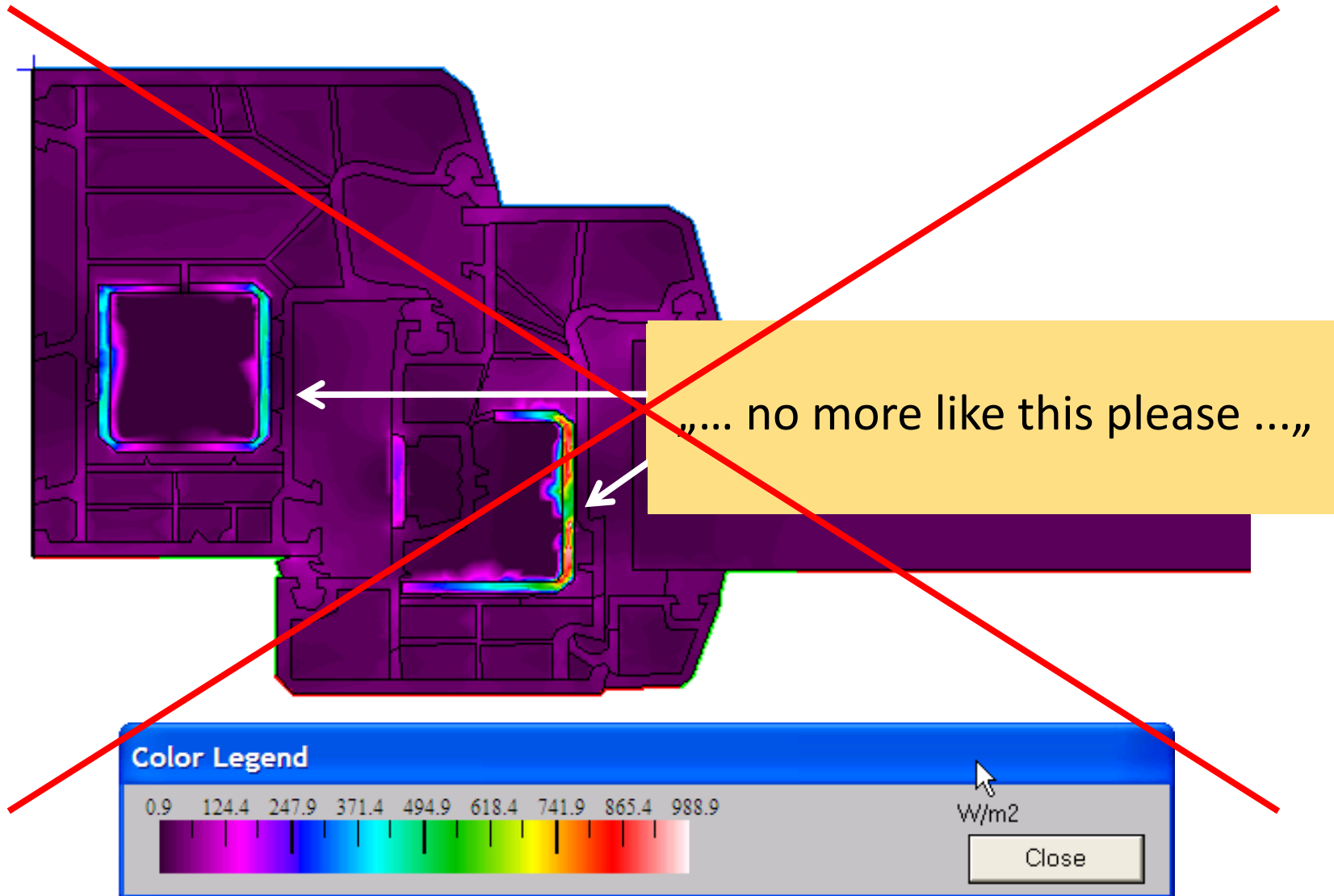
*We will see, my friend!*

*(Josef Lorber, Tischlermeister)*

# How to achieves the efficiency class phA+?



# How to achieves the efficiency class phA+?



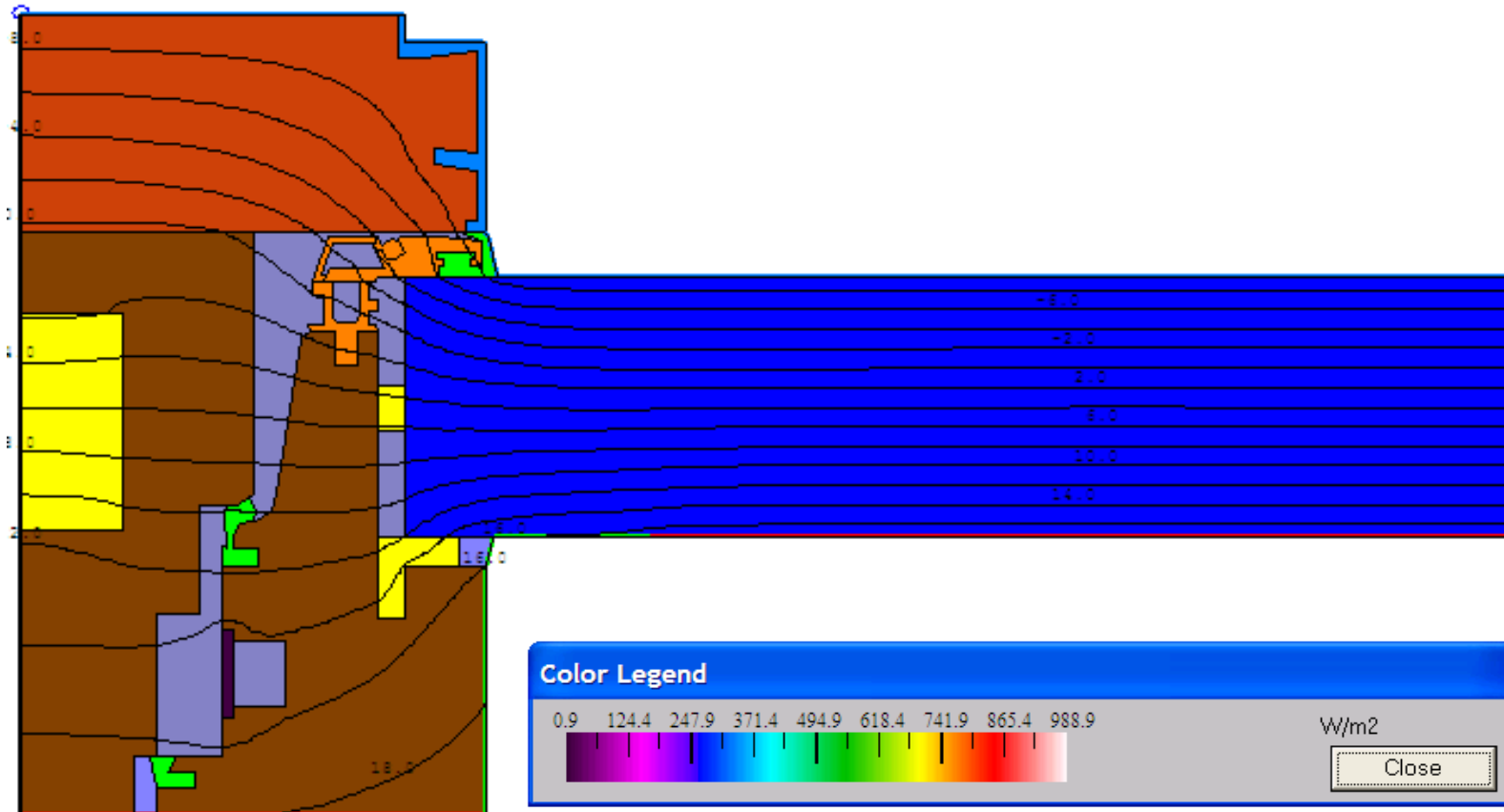
Color Legend

0.9 124.4 247.9 371.4 494.9 618.4 741.9 865.4 988.9

W/m2

Close

# How to achieves the efficiency class phA+?

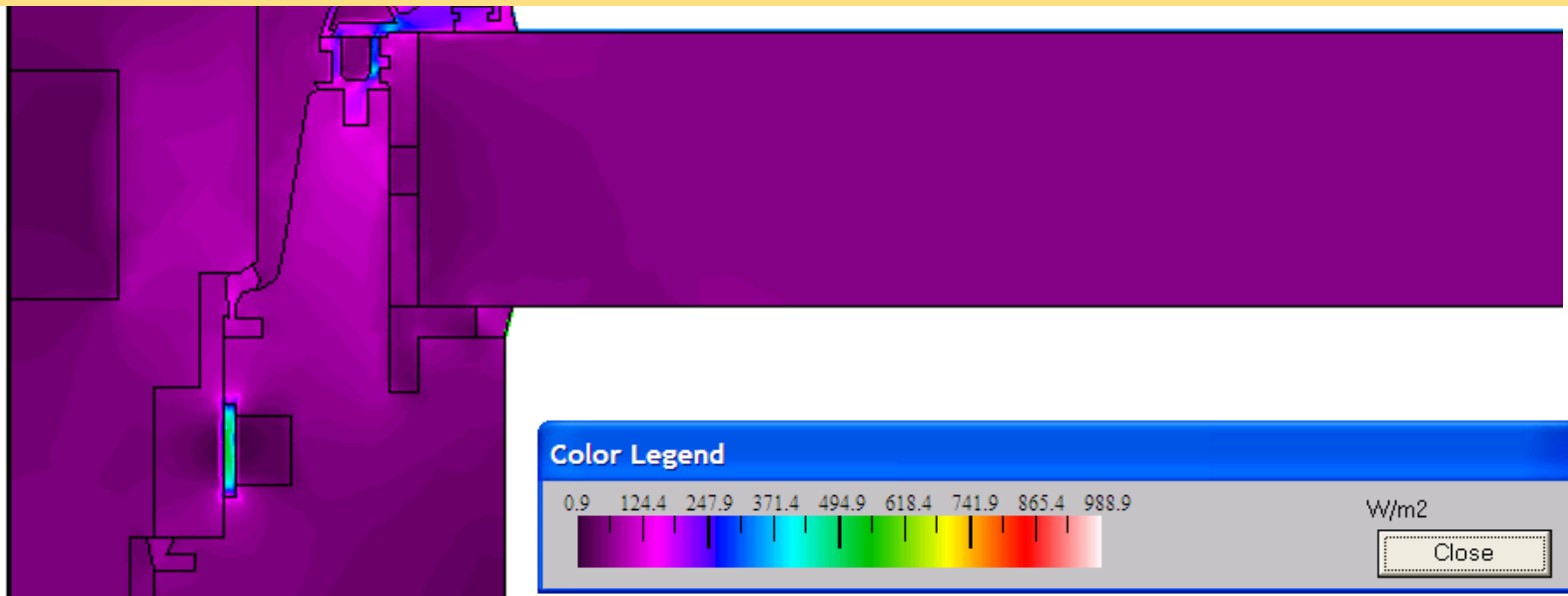


# How to achieves the efficiency class phA+?

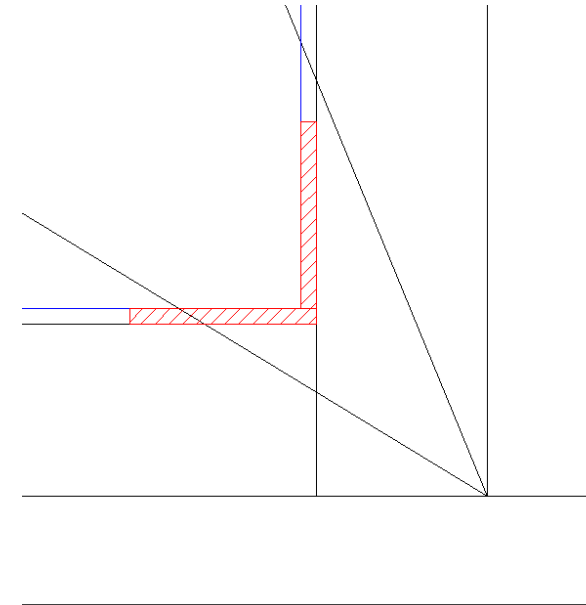
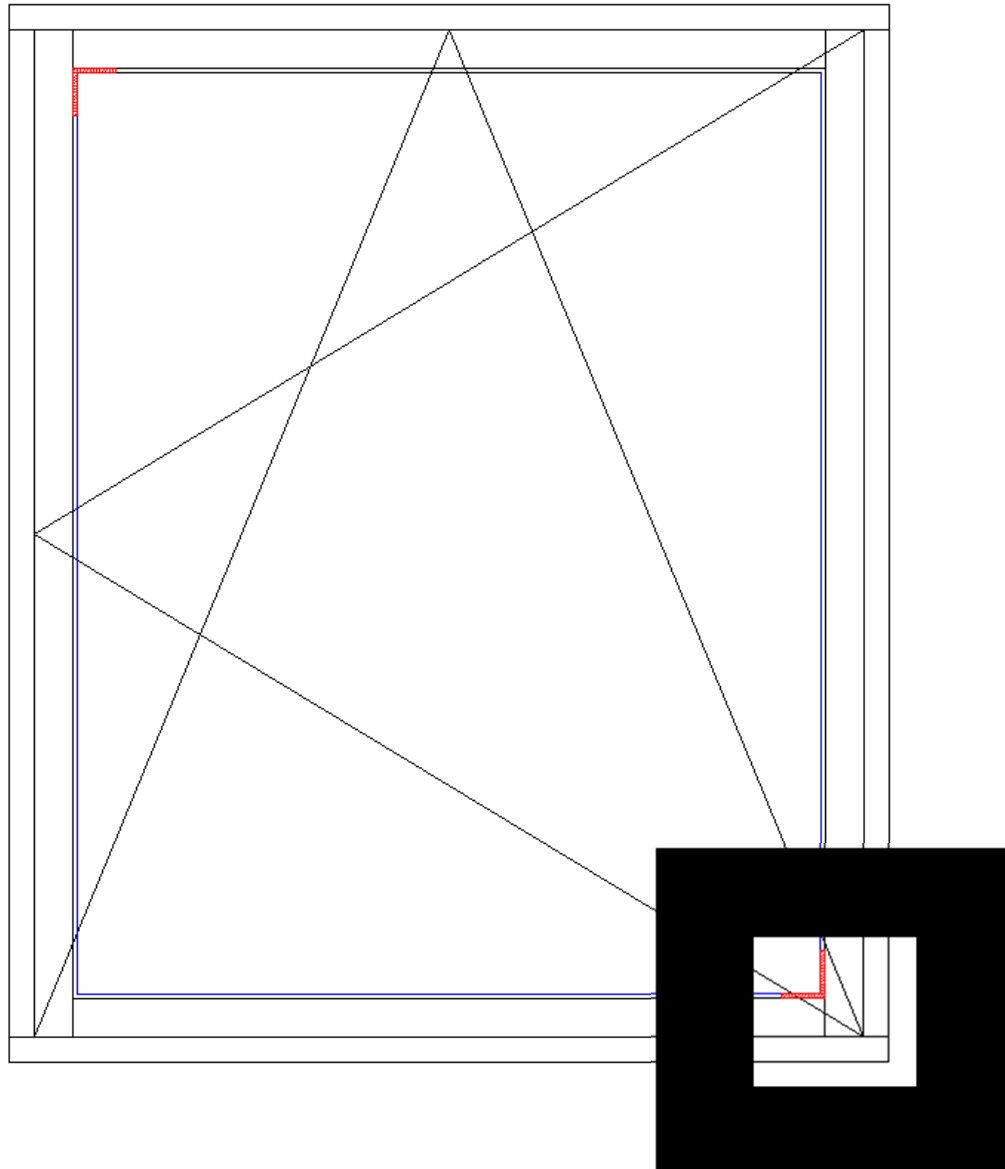


A lot better, but not fully optimized

=> Fully separated static and insulation layers could be the key towards phA+



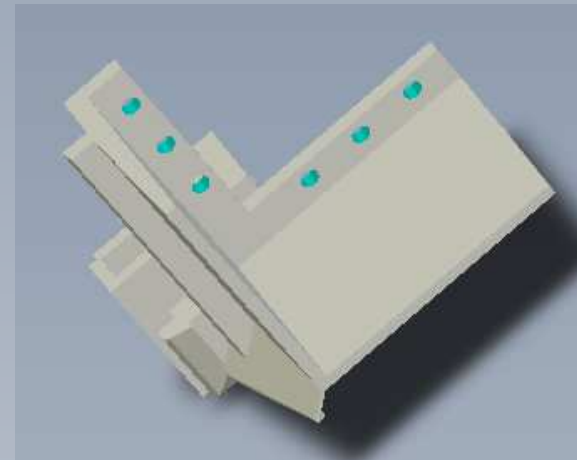
# Static in window sashes, how does it work?



Section at the glazing

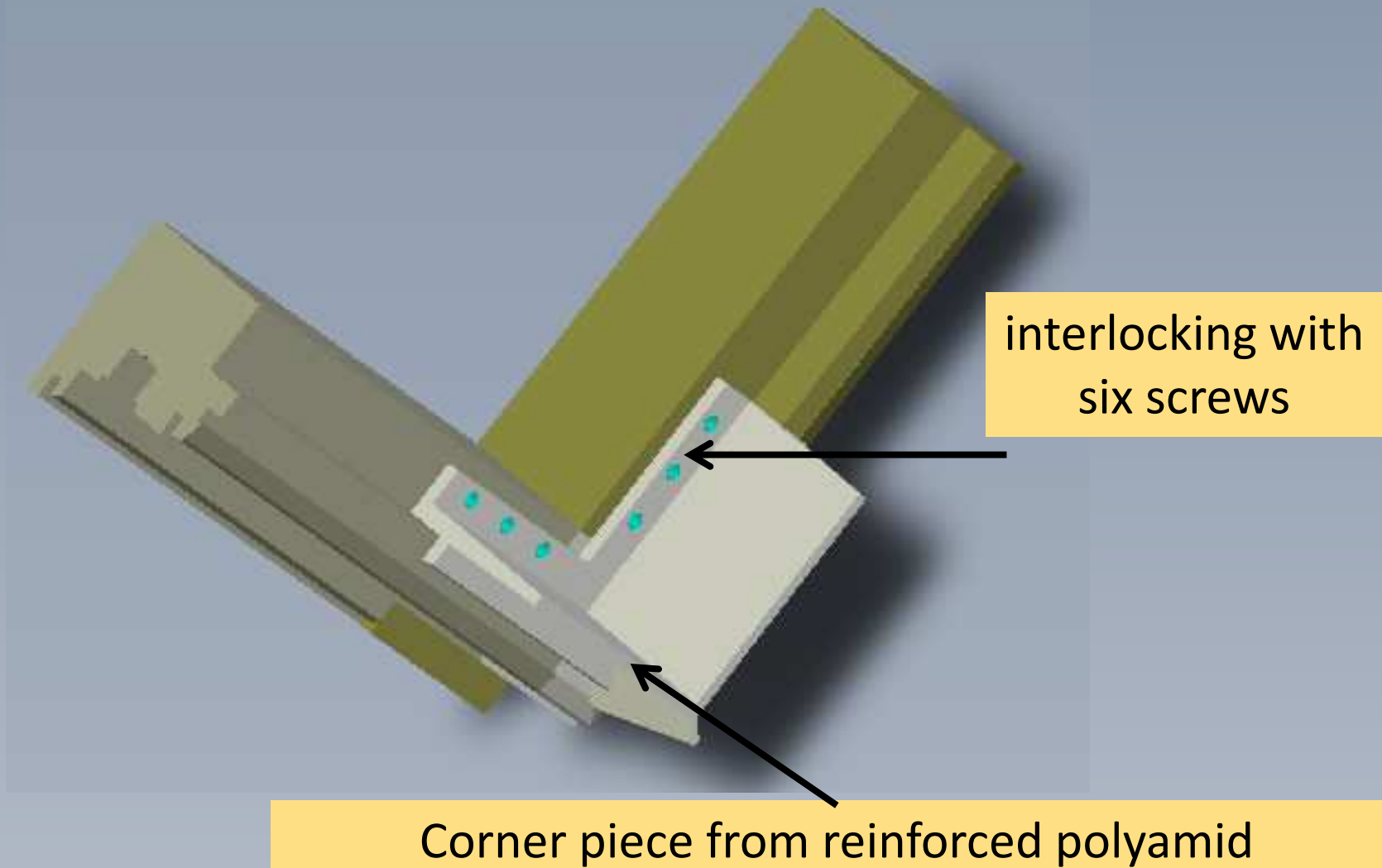
=> 100% of the weight is supported at the corner

# Put the load over the corner piece to the hinge

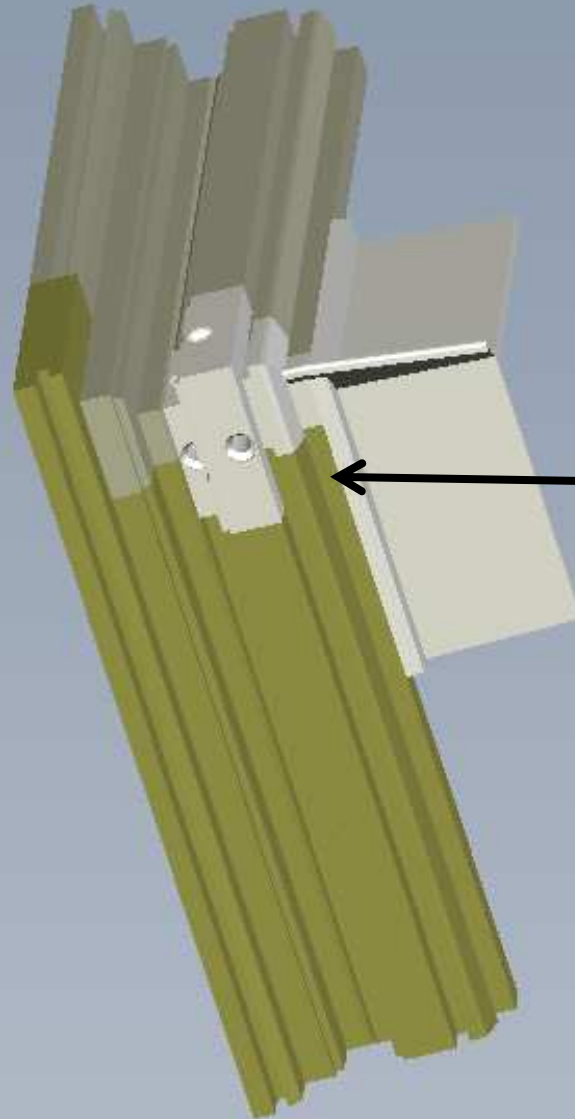




Put the load over the corner piece to the hinge



Put the load over the corner piece to the hinge



Structural „slot and pin“  
connection integrated

=> weight of pane goes  
directly to the hinge

polyamid

# The KISS formula for the new sash

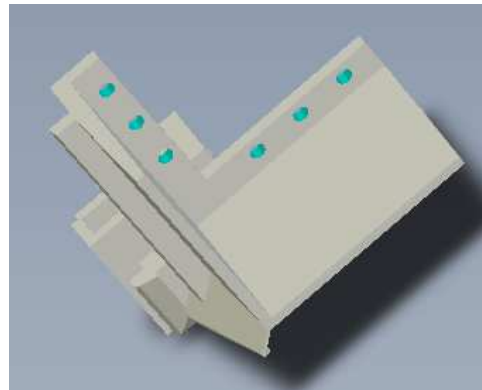


4 wooden laths + 4 corner pieces + 1 pane =  
1 completely new window sash

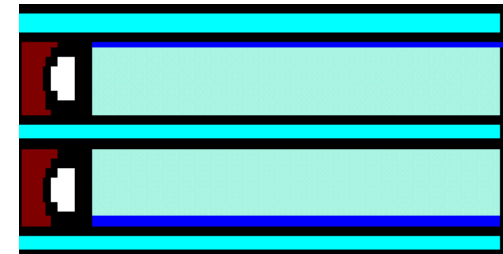
=> static interior – insulation in the middle and continues through in one layer



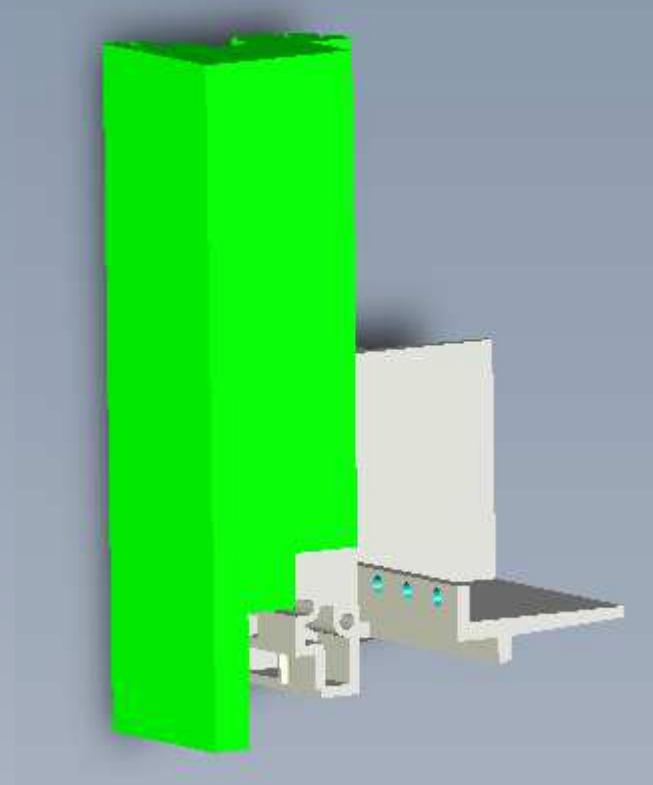
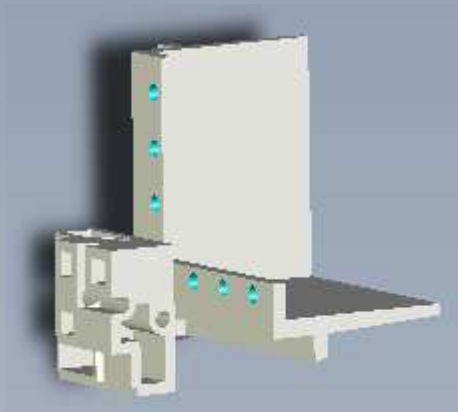
+



+



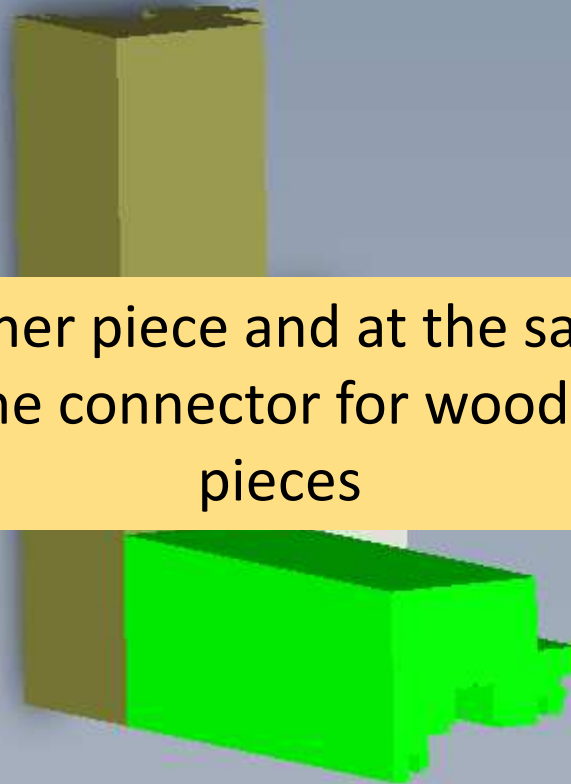
... let's do like this



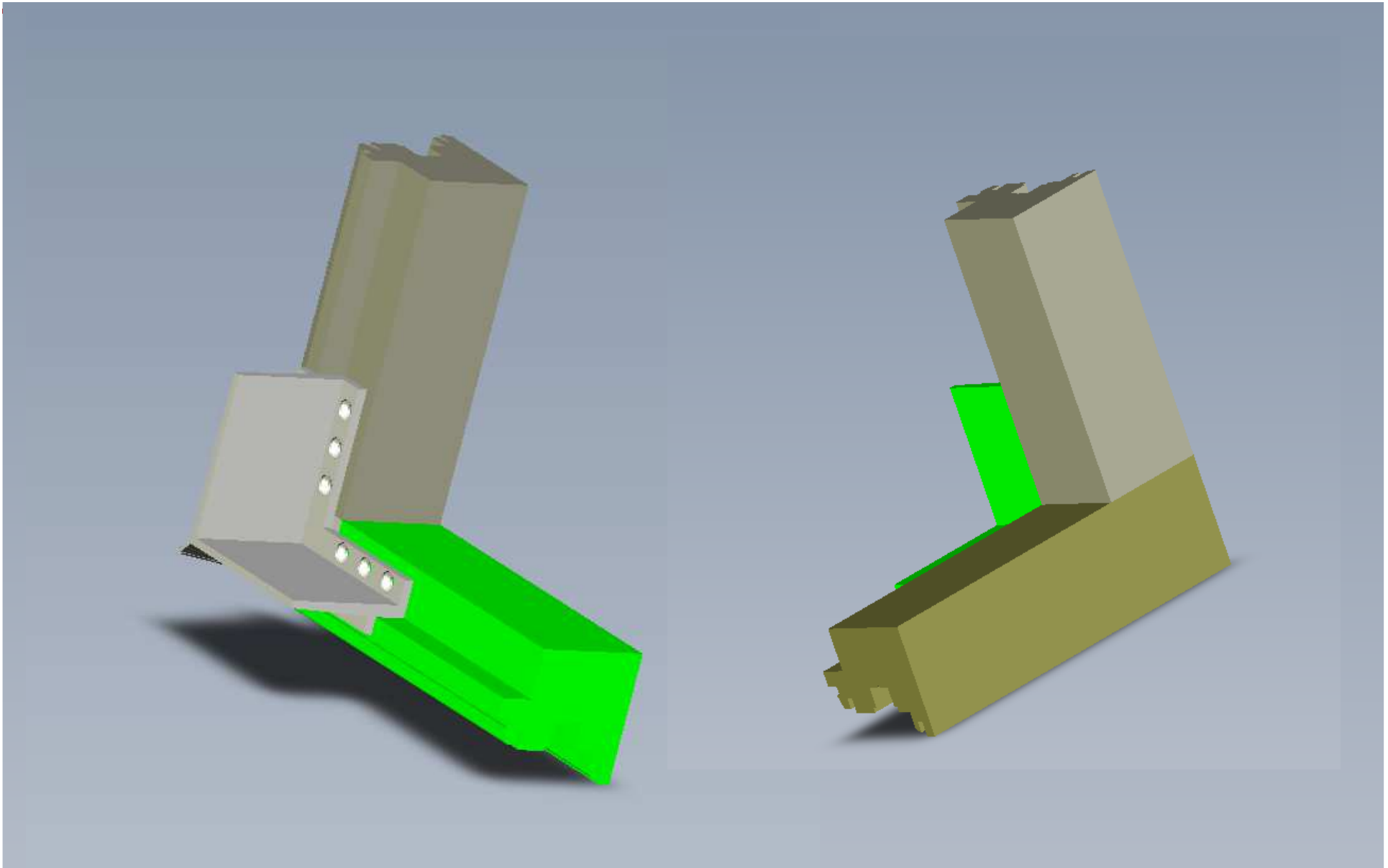
... let's do like this



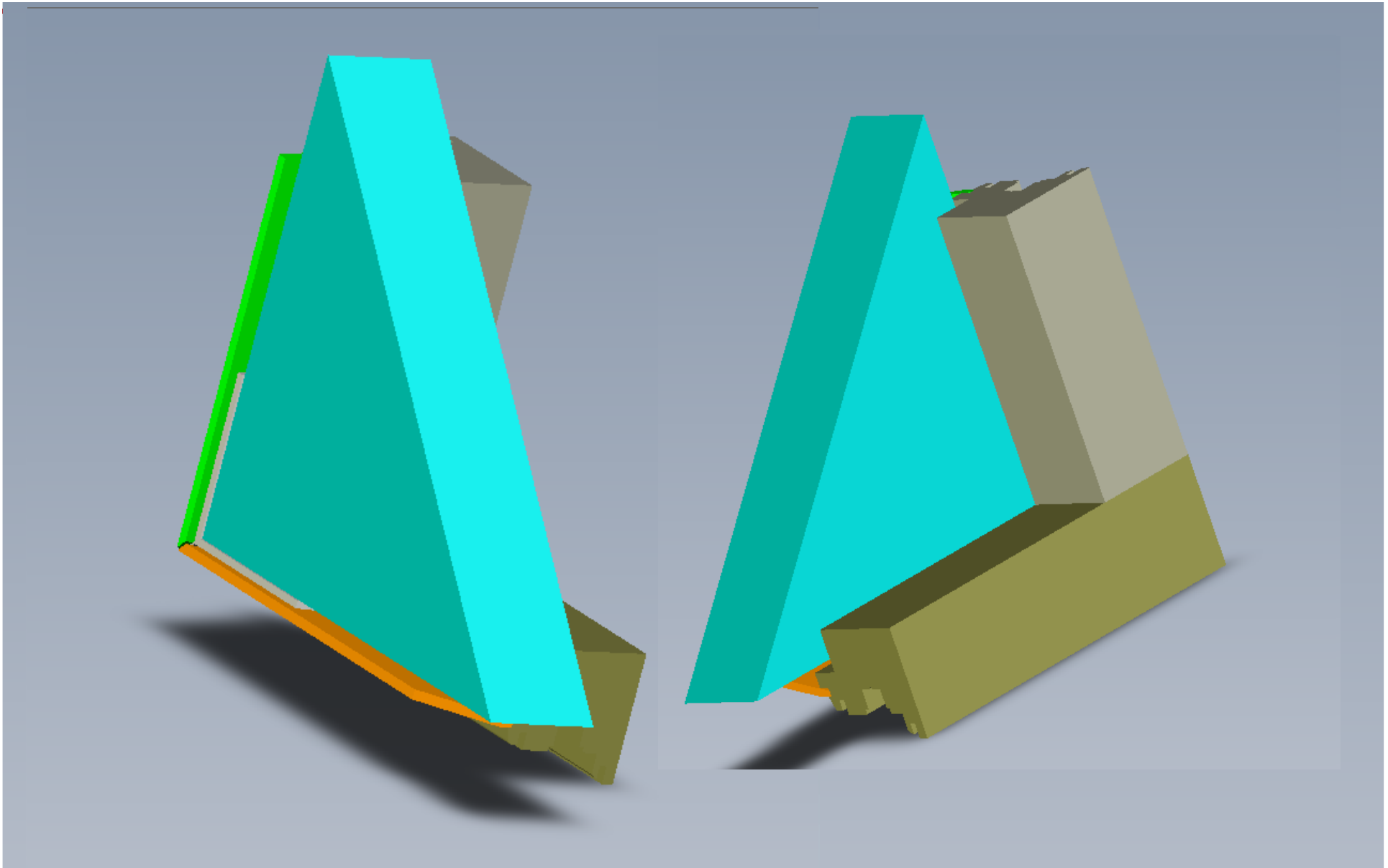
Corner piece and at the same  
time connector for wooden  
pieces



... let's do like this



... let's do like this

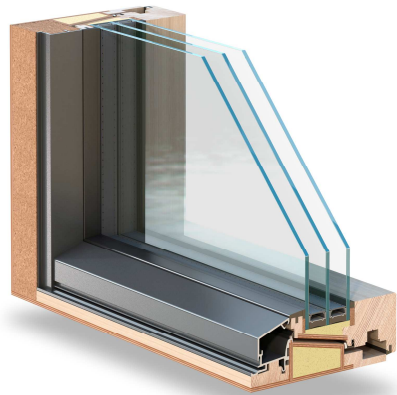


# The thermal facts

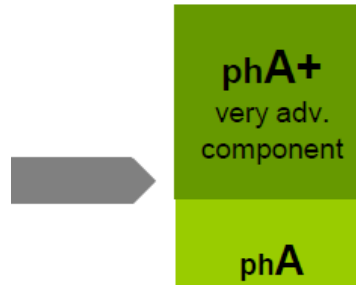


## Certificate

**Certified Passive House Component**  
for cold climates; valid until 31.12.2015



### Passive House Efficiency Class



## Certificate

**Certified Passive House Component**  
for cold climates; valid until 31.12.2015

Category: **Window Frame**  
Manufacturer: **pro Passivhausfenster**  
**83080 Oberaudorf, GERMANY**  
Product name: **smartwin arctic**

This certificate was awarded based on the following criteria:

Given a  $U_g$  value of  $0.520 \text{ W/(m}^2\text{K)}$  and a window size of  $1.23 \text{ m}$  by  $1.48 \text{ m}$ ,

$$U_w = 0.60 \text{ W/(m}^2\text{K)} \leq 0.60 \text{ W/(m}^2\text{K)}$$

Taking into account the installation based thermal bridges and provided that the installation is, with regard to the thermal bridges, equal or better than shown in the data sheet, the window meets the following criterion.

$$U_{w, \text{installed}} \leq 0.65 \text{ W/(m}^2\text{K)}$$

### Thermal data

|          | $U_f$ -value<br>[W/(m <sup>2</sup> K)] | Width<br>[mm] | $\Psi_g$<br>[W/(mK)] | $f_{Rsi=0.25}$<br>[-] |
|----------|----------------------------------------|---------------|----------------------|-----------------------|
| Spacer   |                                        |               | SWISSP. Ultimate PU* |                       |
| Bottom   | 0.72                                   | 58            | 0.021                | 0.76                  |
| Side/top | 0.64                                   | 58            | 0.021                |                       |

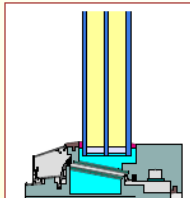
\*Spacers of lower thermal quality, especially those made of aluminium, lead to significantly higher thermal losses and lower temperature factors.

For further information, please see the data sheet

[www.passivehouse.com](http://www.passivehouse.com)

0632wi02

Passive House Institute  
Dr. Wolfgang Feist  
64283 Darmstadt  
GERMANY



### Passive House Efficiency Class

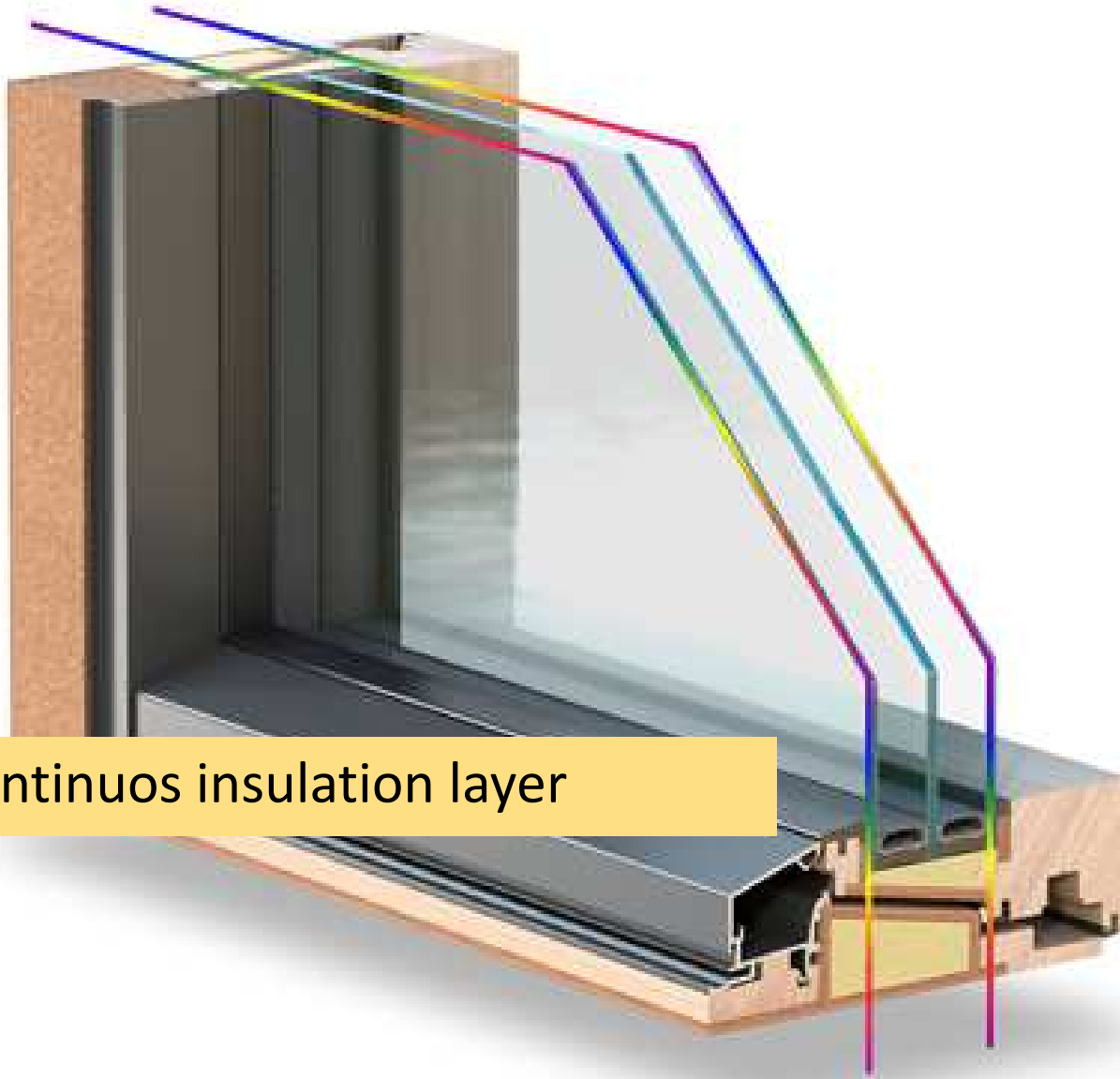


**CERTIFIED COMPONENT**

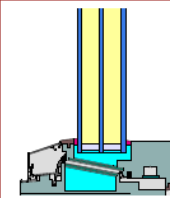
Passive House Institute



# The thermal facts



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GERMANY



Passive House  
Efficiency Class

phA+  
very adv.  
component

phA  
advanced  
component

phB  
basic  
component

phC  
certifiable  
component

not suitable  
for Passive  
Houses

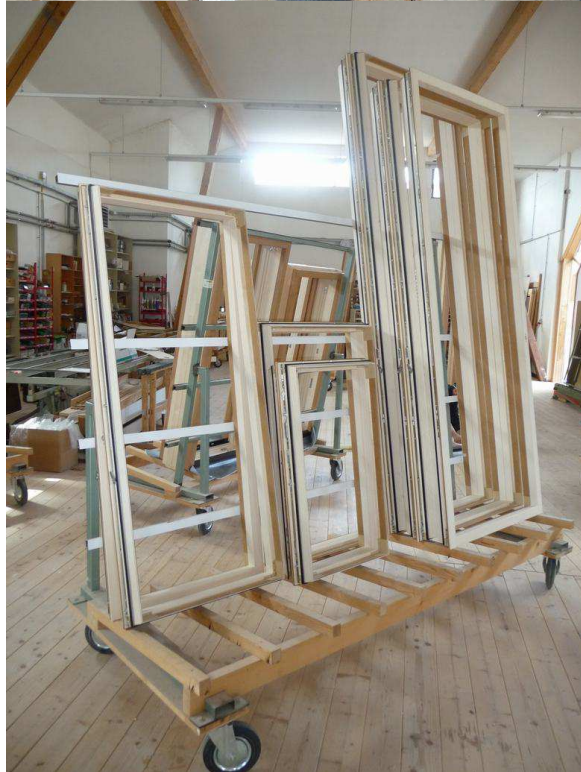


CERTIFIED  
COMPONENT

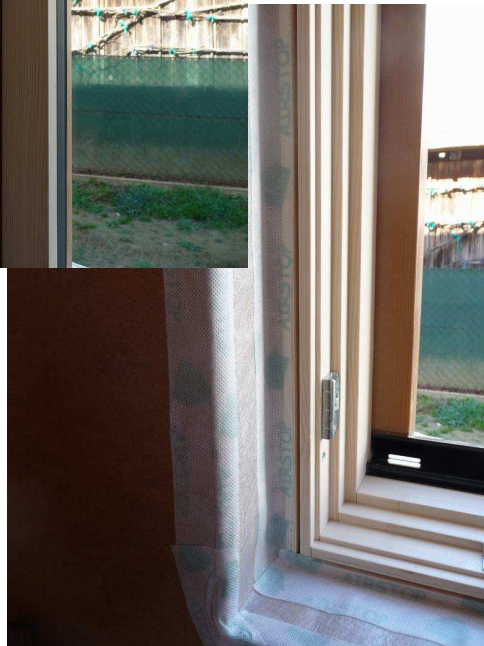
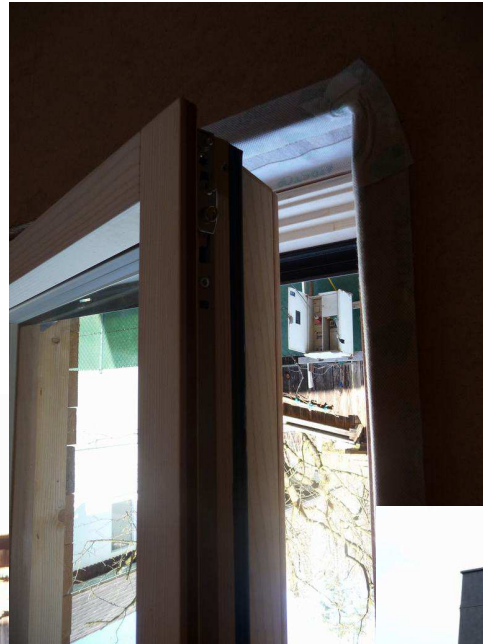
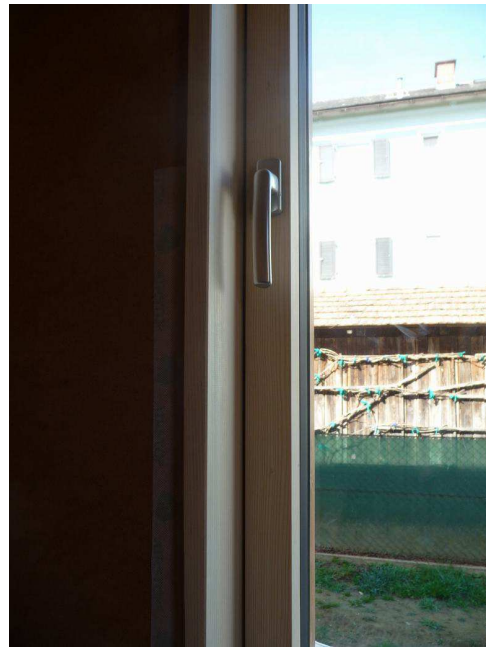
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vi02

# As promised the pilot project in time



# As promised the pilot project in time



# Benefits of the new window system for the future of Passive House



- even better aesthetics of the window with slim profiles
- now possible to build Passive House in cold climates
- allows more creativity for Passive House architecture
- Passive House Standard in the important section of retrofit is now easier to achieve
- more solar gains again because of smaller frames
- a further step to reduce building costs of Passive Houses
- significant reduction of the energy demand in the building sector

# PH windows as a key component

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Deep renovation with Passive House Windows  
of the newest generation - useful across the  
globe!

franz freundorfer passivhaus consulting

Thanks a lot for your interest on my  
presentation!