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GET READY

CHANGING ENERGY USE IN OLD BUILDINGS



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CHANGING ENERGY USE IN OLD BUILDINGS

Foreword

Energy consumption in buildings represents approximately 40 percent of energy use in the European Union (EU), while CO₂ emissions from buildings make up 36 percent of the EU total. It is therefore essential to retrofit existing inefficient buildings using state-of-the-art technologies. Significant energy and financial savings can be achieved by such refurbishment, which will also reduce CO₂ emissions.

This brochure provides information to help in the planning of energy-use changes in old buildings. A checklist is included at the end of the brochure to help you identify possible actions.

- 1 While buildings are now being designed and built according to strict energy-efficiency standards and regulations, it is important to consider improving the energy performance of existing, energy-inefficient buildings.
- 2 If you live in an old building, it can be useful to analyse its energy consumption and explore the possibilities for saving energy.
- 3 In some cases, significant changes can be achieved with relatively small investments. However, if you are able to make a bigger short-term investment to bring your building into compliance with high energy-efficiency standards, you can significantly lower your household energy consumption and costs in the long term.
- 4 It is worth exploring the possibility of using renewable energy sources. Although initial investment costs will be higher, the fuel for operating the system will be free. In addition, using local resources will ensure greater independence and security.

Background information

Step 1. Analyse energy use in your home

Before starting any retrofitting project you will need to examine the characteristics of your home. The total primary energy use of a building (including heating, cooling, domestic hot water and household electricity) can be calculated in kilowatt-hours per square meter per year (kWh/m²/year). Your combined annual electricity, natural gas, oil, coal and biomass consumption divided by the floor area of your home will provide an indication of the building's energy efficiency. Buildings that are more than 30 years old typically consume between 300 and 400 kWh/m²/year, while modern low-energy buildings consume on average 150 to 200 kWh/m²/year and passive houses less than 120 kWh/m²/year.

Since a variety of energy sources are typically used to meet energy needs, you will need to use conversion factors to enable you to calculate your total primary energy consumption in kWh:

- 1 m³ natural gas = 35 MJ = 9.7 kWh
- 1 MJ heat (district heating) = 0.28 kWh
- 1 litre of heating oil = 0.85 kg = 9.44 kWh
- 1 kg brown coal = 5.6 kWh
- 1 kg black coal = 8.4 kWh
- 1 kg wood = 4 kWh
- 1 kg wood pellets = 5 kWh

Table 1. Calculation of total energy consumption

Energy source	Annual consumption	Annual consumption in kWh
Electricity		
Natural gas		
District heating		
Oil		
Coal		
Biomass		
Other		
	Total in kWh (A)	
	Floor area (B)	
	Total primary energy consumption of your home (A/B)	

Step 2. What type of fuel should you use?

If you are renovating your home, consider changing your existing energy sources. Your decision about which fuel to use will depend on its availability, its cost, and its contribution to climate change. If you choose a fossil fuel, the best option is natural gas, which has the lowest impact on the environment among non-renewable energy sources.

Technical elements

Step 3. Energy-efficient renovation of old buildings

So-called passive architecture (http://en.wikipedia.org/wiki/passive_house) has huge environmental and financial advantages: it requires no external energy source and no operational costs and does not contribute to environmental pollution. Passive elements, such as the orientation of windows, the shape of the building and the surrounding shade, are generally taken into consideration when designing new buildings, but it is also possible to incorporate them during renovation work.

A large glass surface on the southern side of a building will increase its heat absorption capacity, even during the winter. However, it is best to avoid large windows in north-facing walls, since from an insulation perspective even the best-insulated window is worse than a wall.

If you are undertaking large-scale renovation work, you might consider altering the shape of your building. The more compact a building is the better: an L-shaped house consumes more energy than a cube because of the large wall surface area through which heat can be lost.

In warmer regions, adequate natural shading will regulate interior temperatures and eliminate the need for air conditioning systems. The most common options are leafy trees and window shutters. However, you might also consider installing projecting external “shelves” above windows to block direct sunlight; flat or tubular solar panels that can shade facades or terraces; or overhanging roof eaves that cast a shadow over walls and windows.

Step 4. Active measures to improve energy performance

Active elements include building materials, heating systems, ventilation and air conditioning systems.

When planning the renovation of your home, take into account the rate of heat loss through the different elements of the building structure. Choosing appropriate building materials will help you lower your energy consumption.

Glass is not a good insulating material, thus a lot of heat can be lost through windows unless they are properly insulated. The U value¹ of old windows is between 2.8 and 3.0 W/m²K. The current minimum

1 The U value is an energy efficiency indicator. It refers to the heat transmission coefficient (thermal transmittance) of a structure, describing the heat flow through the building element in watts per square metre at a temperature difference of

requirement is to have a double pane of glass with the space between them left empty or filled with an inert gas. These windows have a U value of around 1.1 to 1.4 W/m²K. Modern triple-glazed windows are becoming increasingly common and have U values of 0.6 to 0.8 W/m²K). It is important to ensure that windows are properly installed.

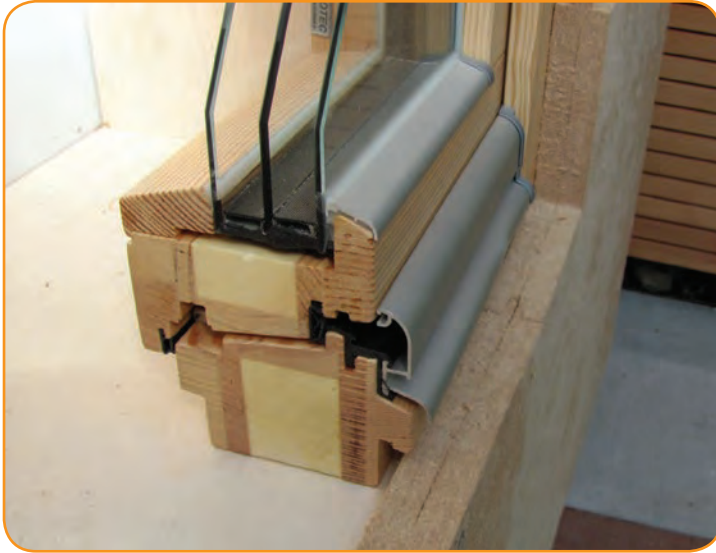


Fig. 1. Modern triple-glazed windows are becoming increasingly common and have U values of 0.6 to 0.8 W/m²K | Image: © Wilfried Walther

The insulation of exterior walls, floors and roofs is now a standard requirement. The thickness of the insulation will depend on the material used, but the average is 15 to 20 cm in walls, 10 to 15 cm under floors, and 30 to 40 cm for roofs.

one degree (K): W/m²K. The higher the U value the lower its thermal resistance, therefore the more heat/energy passes through the building element.



Fig. 2. Insulation of outer walls of a building
Image: © Nikecell

The construction material used will determine the heat absorption and storage capacity of the building walls. Modern, energy-efficient bricks are the best option. If you decide to change your walls in the course of renovation work, discuss the appropriate type and thickness of construction materials with your architect.

Your house may have individual heating, or you may be part of a district heating system. In the latter case, you will have less freedom when retrofitting. Older district heating systems generally use fossil fuels, have poorly insulated distribution systems and provide no possibility for individual metering. However, there are an increasing variety of modern or retrofitted district heating systems, many of which

use local renewable energy sources. Joining such a system can result in big energy savings.

If you have individual central heating it will be easier for you to move in the direction of energy-efficient solutions when upgrading your home. The best option is to carry out the complex retrofitting of the heating system.

In this case, the first step is to assess the efficiency of your boiler. In general, if your gas boiler is more than 10 years old it is worth changing it, preferably to a condensing boiler. These are around 90 percent efficient, as compared to conventional gas boilers that are only around 50 to 60 percent efficient, while some older models are even less efficient. In other words, condensing boilers produce far more heat from the same amount of fuel for the same price.

When changing your boiler it is also worth changing your radiators, especially if they are older than 15 to 20 years. Installing modern radiators of an appropriate size will result in greater energy efficiency. Where possible, you should also think about replacing your distribution pipes with new, insulated piping.

If you are not able to carry out a complex retrofit, an easy and relatively cheap measure is to install thermostatic valves on your radiators. This will enable you to regulate the temperature of your house room by room, for example making the bedrooms cooler than the living spaces, with the highest temperature in the bathroom. Lowering the temperature on the thermostat by just 1 degree will reduce energy consumption by 5 to 6 percent.

Table 2. Recommended temperature settings by room

Room	Recommended temperature
Living room	21°C
Kitchen	21°C
Bedroom	18°C
Bathroom	23°C

A programmable thermostat will also enable you to lower the temperature when you are not at home. A room that is not in use for a longer period may only need to be heated to 17°C rather than 21°C.

Using natural ventilation and shading rather than air conditioning is the most environmentally friendly and least expensive option, as no electricity is required.

Traditional architecture exploits the advantages of natural ventilation, allowing air to flow from cooler to warmer parts of the building during the summer. The efficiency of this air flow, which can also be boosted by fans, will depend on the orientation of the building and the position and size of the windows. Opening windows on opposite sides of a room will provide natural ventilation. However, if your building requires mechanical ventilation, you should consult an expert for advice on the most appropriate and most efficient system.

Step 5. Change to renewable energy sources where possible

Consider using renewable energy sources when renovating your home or retrofitting your heating system:

- If you have an appropriate, south-facing roof, consider installing solar panels to provide hot water, or photovoltaic cells to generate electricity.

- Small-scale, efficient wind turbines can be installed on individual houses to generate electricity. First check out the permit requirements and zoning laws with your local authority.
- Using biomass (wood or wood pellets) for heating is possible with an appropriate boiler and some minor technical adjustments to connect it to your existing heating system.
- A heat pump requires a larger investment but can heat and cool your home using only a relatively small amount of electricity. As heat pumps use thermal energy from the ground, you will need either a large surface area or a deep hole to collect the heat.

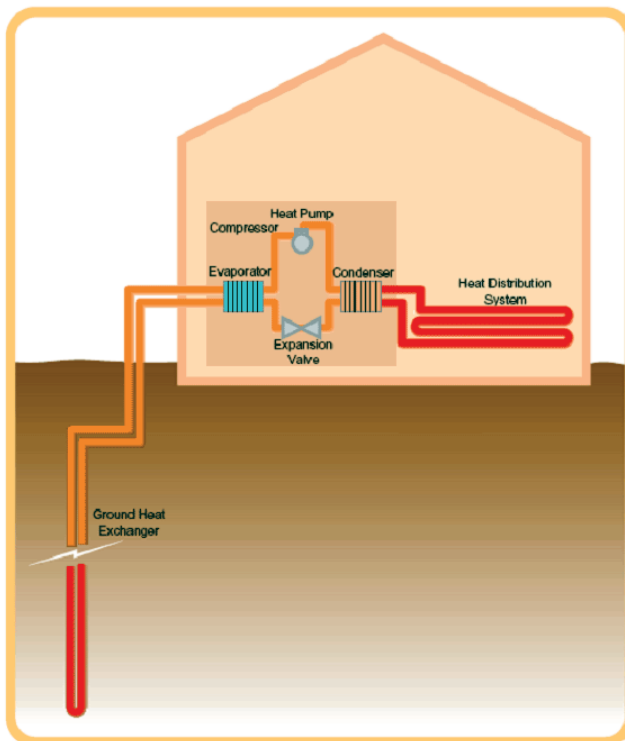


Fig. 3. How a heat pump works

Image: http://www.kyotoinhome.info/HU/heat_pumps/basic_principles.htm

A professional will be able to provide you with advice on the technical, financial and regulatory aspects.

Monitoring

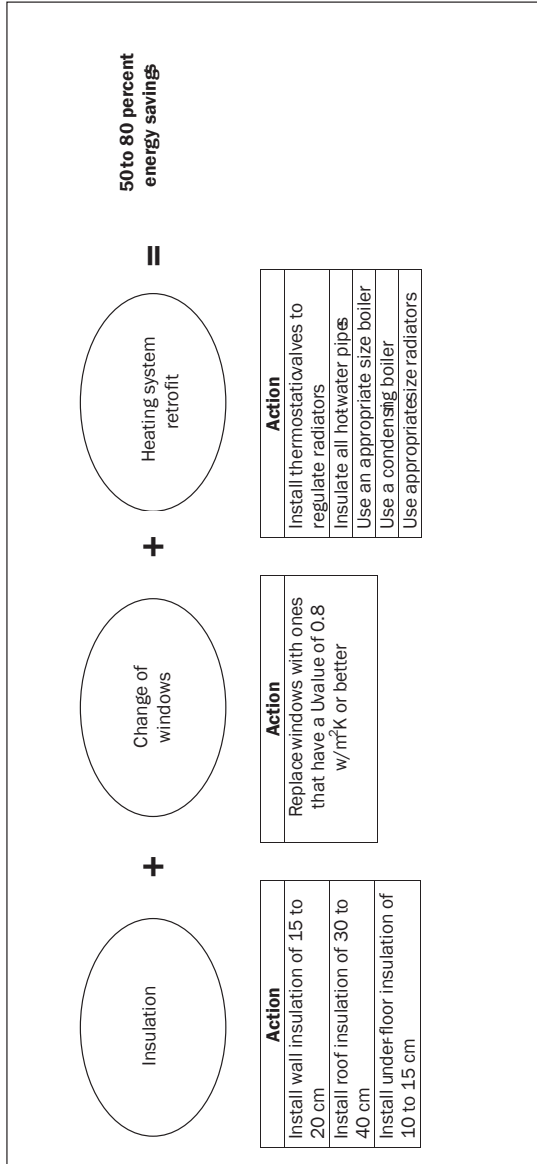
Step 6. Monitor your energy consumption and make the necessary adjustments

Following renovation or retrofitting, it is important to monitor your energy and water consumption regularly. The system will need to be fine-tuned to make it as effective as possible.

Check your electricity, gas and water meters regularly and record your consumption per month and per year. Remember to include other energy sources (e.g. biomass) in your calculations. Compare the consumption figures over a full year before and after installing insulation and discuss the results with an engineer.

Using an Internet carbon calculator, you can also calculate the carbon footprint of your house before and after renovation www.carbonfootprint.com/calculator.aspx.

Checklist



For your notes