Summary

Energy savings potential in existing buildings in Germany

In Germany around 30% of end-use energy consumption – and therefore approx. 20% of CO_2 emissions – is accounted for by private households. The main portion of this, at around 76%, falls on space heating (Figure 1).

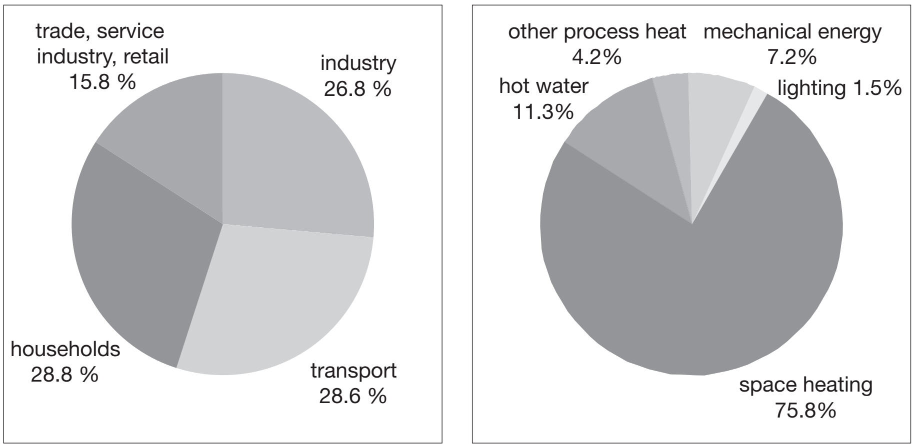

Fig. 1 Left: Breakdown of end-use energy consumption. Right: Breakdown of energy consumption in private households. Figures for 2005 [BMWi 2006]

Against a background of advancing climate change, brought about by CO_2 emissions, and rising energy prices, it becomes ever more important not only to use renewable energy sources but also to improve the energy performance of existing buildings. A comparison between the energy savings that can be gained through targeted improvements to existing buildings and the amount of energy currently generated from renewable sources illustrates the potential in this field. In 2006, for example, the estimates for residential buildings alone exceed many times the total figures for energy generated from renewable sources (Figure 2).

There is therefore tremendous potential for saving energy in buildings – primarily through improving thermal insulation, but also through a range of other targeted measures.

Energy performance certificates for buildings

A significant step in this connection is the introduction of energy certificates for buildings (Figure 3). Of interest to property owners, buyers and tenants, this certificate sets out in compact form the annual energy requirements of the building in question. It also comes with recommendations on how to modernise the building (structure and installations) with the aim of reducing energy consumption. One problem with this

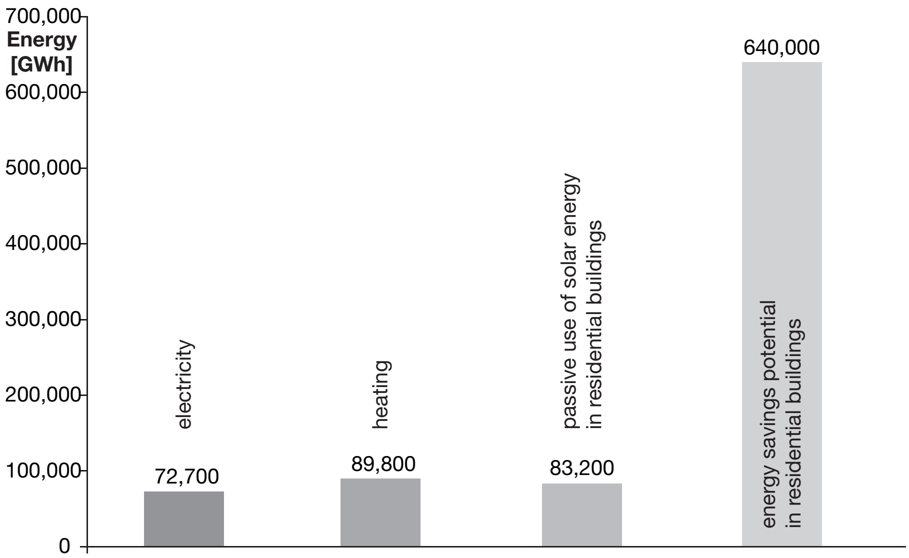

Fig. 2 Energy supplied from renewable sources in Germany in 2006, compared to the energy savings achievable through improving the energy performance of existing residential building [Hauser 2007].

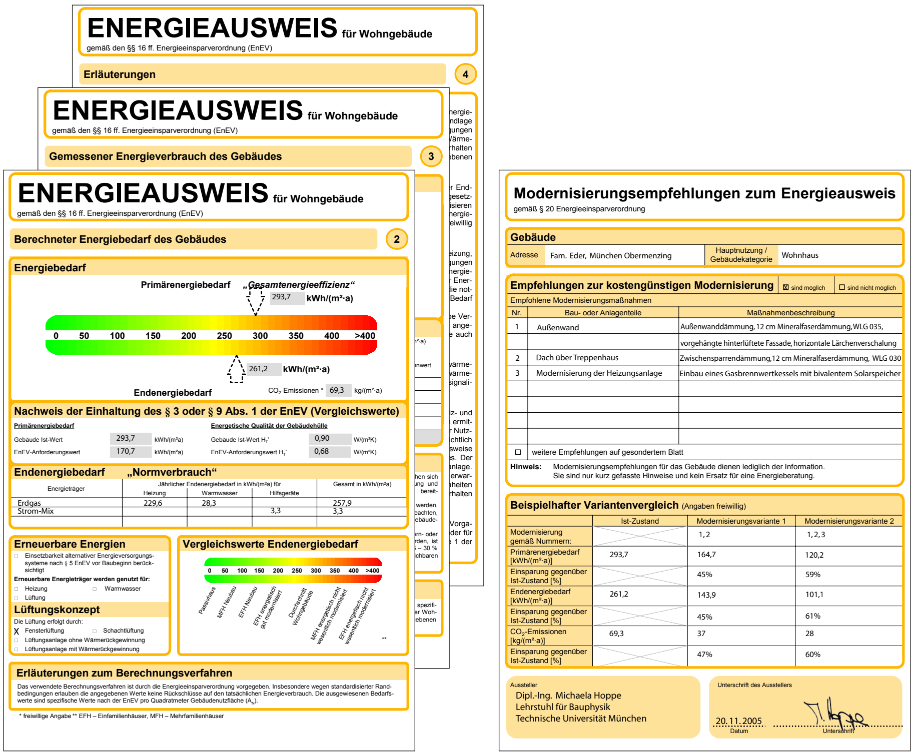

Fig. 3 Sample pages from the energy certificate for residential buildings according to the Energy Conservation Regulations 2007 [EnEV 2007]

new system is that the persons involved in issuing these certificates come from a range of technical backgrounds, as provided for in the Energy Conservation Regulations 2007 (Energieeinsparverordnung 2007) [Hauser et al. 2007]. An important aspect of the research was therefore not only to develop sensible eco-friendly improvement strategies as regards a building´s structure and physical properties, but also to produce a practical manual that would give professional support to those persons whose job it is to issue the energy certificates, but whose core competence does not lie directly in the field of construction (e.g. installations engineers, chimney sweeps etc.)

Manual of energy-efficiency improvements in buildings

Because of the above-mentioned issue of rising energy costs, many property owners are willing to undertake measures to reduce the energy consumption of their buildings. Yet often there is great uncertainty about what measures to take and how these changes will impact on the look of the building. Worries about possible complications, e.g. damp, also affect decisions, as do concerns about the actual cost-effectiveness of any measures taken.

This frequently leads to owners opting for conventional solutions, such as a composite thermal insulation system based on rigid foam polystyrene. A central aim of the study was to identify sensible alternatives to conventional modernisation approaches, alternatives that are based on the use of a material that has good ecological, structural and physical properties, is also easy to work and in addition offers great scope in terms of design.

Timber is an excellent construction material for energy refurbishment measures, not only for the positive carbon dioxide balance (Figure 4) and good recyclability but also for its technical qualities. As a lightweight but strong material, timber is commonly used as a material for facade cladding [Wegener/Zimmer 2003] [Herzog et al. 2004].

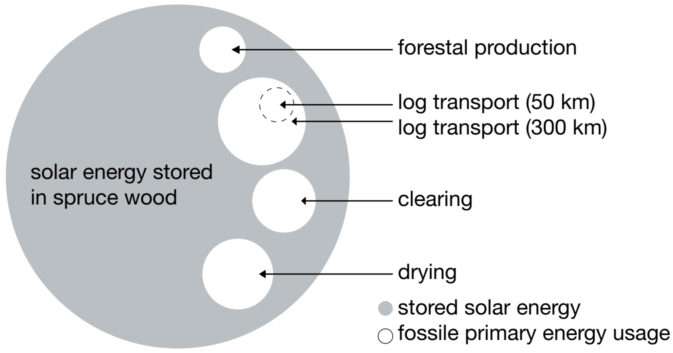

Fig. 4 Energy balance for timber production, white circles showing the cumulated fossile energy demand in comparison to the amount of energy stored within the material (grey circle) [Wegener/Zimmer 2003]

The resulting manual takes a detailed look at the various options for modernisation, and as such is intended for both energy-certificate issuers and building owners who are interested in more in-depth information. The main aspects covered in the manual are:

- how to assess the energy performance of an existing building;
- a review of the requirements that have to be met;
- a presentation of the options for modernisation;
- the criteria for selecting options;
- an itemisation of the expected building costs;
- and an investigation of the cost-effectiveness of the individual measures.

Fact sheets

The manual is accompanied a series of fact sheets on the recommended measures (Figure 5) which set out, on a double page, what is involved in each case. They are directed primarily at the property owner and can be included with an energy certificate to provide further information on the recommended modernisation measures. The fact sheets contain a short description of the proposed measure, and illustrations to represent the situation before and after measures are taken. Plus a summary of the advantages and disadvantages, as well as an explanation of the main structural and physical aspects such as thermal insulation, thermal bridges, damp proofing, acoustic insulation and fire protection. To conclude the main parameters affecting the cost-effectiveness of the particular measures are set out in a table.

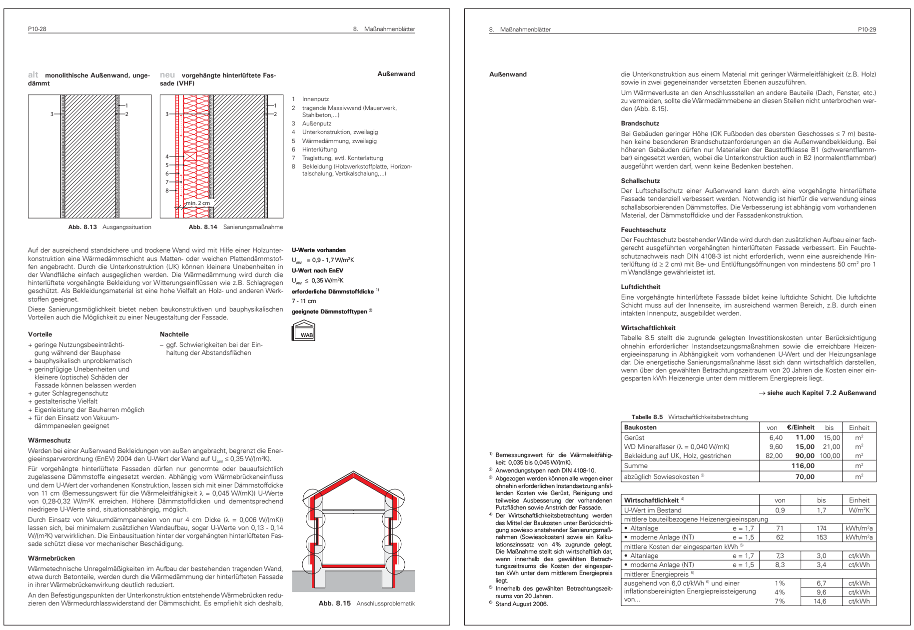

Fig. 5 Sample fact sheets: Insulating a monolithic exterior wall by fitting a ventilated façade.

Cost-effectiveness analysis

The cost-effectiveness of each individual measure to improve energy efficiency is illustrated in the form of a table (Table 1 below) which compares the mean costs of carrying out building work to save one kilowatt-hour of heating energy with the mean energy costs to be expected in the future. A range of energy parameters (U-value in the existing building, heating system) is taken into account. An individual modernisation measure is thus only considered cost-effective when the costs for the kilowatt-hour saved lie below the mean energy costs in the time period. This table can help in the initial assessment of the cost-effectiveness of a particular modernisation measure.

Table 1 Cost-effectiveness (sample table): Insulating a monolithic exterior wall by fitting a ventilated façade

Building costs	from	**€/unit**	to	unit
Scaffolding	6.40	**11.00**	15.00	m^2
Insulation (λ = 0.040 W/mK)	9.60	**15.00**	21.00	m^2
Cladding on frame, wood, varnished	82.00	**90,00**	100.00	m^2
Total		**116.00**		m^2
minus base costs [1)]		**70.00**		m^2

Cost-effectiveness [2)]		from	to	unit
Existing U-value		0.9	1.7	W/(m^2K)
Mean savings in heating energy for building component				
• old system	e = 1.7	71	174	kWh/m^2a
• modern system	e = 1.5	62	153	kWh/m^2a
Mean costs per kWh saved [3)]				
• old system	e = 1.7	7.3	3.0	ct/kWh
• modern system	e = 1.5	8.3	3.4	ct/kWh
Mean energy price [3)]				
Assuming 6.0 ct/kWh 4) and an inflation-adjusted rise in energy prices of...		1 %	6.7	ct/kWh
		4 %	9.6	ct/kWh
		7 %	14.6	ct/kWh

1) Costs that would have been incurred anyway during necessary maintenance, e.g. scaffolding, cleaning and where needed renovation of existing render and painting the façade. These are deducted from the total.

2) The cost-effectiveness calculation is based on mean building costs, taking into account any costs that would in any case have been incurred on necessary maintenance (base costs), and an assumed interest rate on the loan of 4 %. The measure is deemed to be cost-effective when within the chosen time period the costs of the kWh saved are below the mean energy price.

3) Within the chosen time period of 20 years.

4) Date: August 2006.