3rd QUALICHeCK

New data collection activity Belgium 2: Correctness of input data on window thermal performance

Results

Lien De Backer

Prof. Arnold Janssens

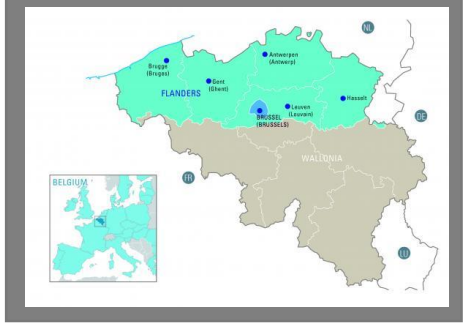
GHENT UNIVERSITY - DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING - BUILDING PHYSICS

Introduction

Legislation - U_w-value of the window - Goal

EPBD Regulations in Flanders

EPB legislation



Imposed requirements new buildings:

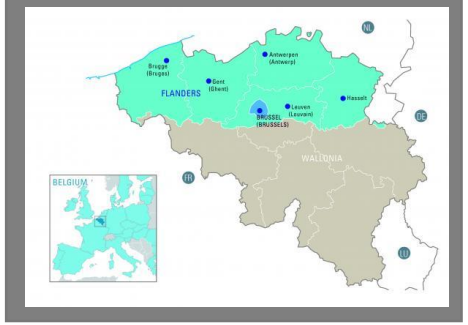
- Energy efficiency of the building
  - Insulation level
    - Individual building element → U_{max} or R_{min} value
    - Building as a whole → K_{max}
  - Energy *p*erformance of the building
    - Max energy performance → E_{max}-level
    - Max net heating demand
- Indoor climate demands
  - Summer comfort → Overheating Indicator
  - Air quality → Minimum ventilation

Introduction

Legislation - U_w-value of the window - Goal

EPBD Regulations in Flanders

EPB legislation



For each project:

- As-built performance reported by an ‘energy reporter’
- Through software provided by the Flemish Energy Agency (VEA).
- In case of non-compliance: fines

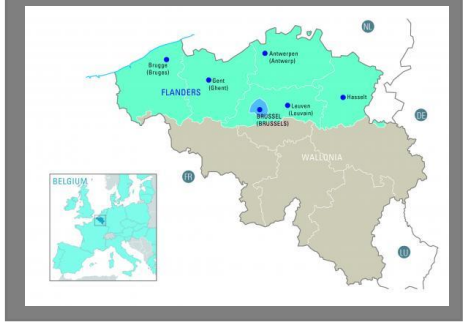
- Individual building element → U_{max} or R_{min} value
- Building as a whole → K_{max}
- Max energy performance → E_{max}-level
- Max net heating demand
- Overheating Indicator
- Minimum ventilation

Introduction

Legislation - U_w-value of the window - Goal

EPBD Regulations in Flanders

EPB legislation



Imposed requirements new buildings:

- Energy efficiency of the building
- Indoor climate demands

- The performance of components and systems may often be assessed by means of different methods:
  - Simplified method (easy input, conservative)
  - Detailed method (laborious, more accurate)
- Also the case for the thermal performance of windows
- Simplified method is often preferred by energy reporters, but:
  - Rather conservative, on the safe side
  - Energy performance may not be correctly assessed

Introduction

Legislation - U_w-value of the window (or door) - Goal

Calculation based on the effective geometry and properties of all the windows in the project

Method		Glazing and frame	Ventilation vent	Opaque panel
Detailed method:		$U_w = \frac{A_g U_g + A_f U_f + A_p U_p + A_r U_r + l_g \Psi_g + l_p \Psi_p}{A_g + A_f + A_p + A_r}$		
Simplified method:	Ug ≤ Uf	$(0.7U_g + 0.3U_f + 3\Psi_g)$	$+ \frac{\sum A_r(U_r - U_g)}{\sum A_{w,out}}$	$+ \frac{\sum A_p(U_p - U_g)}{\sum A_{w,out}}$
	Ug > Uf	$(0.8U_g + 0.2U_f + 3\Psi_g)$	$+ \frac{\sum A_r(U_r - U_f)}{\sum A_{w,out}}$	$+ \frac{\sum A_p(U_p - U_f)}{\sum A_{w,out}}$

$A_{w,out}$ the outside area of the window

Ψ = Psi-value [W/mK]
U = U-value [W/m²K]
A = Area [m²]
g = glazing
f = frame

Fixed area ratio between glazing and frame and fixed relative perimeter of spacers for all the windows in the project

Method

- 32 randomly selected projects: 1 office building, 22 single family houses and 9 apartments (311 windows in total). The project information was obtained after contacting architects, engineering offices and EPB-reporters.

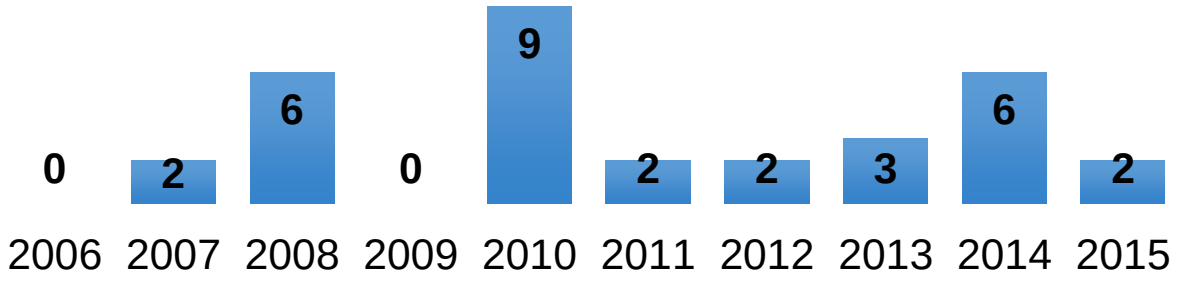
- U-value of all the windows was calculated by the following methods:
  1. Simplified calculation method, thermal characteristics of components default values
  2. Simplified calculation method, thermal characteristics of components provided by the manufacturers
  3. Detailed calculation, thermal characteristics of components provided by the manufacturers

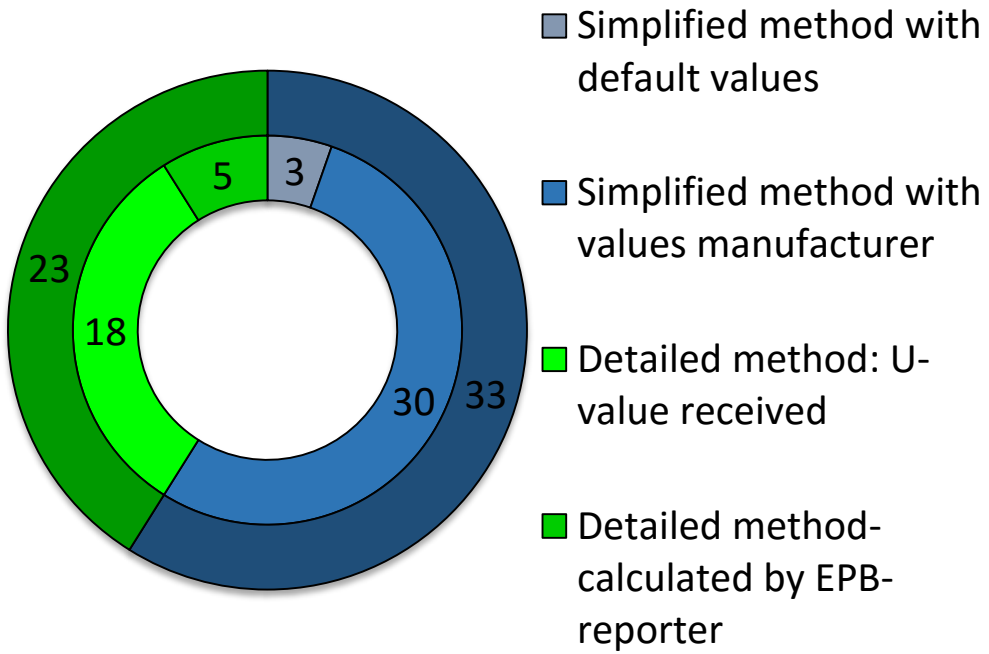
- Looked at:
  - Causes of deviations on the U-value
  - Influence of the U-value-calculation method on the K-level, the E-level, the net energy use for heating and the overheating indicator

Results

Used Method – Effect at building level – Reason: at component level

- Total epb-files (=projects) : 56
- In 41% (23/56): detailed method used
  - 5 performed by energy reporter
  - 18 provided by the manufacturer
  - More used in case building is “passive”
- In 59% (33/56): simplified method used Arguments were:
  - **No time** to measure the areas (study = fixes price)
  - **More safe**
  - Most of the time the **information** needed for the detailed calculation is **not provided** by the manufacturers. Consequently the simplified method is often used.”
- 32/56 were suitable to compare the different calculation methods (lacking information)

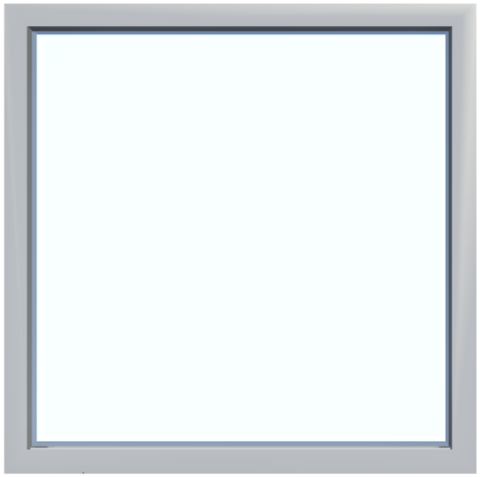


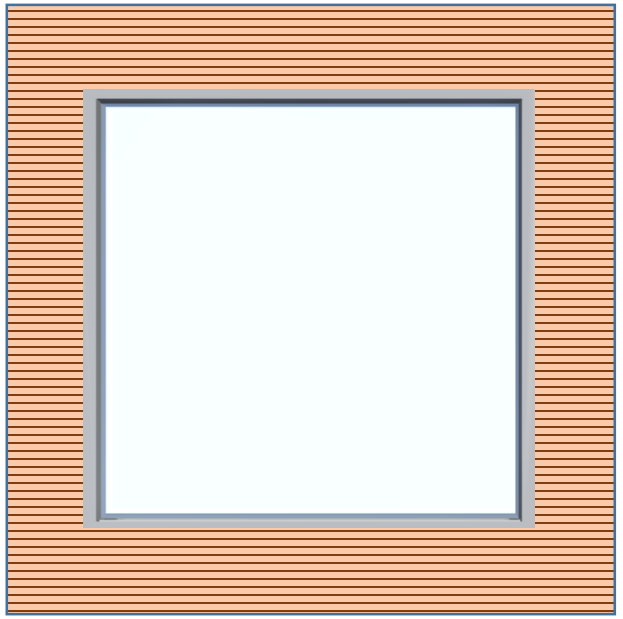


Results

Used Method – Effect at building level – Reason: at component level

- Total epb-files (=projects) : 56
- In 41% (23/56): detailed method used
- In 59% (33/56): simplified method used
- 32/56 were suitable to compare the different calculation methods (lacking information)
- 2/32 did not comply
- In 4/32 projects: window input data in software was not correct
  - Difference between outside window area used for the total building insulation level and the real window area used for the Uw-value
    => lower Uw-value
  - 1 /4 did not comply when correct data was used





Results

Used Method – Effect at building level – Reason: at component level

- When other window U-value calculation methods were applied than the ones used in the original EPB-reports:
  - 8 projects did not comply with the simplified method with default values,
  - 3 projects did not comply with the simplified method with manufacturer data
  - 2 projects did not comply with the detailed method

Results

Used Method – Effect at building level – Reason: at component level

- When other window U-value calculation methods were applied than the ones used in the original EPB-reports:
  - 8 projects did not comply with the simplified method with default values,
  - 3 projects did not comply with the simplified method with manufacturer data
    - non-compliance of the project was related to exceeding the maximum values for:
      - the K-level,
      - the E-level,
      - the net heating demand
      - or the weighted average U-value of the window
  - *2 projects did not comply with the detailed method*

Results

Used Method – Effect at building level – Reason: at component level

- When other window U-value calculation methods were applied than the ones used in the original EPB-reports:
  - 8 projects did not comply with the simplified method with default values,
  - 3 projects did not comply with the simplified method with manufacturer data
    - Non-compliance of the project was related to exceeding the maximum values for:
      - the K-level,
      - the E-level,
      - the net heating demand
      - or the weighted average U-value of the window
  - 2 projects did not comply with the detailed method:
    - Non-compliance was caused by a too high value of the overheating indicator

Results

Used Method – Effect at building level – Reason: at component level

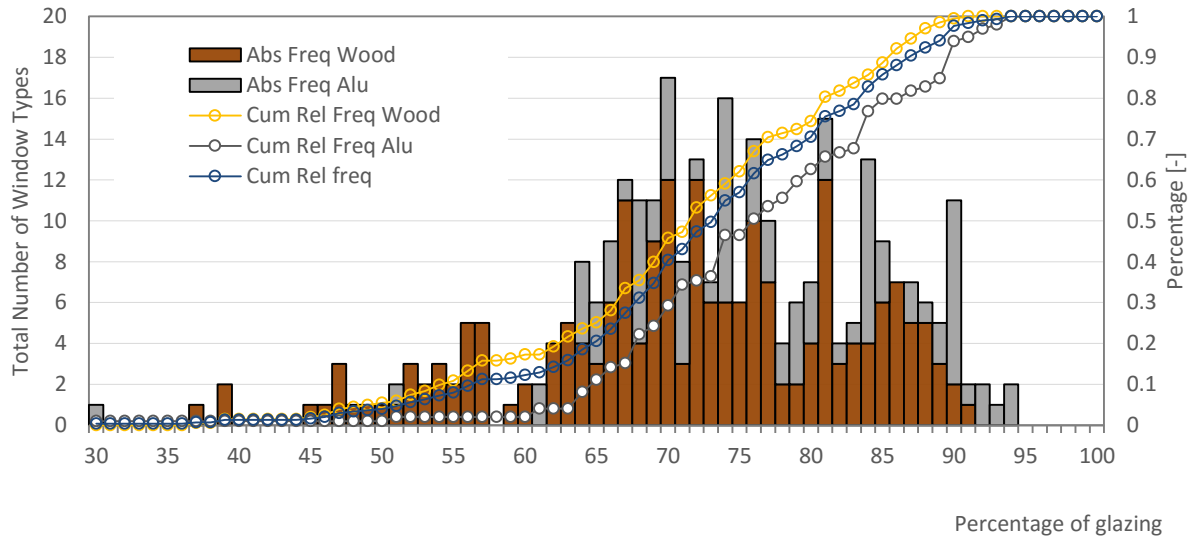
Cause ?

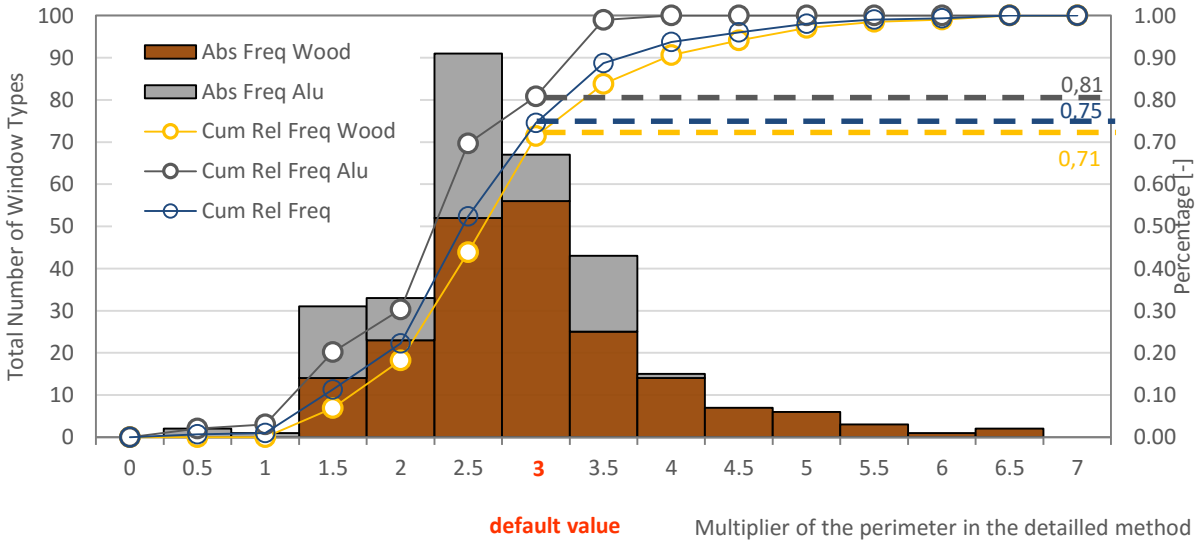
Results

Used Method –Effect at building level – Reason: at component level

U-value of the windows

- Simplified method with default values on the safe side (always higher)
- Simplified method with values manufacturers: may be too positive compared to reality (26%)
- Too positive values are related to real window geometry:
  - Glazing-frame area ratio (40% of 311 windows had a smaller glazing area⇨higher U_w)
  - Perimeter of spacer (25% of 311 windows had a larger relative glazing perimeter)





Results

Used Method –Effect at building level – Reason: at component level

Result for U-value of the windows

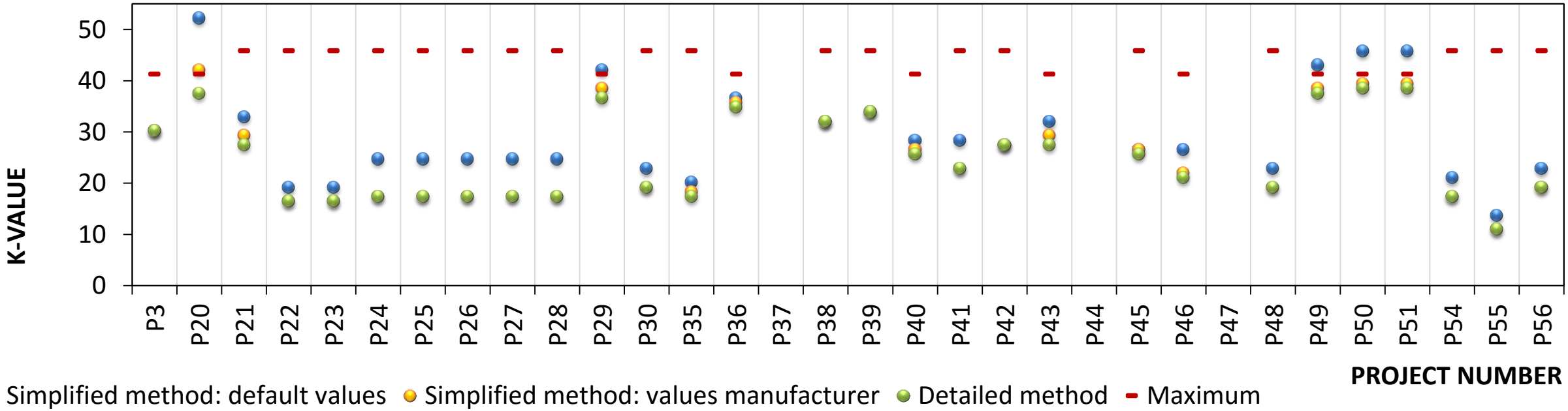
- In case:
  - Effective glazing area ratio is higher than fixed value, and
  - Relative length of spacer is smaller than the fixed value (majority of windows):
- Results in:
  - Reduction of net heating demand
  - Increase of net cooling demand and overheating indicator
  - Consequently:
    - Transmission heat loss is reduced (lower window U-values)
    - Solar gains increase (higher effective glazing area)

Results

Used Method –Effect at building level – Reason: at component level

K-value

- The K-value of a building is directly related to the weighted average U-value of the windows.
- As a consequence:
  - Increase (decrease) of weighted average U-value
  - Increase (decrease) of K-value.



Results

Used Method –Effect at building level – Reason: at component level

E-level

- E-level calculated by dividing the characteristic annual primary energy use by a reference value based on the heat loss area and heat loss volume
- Characteristic annual primary energy use calculated by:

$$E_{char\ ann\ prim\ en\ cons} = \sum_{m=1}^{12} E_{p,heat,m} + E_{p,cool,m} + E_{p,water,m} + E_{p,aux,m} - E_{p,pv,m} - E_{p,cogen,m}$$

- $E_{p,heat,m}$: by heating
- $E_{p,cool,m}$: by cooling
- $E_{p,water,m}$: domestic hot water
- $E_{p,aux,m}$: auxiliaries
- $E_{p,pv,m}$: solar panels
- $E_{p,cogen,m}$: cogeneration

Results

Used Method –Effect at building level – Reason: at component level

E-level

- E level calculated by dividing the characteristic annual primary energy use by a reference value based on the heat loss area and heat loss volume
- Characteristic annual primary energy use calculate by:

Detailed method: Decreases due to lower U_w-average

$$E_{char\ ann\ prim\ en\ cons} = \sum_{m=1}^{12} E_{p,heat,m} + E_{p,cool,m} + E_{p,water,m} + E_{p,aux,m} - E_{p,pv,m} - E_{p,cogen,m}$$

Detailed method: Increases due to lower U_w and (in some cases) higher glazing percentage

Recommendations

I. Adjust the fixed values in the simplified calculation method

A. Relative length of the spacer
   - Value of 3 m/m² is representative for the higher quartile of the windows investigated
   - May be maintained as a conservative value.

B. The glazing area ratio
   - Not possible to define a fixed value which leads to a conservative estimate of all performance figures:
     - Conservative estimate of the U-value of window: lower than average value of the glazing area ratio
     - Conservative estimate of the overheating indicator: higher than average value should be used
   - It seems best to select the median value of the windows investigated:
     - 76% for aluminium windows,
     - 71% for wooden windows

Recommendations

II. Detailed calculation method may be facilitated by the manufacturers

- Manufacturers have detailed information on window geometry and component thermal characteristics of the windows
- Could, with a minimum effort, label each window they produce with correct window U-value calculated according to the detailed calculation method
- Will reduce work load of the EPB-reporter for a correct window performance evaluation

Co-funded by the Intelligent Energy Europe
Programme of the European Union