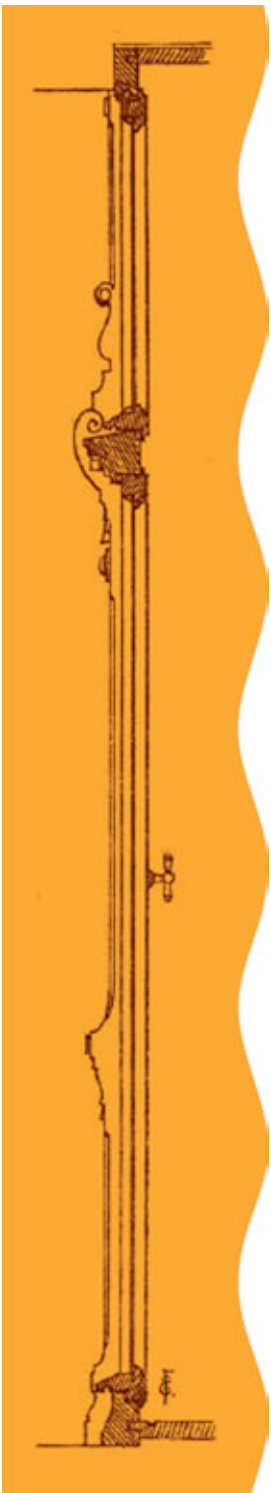


Dr. Zsuzsa Szalay, UCD Energy Research Group

The Energy Performance of Old Windows



16 April 2010, New4Old workshop Dublin



Intelligent Energy  Europe



Introduction

Europe can be proud
of the large number
of historic buildings
across its countries

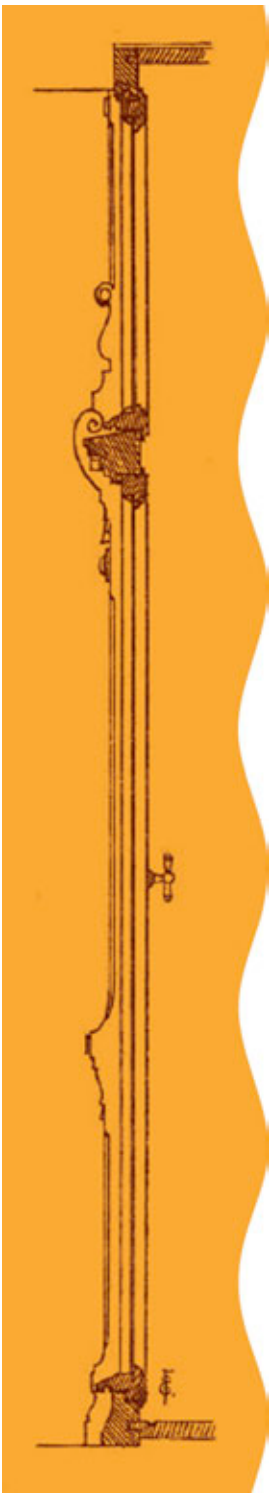
... but these buildings
gobble up large
amounts of energy

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Old windows...

- are 'weak points' from a building energetic point of view
- have a high thermal transmittance value (U-value)
- are not airtight
- are prone to condensation
- cause discomfort in users positioned near the window
- can lead to overheating





Survey by the Scottish Civic Trust: in a randomly selected street in a conservation area 74 % of the properties had lost their original windows

...but old windows

- are characteristic features in the elevation
- are characteristic for the period
- have a high aesthetic value









Are they really so bad?

Historic windows

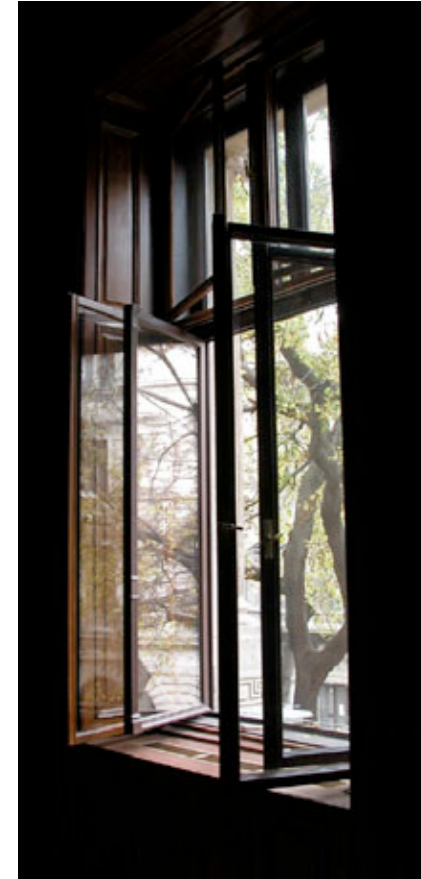
- were made of high quality wood by skilled joiners
- have proven their quality by surviving over centuries
- are easy to repair
- evolved over hundreds of years in response to the local climate and available techniques
- reduce the demand for new windows
- sash windows allow gentle and beneficial ventilation
- provide good lighting conditions



Regional characteristics



maritime climates

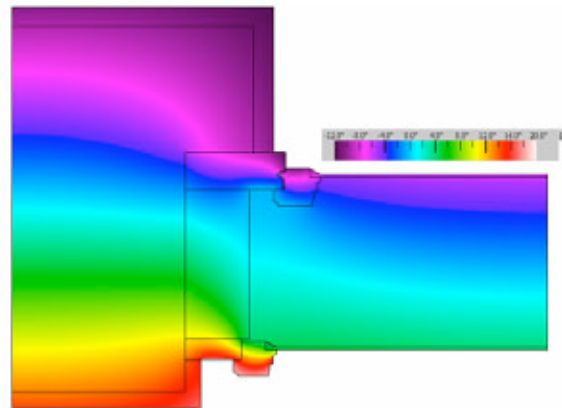
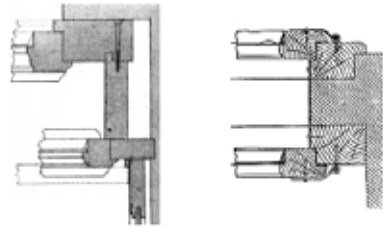


continental climate

Are they really so bad?

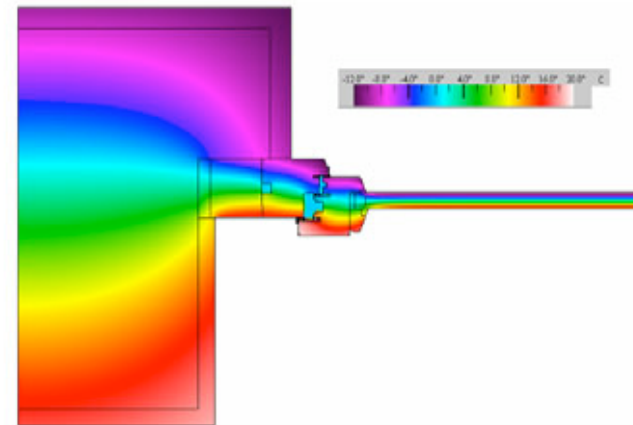
Box-type window

$$U_w = 2,2 - 2,5 \text{ W/m}^2\text{K}$$



Double glazed window

$$U_w = 2,4 - 2,6 \text{ W/m}^2\text{K}$$

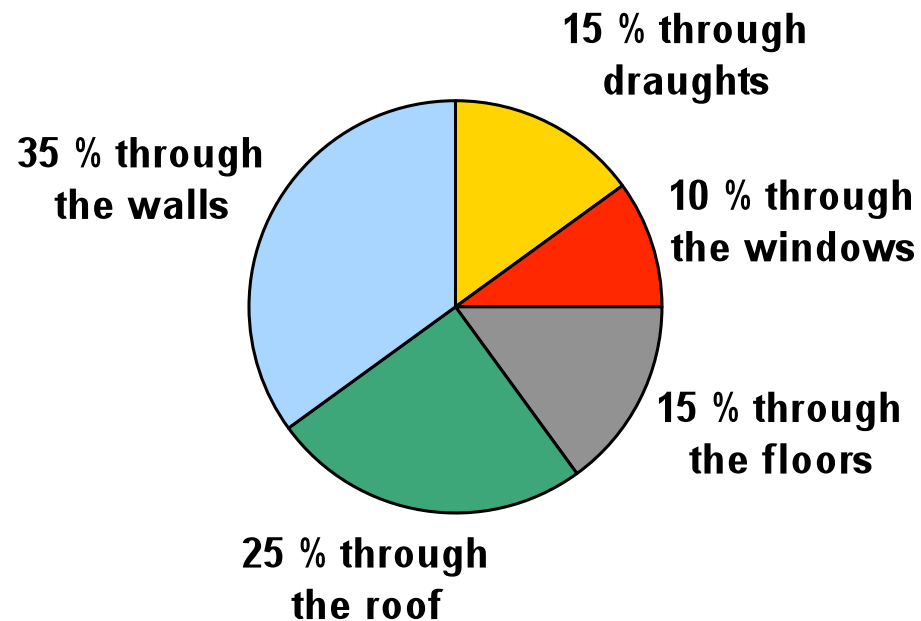


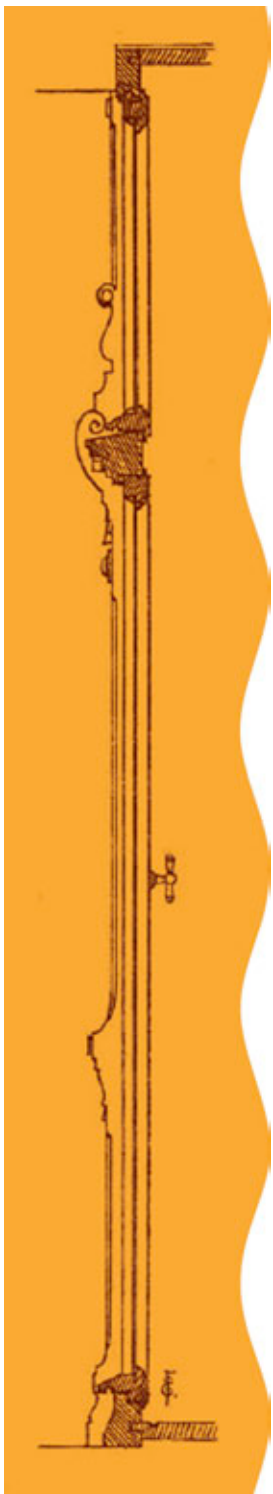
The thermal and acoustic properties of box-type windows are reasonable. Intelligent construction, re-invented in double facades.

Are they really so bad?

Single glazed windows
 $U_w \sim 4.6 \text{ W/m}^2\text{K}$

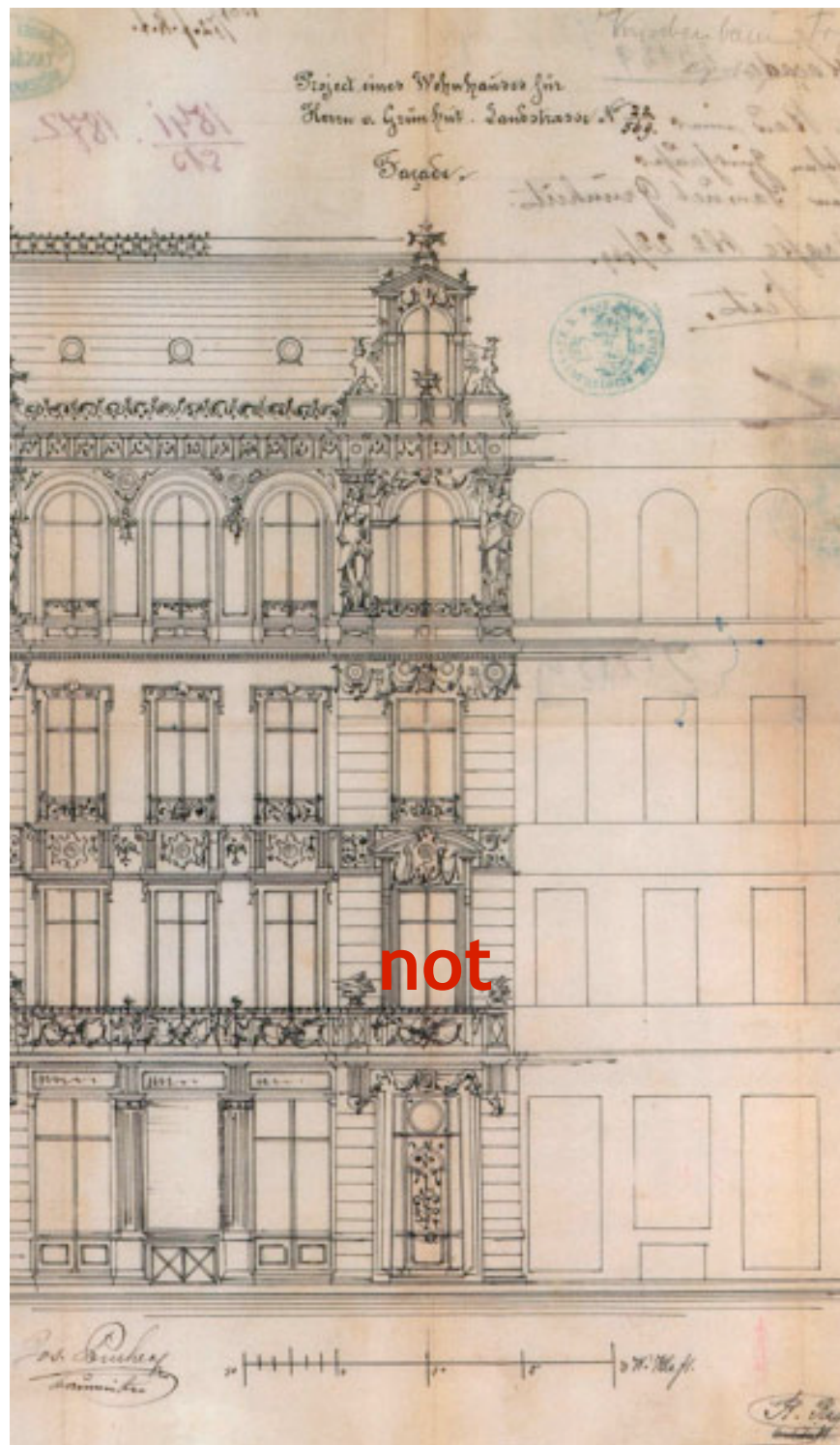
+ shutters
 $U_w \sim 1.8\text{-}2 \text{ W/m}^2\text{K}$





Restore

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replace

☒ Lőrinczi, 2008 ☒

Maintenance and repair

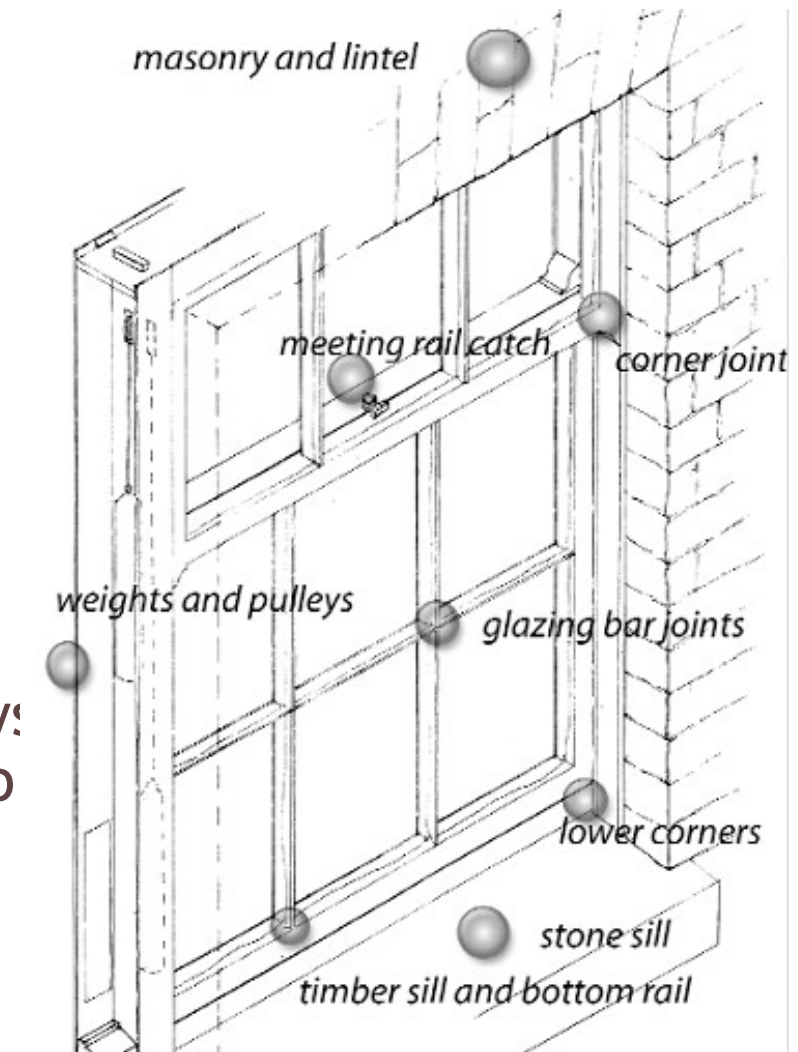


Most windows appear more damaged than they really are

Maintenance and repair

First physical inspection.

- paint and putty
- loose joints tightened
- decayed timber cut out and fitted with sound wood
- heavy to pull up or down: check weights, distorted timber
- if stuck: cord broken, pulleys need oiling or paint build-up
- replacement only if wide spread decay



Options for upgrade

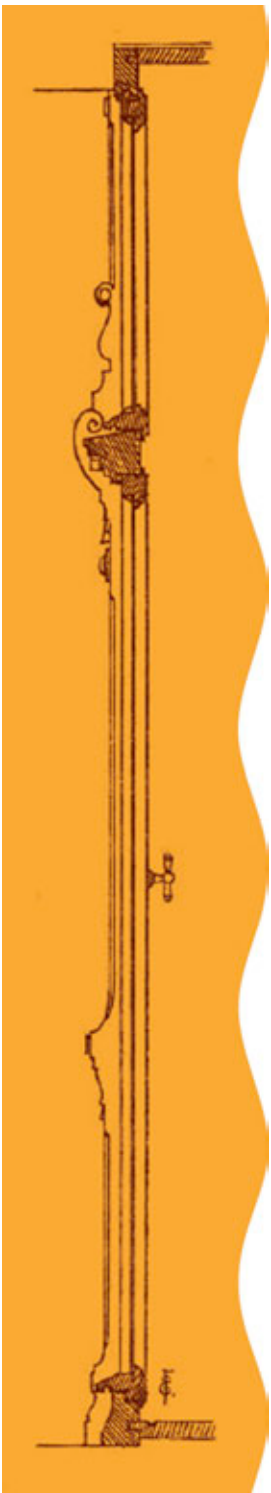
Shutters, blinds and curtains

Draught proofing

Secondary glazing

Integration of double glazing to the sash

Replacement windows

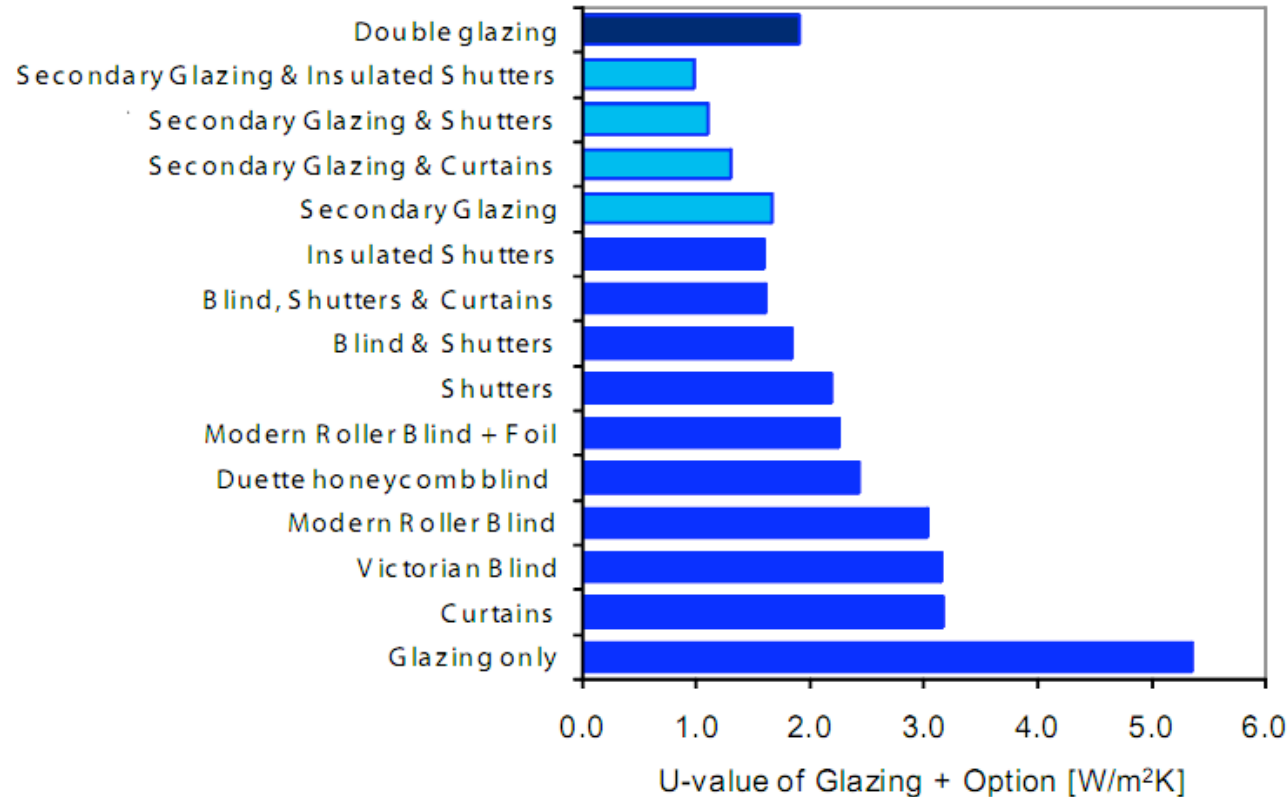


Shutters, blinds and curtains

- simple and cheap
- temporary solution at night
- the better the windows, the smaller the influence



Shutters, blinds and curtains



Measurements of the Glasgow Caledonian University (Historic Scotland window)

Shutters, blinds and curtains

TABLE 1: CONDUCTION HEAT LOSSES THROUGH THE GLASS AND WINDOW

DETAILS OF THE TEST ASSEMBLY	For glass only: Directly measured		Temperature of innermost surface (°C)	For glass & frame: Using FRAME model		COMMENTS
	U-value of glass (W/m²K)	Reduction in heat loss through glazing only		U-value of whole window, (W/m²K)	Reduction in heat loss through whole window	
Window as found	5.3	—	12 (glass)	4.3	—	
Joinery repaired	5.3	—	12 (glass)	4.3	—	This also reduced air infiltration by 34%
Heavy curtains	3.3	39%	21 (curtain)	2.5	41%	
Well-fitting shutters	2.0	64%	17 (shutter)	1.7	58%	
Plain roller blind	3.4	37%	18 (blind)	2.7	38%	When the blind was tightly fitted, the U-values fell by about 0.3
Reflective roller blind	1.8	66%	19 (blind)	1.9	57%	Reflective side facing towards the outside
Honeycomb blind	2.1	60%	20 (blind)	2.1	51%	Insulating blind
Low-emissivity secondary glazing	2.0	63%	19 (glass)	1.8	58%	Aluminium frame secondary system with spring balances
Low-emissivity secondary glazing and shutters	1.4	73%	20 (shutter)	1.6	62%	With both the glazing and the shutters closed

NB: the experimental error in the tests is equivalent to an uncertainty of ± 0.3 in the U-values above⁴

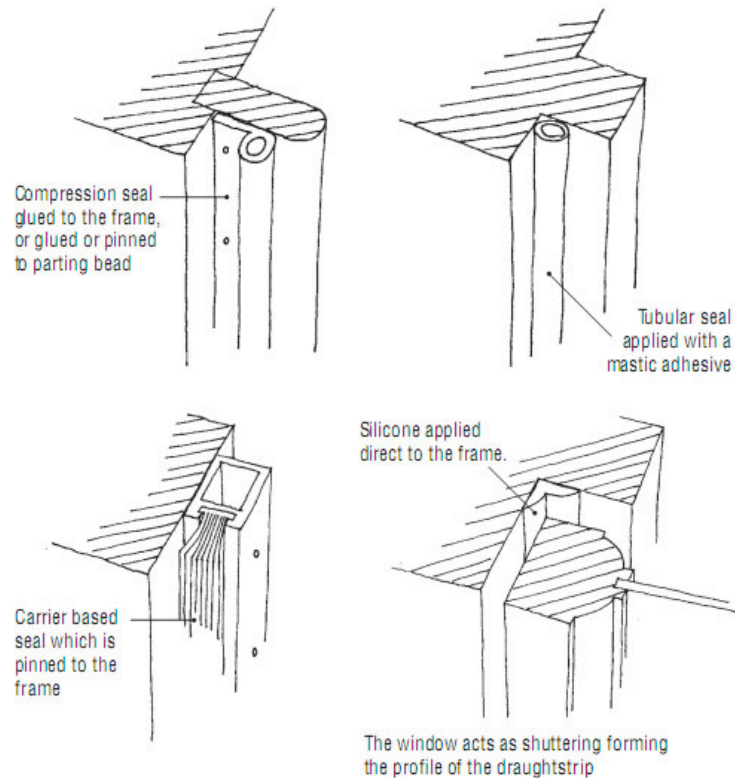
Draught proofing



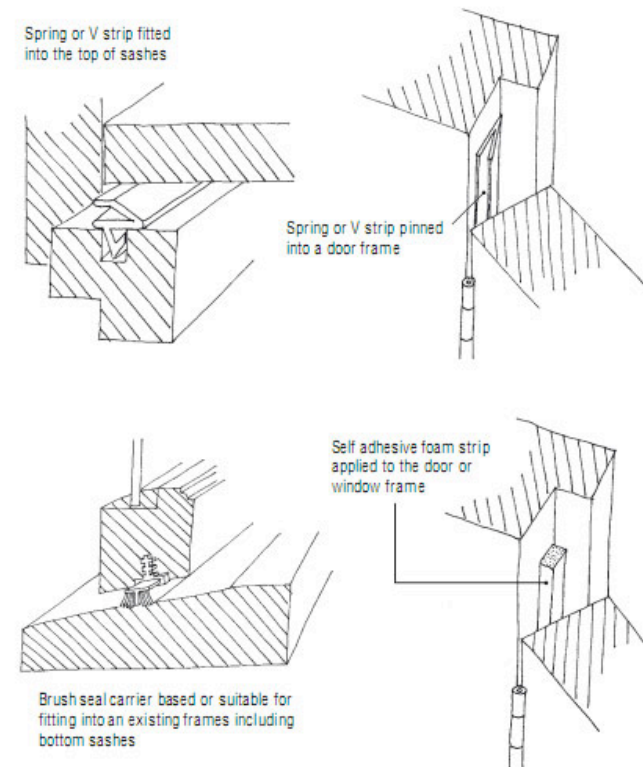
‘It is pitiful to see the extent to which women, and men too, allow themselves to be dominated by a little wind and a little weather... They must seal themselves up hermetically by weather-strips, and thus exclude the little sweetness that would make its way to them.’

Irish Builder, 1888 (DoEHLG, 2007)

Draught proofing



compression seals



low-friction seals

Draught proofing

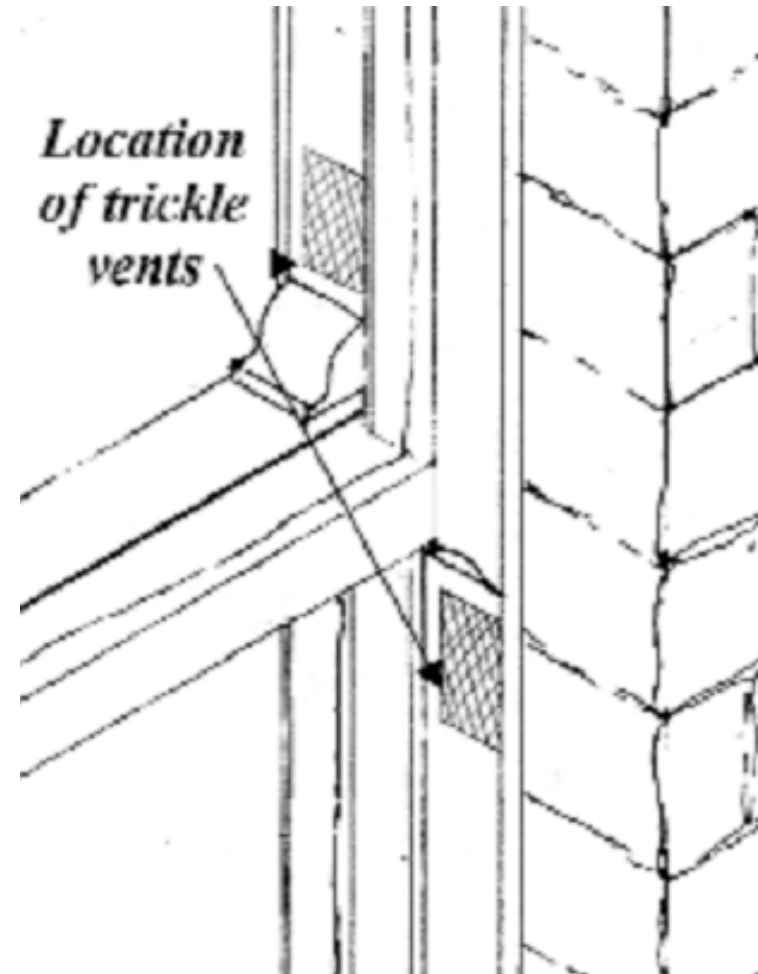
- Surface mounted systems: glued, pinned or screwed
- Integral systems: fitted into grooves
- life time 10-20 years
- if secondary glazing: the internal sash should be sealed, otherwise risk of condensation
- wall junction and shutter box should also be sealed

Relatively simple, but drastic reduction of infiltration losses. Improved thermal comfort and acoustics.



Draught proofing

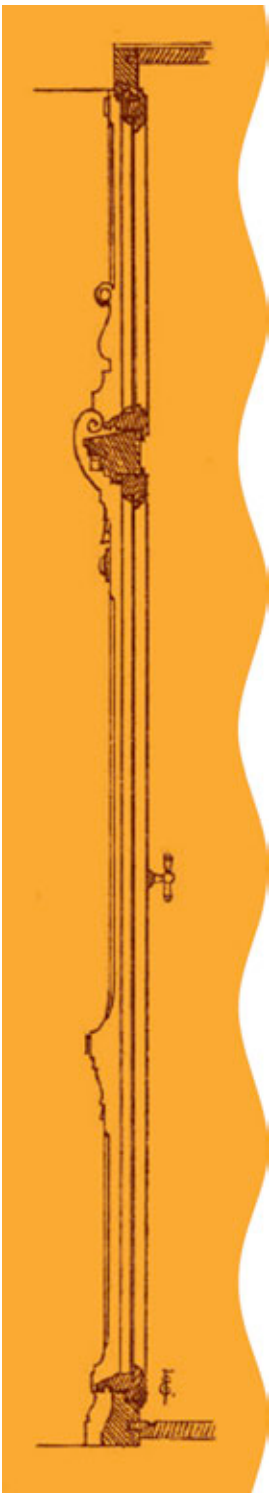
Alternative means of ventilation must be provided



Secondary glazing

19th century:

second pair of sash windows which drop down together into a pocket below the window, covered by a hinged extension of the window sill, fronted by an attractively moulded panel



Secondary glazing

- directly against the main window: Alu-frame, low-e glazing

$$U_w = 1.8-2.3 \text{ W/m}^2\text{K}$$



- own subframe: shutters affected, but can be double glazed

$$U_w = 1.2-1.4 \text{ W/m}^2\text{K}$$







Secondary glazing

- little visual difference
- should enable access to the original window
- permanent or temporary
- slide, tilt, open inwards
- double reflection: painting the spacer dark and avoiding the duplication of the external pane division
- the original window should not be draughtproofed



Double glazing of the existing frame

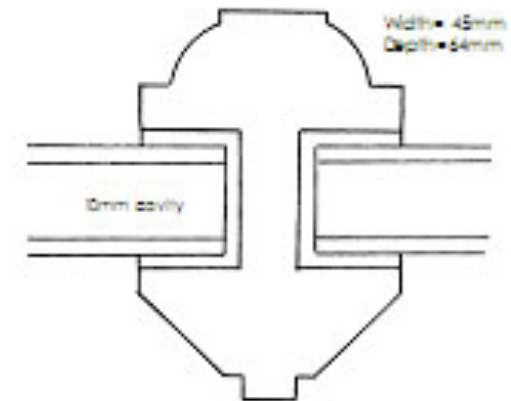
For sash windows generally not recommended

Problems:

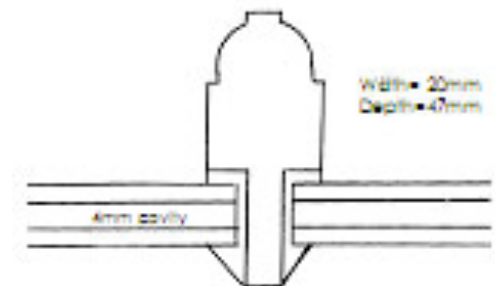
- glazing is heavier than historic glazing
- profiles are not wide enough

Slim-line double glazing:
space 4,6 or 10 mm, but less efficient

In one-over-one sash and casement windows the feasibility should be investigated in the actual case



Typical modern double glazing



Standard section with slim double glazed units



Typical early Georgian section with single glazing (The Barons, Reigate, 1721)

Double glazing of the existing frame



Box-type window, double
glazing in one sash:
 $U_w = 1.1-1.2 \text{ W/m}^2\text{K}$



Replacement windows

Only if the window is beyond repair.

Listed building:
like-for-like replacement

Issues with standard double glazing:

- stockier profiles
- 'false' glazing bars
- different opening mechanism

Listed building:
like-for-like replacement

Slim-line double glazing: allowed in certain cases, e.g. in Edinburgh in one-over-one sash windows in category 'C' listed buildings

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Casement window - innovation

- double glazing with low-e coating and krypton gas filling
- slim profiles (4-10-4)
- real glazing bars
- glazing sealed with an acrylic material that can be painted
- thermally decoupled glass spacer, colour can be adjusted to the frame

$$U_w = 1,5 \text{ W/m}^2\text{K}$$

In box-type window:

$$U_w = 1,1 \text{ W/m}^2\text{K}$$

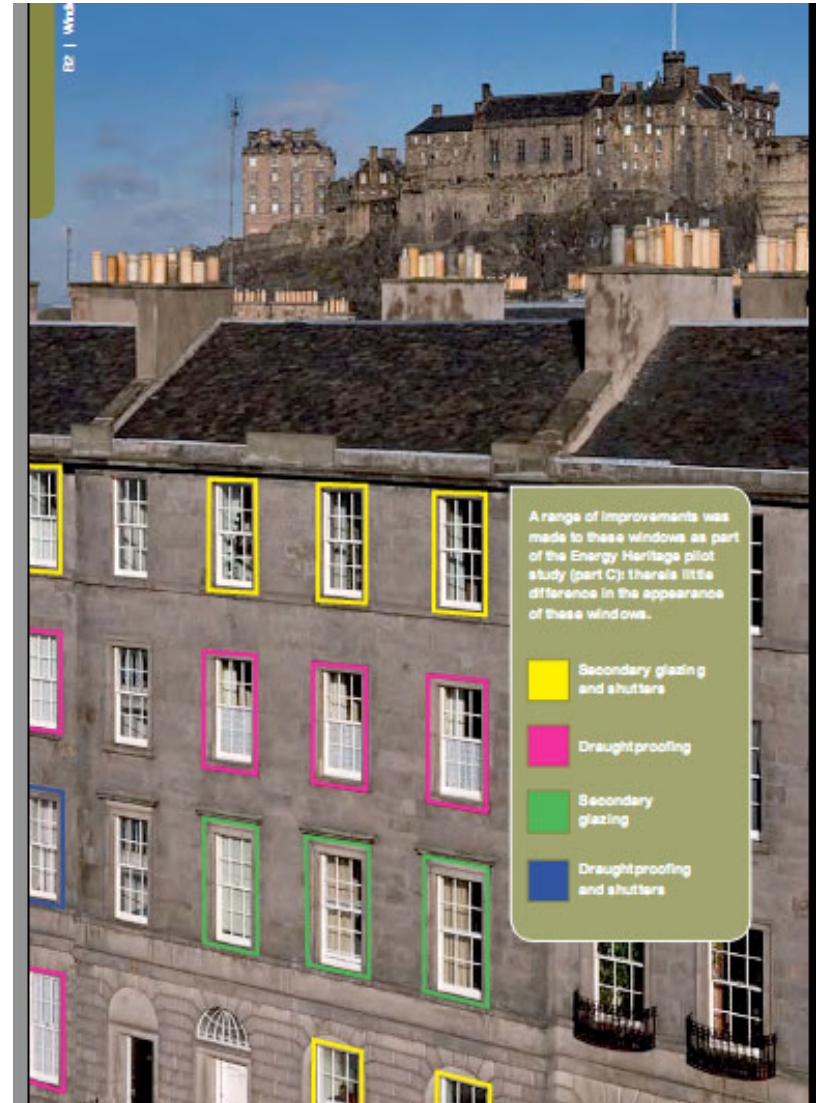


Edinburgh, Lauriston Place

‘B’ listed tenement building.
Retrofit in 2007-2008 by
Changeworks

Windows:

- secondary glazing in 5 flats
- draughtproofing in 4 flats
- shutter reinstatement



Edinburgh, Lauriston Place

Single glazing

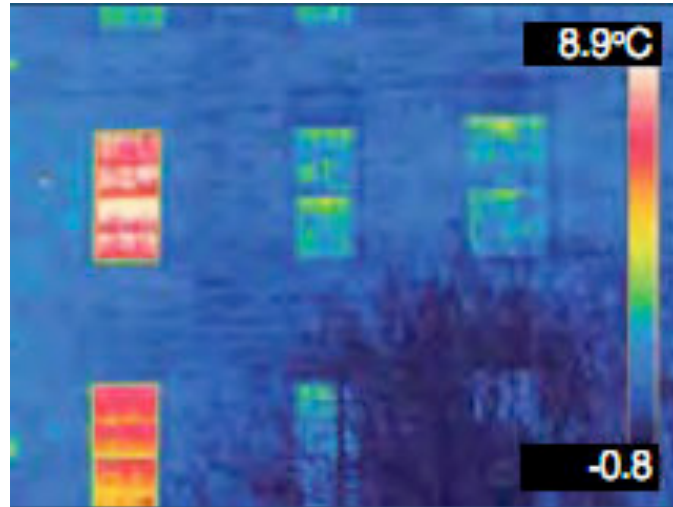
$$U_g = 5,5 \text{ W/m}^2\text{k}$$

+ secondary glazing

$$U_g = 2,3 \text{ W/m}^2\text{K}$$

+ shutters

$$U_g = 2,2 \text{ W/m}^2\text{K}$$



Renewable Energy House Brussels

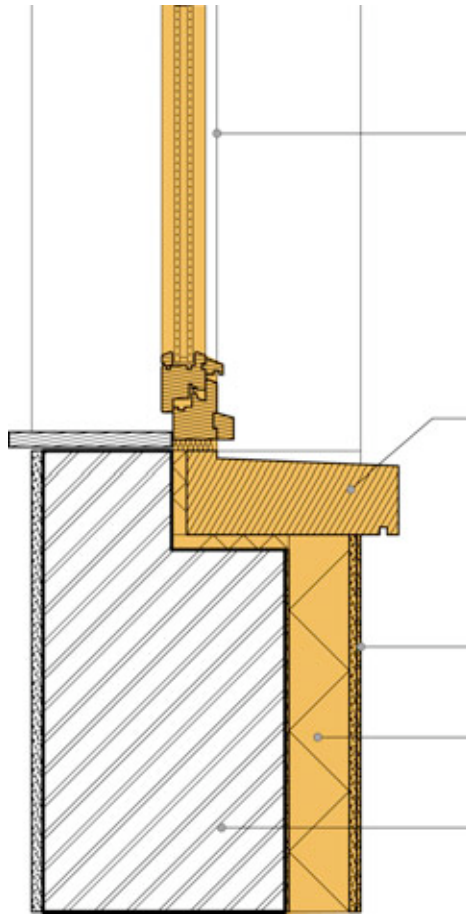


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Back façade

External insulation of the wall

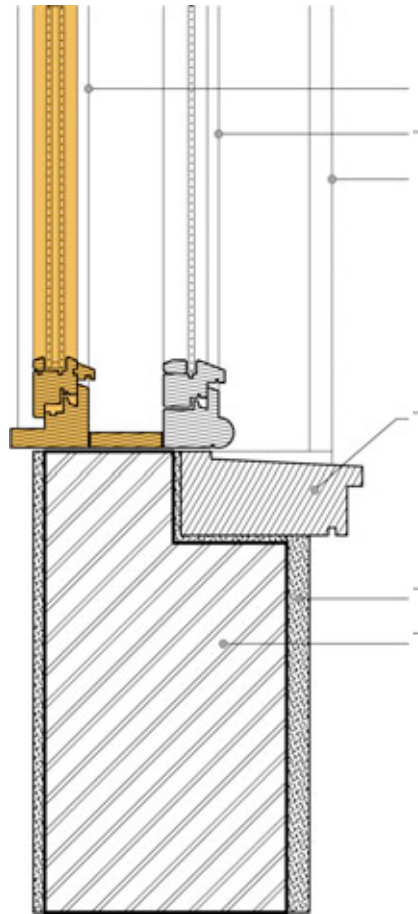
Change of windows: $U_w = 1,5 \text{ W/m}^2\text{K}$



Front façade

Single glazing + secondary glazing

$$U_w = 1,3 \text{ W/m}^2\text{K}$$



Renewable Energy House Brussels

www.erec.org



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Intelligent Energy  Europe

The goal of the New4Old project is to promote the integration of renewable energy and energy efficiency technologies into historic buildings.

Technical Guidelines:

- Part I: The Outside of the Building
 - Windows
- Part II: The Inside of the Building
- Part III: Regulation and Control

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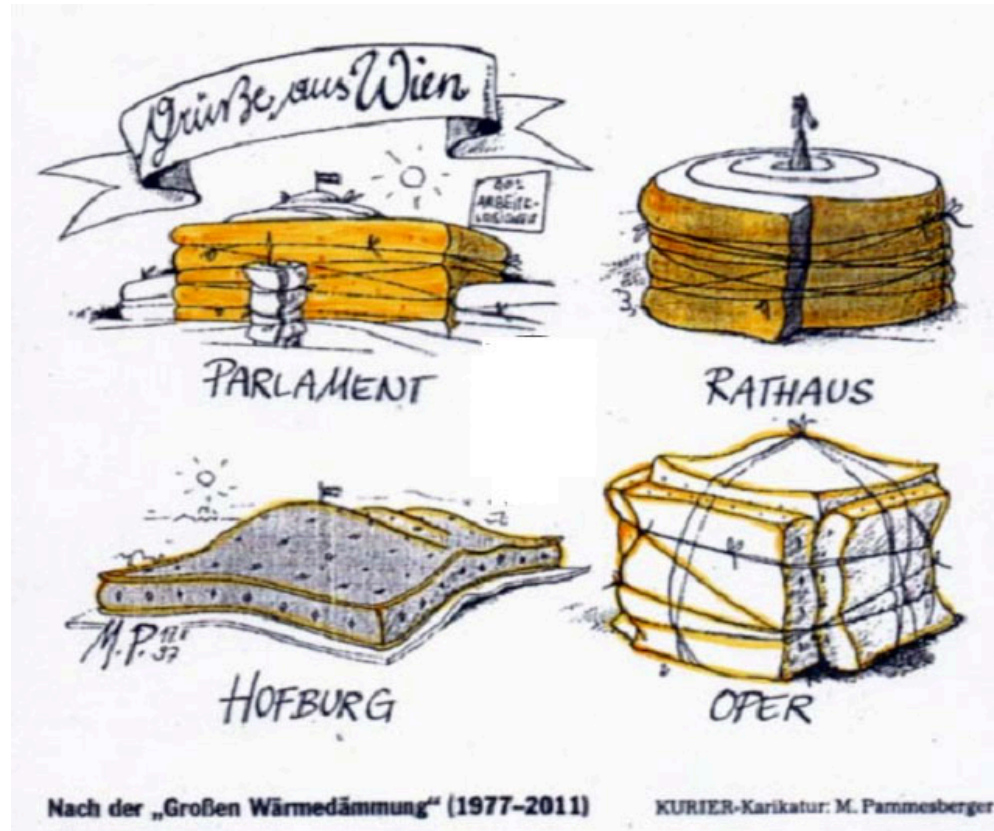
New4Old

www.new4old.eu

TECHNICAL GUIDELINES
FOR BUILDING DESIGNERS



After the „Big Insulation” (1977-2011)



Thank you for your attention
zsuzsa.szalay@ucd.ie

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