Polski Komitet Narodowy Międzynarodowej Rady Ochrony Zabytków ICOMOS

FONDAZIONE ROMUALDO DEL BIANCO

SAPIENZA UNIVERSITÀ DI ROMA

POLITECHNIKA LUBELSKA

UNIVERSIDAD POLITÉCNICA MADRID

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

FONDAZIONE FLAMINIA PER L'UNIVERSITÀ IN ROMAGNA

Sustainable Urban Rehabilitation in Europe

LECTURE 6
ENERGY EFFICIENCY FOR HISTORIC BUILDINGS

OVERALL AIM:
Gaining knowledge on solutions to overcome barriers for the regeneration and the retrofit of existing buildings

Erasmus+

Contents of the lecture

Facts and figures

General principles

Whole building approach

Facts and figures

Statistical data on historic buildings in Europe:

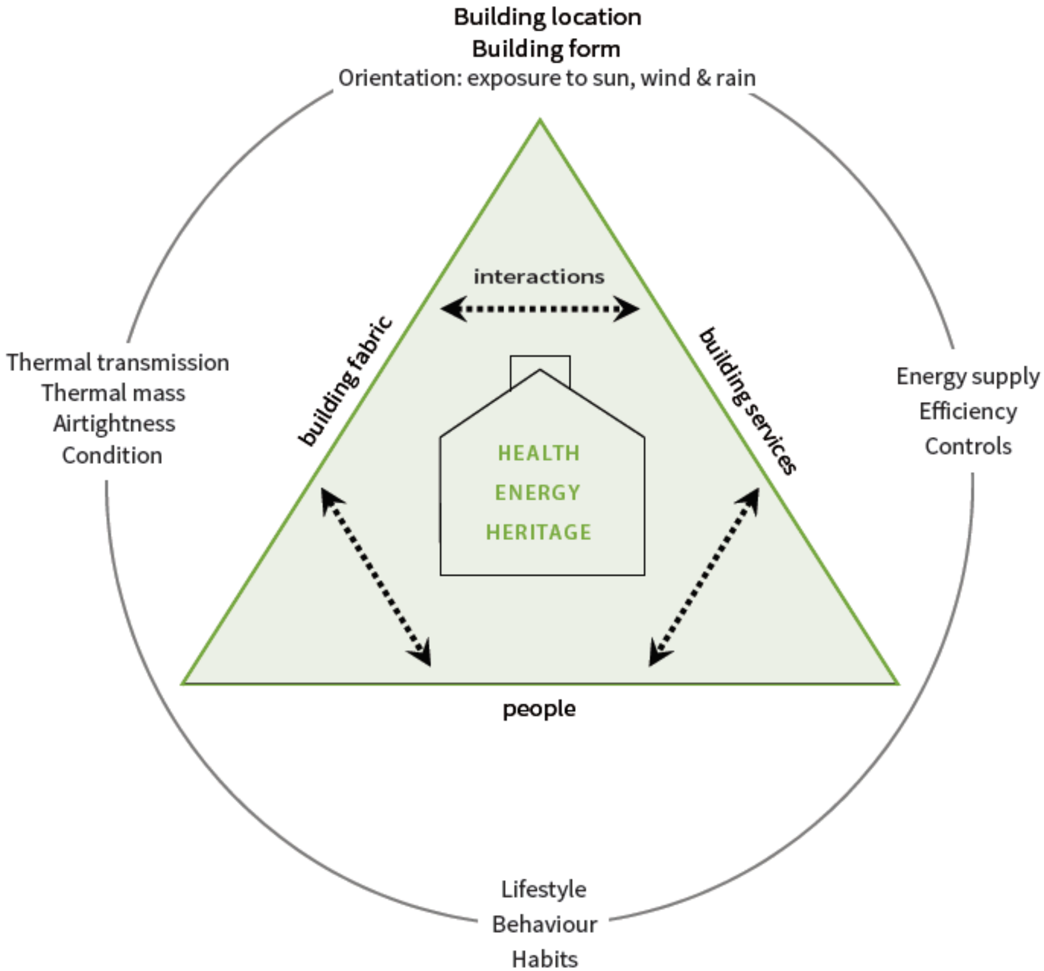
- 14 % of the EU27* building stock dates from before 1919
- 12 % from between 1919 and 1945 (with considerable national differences)

History, memory, continuing management of heritage
some of the reasons to preserve historic buildings, which form the distinctive character of many urban centres, creating continuity with the past, and providing a visual cultural reference

Even though historic buildings are currently exempted from most EPBD requirements, there is a growing awareness that cultural heritage preservation and preservation of the natural basis of life are equally important goals.

* data not available for Croatia

Factors affecting energy use



Source: Belgian Building Research Institute, 2016

No one-size-fits-all approach

But general principles:

Understanding the building and its context

- The significance of the building and potential harm from possible changes
- Influence of local environmental factors such as exposure to sun, wind and rain
- Design, construction and condition of the building
- Performance and behaviour of the building fabric
- Design, condition and operation of engineering services
- Building use, occupancy and management
- Requirements, aspirations and aims
- Available resources: financial; skills; materials
- Opportunities and constraints

No one-size-fits-all approach

Engaging building users, owners and managers
Owners, managers and occupiers of the building should be fully involved in the plans for saving energy at every stage

Reducing demand on energy-using systems
Current expectations, habits and standards should be reviewed and questioned to find out what is really necessary. Energy savings might be made through a more flexible approach to comfort standards in different parts of the building

Avoiding waste
Much equipment in buildings operates wastefully, or is left on unnecessarily. It is important to commission and control energy-using systems properly, and to turn all energy-using equipment off or down when not needed

No one-size-fits-all approach

Increasing efficiency

Building services such as heating, hot water supply and lighting and other energy-using equipment like computers and appliances should be designed, selected and run to use as little energy as possible

Improving controls

Control systems should be as efficient as possible and easy to understand and use. Many systems are not as manageable and responsive as they could be. This can lead to increased energy use

Using lower-carbon energy supplies

Switch to energy sources with lower emissions such as on- or off-site renewable energy (solar, wind or water power), or select lower-carbon supplies such as gas or wood instead of coal

No one-size-fits-all approach

Avoiding complication

Unmanageable complication is the enemy of good performance. Solutions should be kept as simple as possible and done well

Reviewing outcomes

Solutions of all kinds should be reviewed and assessed carefully at every stage of the energy-planning process. The aims should be to understand how measures perform as part of the overall system, and to minimise unintended consequences, such as overheating, moisture problems and poor indoor air quality. Measures used in combination can have a powerful multiplier effect

Whole building approach

The ‘whole building approach’ ensures that energy-efficiency measures are suitable, robust, well integrated, properly coordinated and sustainable (Historic England 2018)

Key stages:

1) assessment – understanding the context
2) setting objectives and planning improvements
3) detailed design and specification
4) installation
5) use and evaluation
6) maintenance

1) assessment – understanding the building and its context

- Character and significance of the building
- Local climate, orientation and exposure
- Hygrothermal behaviour of building fabric
- The condition of the building
- Energy performance of building services
- Levels of energy use related to occupancy and human behaviour

1) assessment – understanding the building and its context

- Energy performance of the building envelope

Non-destructive tests:

Air pressurisation testing
This test is used to determine the airtightness of a building. A fan is set temporarily into a doorway to create a pressure differential that allows the amount of air leakage through the building envelope to be quantified.

Infrared thermography
Infrared video and still cameras can be used to produce images of the building envelope that show variations in surface temperature. In this way, thermal defects, such as cold bridges, can be detected.

1) assessment – understanding the building and its context

- Energy performance of the building envelope

Non-destructive tests:

U-value measurement
The thermal performance of building elements can be assessed *in situ* using sensors to measure the rate that heat flows through them. Measurements are usually carried out over a period of at least two weeks during the winter when the temperature gradient across the element is at least 20°C.

Co-heating test
This test measures the amount of heat lost through the building envelope and is used to determine the heat loss coefficient in W/K. It is normally carried out on an unoccupied building over a period of 1–3 weeks during the winter months.

2) Setting objectives

short and long term objectives for the project

identify the measures likely to be appropriate and practicable in the specific context

- User requirements, aspirations and aims
- Opportunities, constraints, and resources
- Identifying areas for improvement
- Simple cost-effective improvements
- Appraising the options
- Determining priorities

3) Detailed design and specification

The preliminary energy plan is developed in detail

Depending on the size and complexity of the project, detailed design drawings and specifications will be required to enable necessary consents to be obtained and the works procured

Documentation should be detailed, clear and unambiguous.

Last three stages

4) Installation

Installers should have sufficient training, expertise and interest in the whole building approach

5) and 6) Use, review and maintenance

Handover should be managed in a way that ensures that building engineering services are properly commissioned, and building users/managers understand what has been done, how it is intended to work, and how they can maintain it.

Projects where user manuals, maintenance schedules, verbal briefings and follow up visits have been provided prove to be significantly more successful than those where little or no information was offered.

How to select the measures

Priority list

GREEN actions to improve thermal performance

Low-cost and low-risk options that could be considered for every building.

AMBER actions to improve thermal performance

Options that involve some risk and/or some cost: suitability will depend on the particular building.

RED actions to improve thermal performance

High-risk and/or high-cost options: careful consideration needed.

Source: Belgian Building Research Institute, 2016

How to select the measures

Low costs measures (Historic England 2018)

‘GREEN’ actions to improve thermal performance Low-cost and low-risk options that could be considered for every building			
	Action	**General comments**	**Other considerations**
Reducing demand	**Dealing with sources of discomfort**	As far as possible remove or modify the sources of discomfort in reversible ways that do not require significant energy input. Examples include: ▪ dealing with draughts (incuding draughts from poorly chosen heating) ▪ using rugs, wall hangings, screens to reduce radiant heat loss into large heat-absorbent surfaces	By reducing the demand for heating or cooling, any artificial conditioning systems can be made smaller and more effective
	Optimising use of natural and artificial lighting	If possible, adjust building use so that any artificial lighting can be concentrated to best effect	By reducing the demand for lighting, any artificial lighting systems can be made smaller and more effective
	Reducing the quantity of energy-using equipment	Energy-using equipment tends to accrete with time, and a proper audit may identify equipment that could be removed with little loss to building operation but significant energy savings	Any energy-using equipment should have to ‘pay its way’: its use of resources should have to be justified by its utility

Source: Belgian Building Research Institute, 2016

Erasmus+ Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

How to select the measures

Low costs measures (Historic England 2018)

Windows and doors	**Draughtproofing**	Draughtproofing is an unobtrusive and cost-effective way of improving comfort and reducing energy use	Any necessary repairs should be carried out before draughtproofing
	Adding curtains and blinds	Curtains (including door curtains) can provide excellent draughtproofing On large areas of glass, can reduce both heating loads in winter, and cooling loads in summer	Traditionally, windows often had different curtains for summer and winter
	Refurbishing or replacing lost shutters	External shutters protect against both solar gain and heat loss, and provide security and weather protection Internal shutters are good at reducing heat loss, but are less effective against heat gain	Shutters can be of many types, designs and sizes Some traditional windows had both internal and external shutters Consider incorporating draughtproofing in new and refurbished shutters, to enhance performance
Floors	**Adding rugs or carpets to solid ground floors**	Reduces radiant heat loss	Floor coverings and underlays must be permeable to avoid trapping moisture
	Adding rugs or carpets to suspended timber floors	Reduces radiant heat loss and draughts through floorboards Close (fitted) carpeting will reduce air leakage through gaps in floorboards	Floor coverings and underlays must be permeable to avoid trapping moisture or preventing air flow

Source: Belgian Building Research Institute, 2016

How to select the measures

Medium costs measures (Historic England 2018)

'AMBER' actions to improve thermal performance Involve some risk and/or some cost: suitability will depend on particular building			
	Action	General comments	Other considerations
Windows	**Adding shutters**	Shutters were originally made to suit almost every type of window	Consider designing bespoke shutters
Windows	**Adding awnings or other shading and weather protection**	Can protect windows from solar gain, or let them stay open for ventilation when raining Some Victorian models were specifically designed to assist ventilation through the window	Solar films and varnishes can be used to reduce solar gain, but they have short lifespans and are difficult to remove; they would not be suitable for use on handmade or early machine-made glass
Floors	**Insulating existing solid ground floors**	Thin, high-performance insulation board can be installed with minimal disturbance to the original floor Moisture problems must be tackled before work begins, and a good monitoring and maintenance regime set into place	Floor level will be raised, so skirting boards may need to be removed and reinstated, doors will have to be shortened, and junctions with staircases resolved
Floors	**Insulating suspended timber floors (draught-sealing)**	Reduces air leakage between skirting boards and floor, and through gaps between floorboards Moisture problems must be eliminated before work begins, and a good monitoring and maintenance regime set into place	Reducing air movement in the floor void may affect the moisture equilibrium

Source: Belgian Building Research Institute, 2016

How to select the measures

High costs measures (Historic England 2018)

'RED' actions to improve thermal performance High-risk and/or high-cost options: careful consideration needed			
	Action	General comments	Other considerations
Floors	Insulating solid ground floors	**REPLACING AN EXISTING FLOOR WITH A NEW INSULATED FLOOR** Insulation used will be impermeable, so work can affect moisture distribution in walls and other adjacent fabric Moisture problems must be tackled before work begins, and a good monitoring and maintenance regime set into place	Often carried out in conjunction with underfloor heating It may be possible to lift and reinstate some historic floor finishes, but the pattern of settlement and wear will be lost Excavation risks undermining wall foundations
		CONCRETE SLAB Usual approach; insulation may be laid above or below the slab	
		LIME-CONCRETE SLAB Insulation material is either mixed within the lime concrete, or laid as a layer beneath the slab For same strength, will need to be thicker than concrete slab, and so may require deeper excavation	
		See the Historic England guidance on insulating solid ground floors	

Source: Belgian Building Research Institute, 2016

Further readings

- HISTORIC ENGLAND (2018) Energy Efficiency and Historic Buildings. How to Improve Energy Efficiency
- A. Troi and Z. Bastian (eds) (2015) Energy Efficiency solutions for historic buildings. A Handbook. Basel: Birkhäuser
- Belgian Building Research Institute (2016) Proceedings EECHB-2016 Energy Efficiency and Comfort of Historic Buildings Brussels, Belgium 19th -21st October, 2016

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Key Action 2: Strategic Partnership Projects

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This publication has been funded within support from the European Commission.

Free copy.

Co-funded by the
Erasmus+ Programme
of the European Union