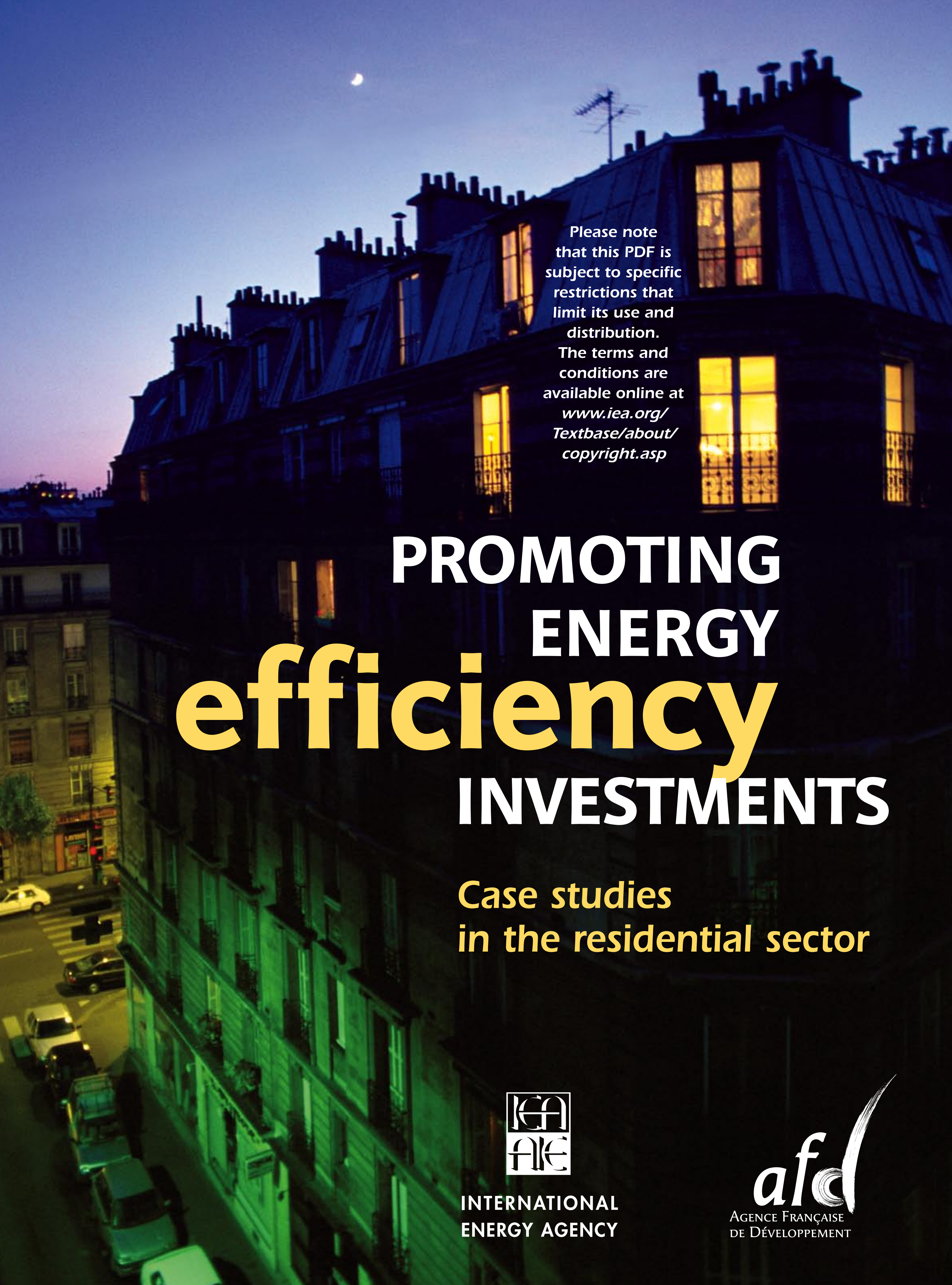

PROMOTING ENERGY efficiency INVESTMENTS

Case studies in the residential sector

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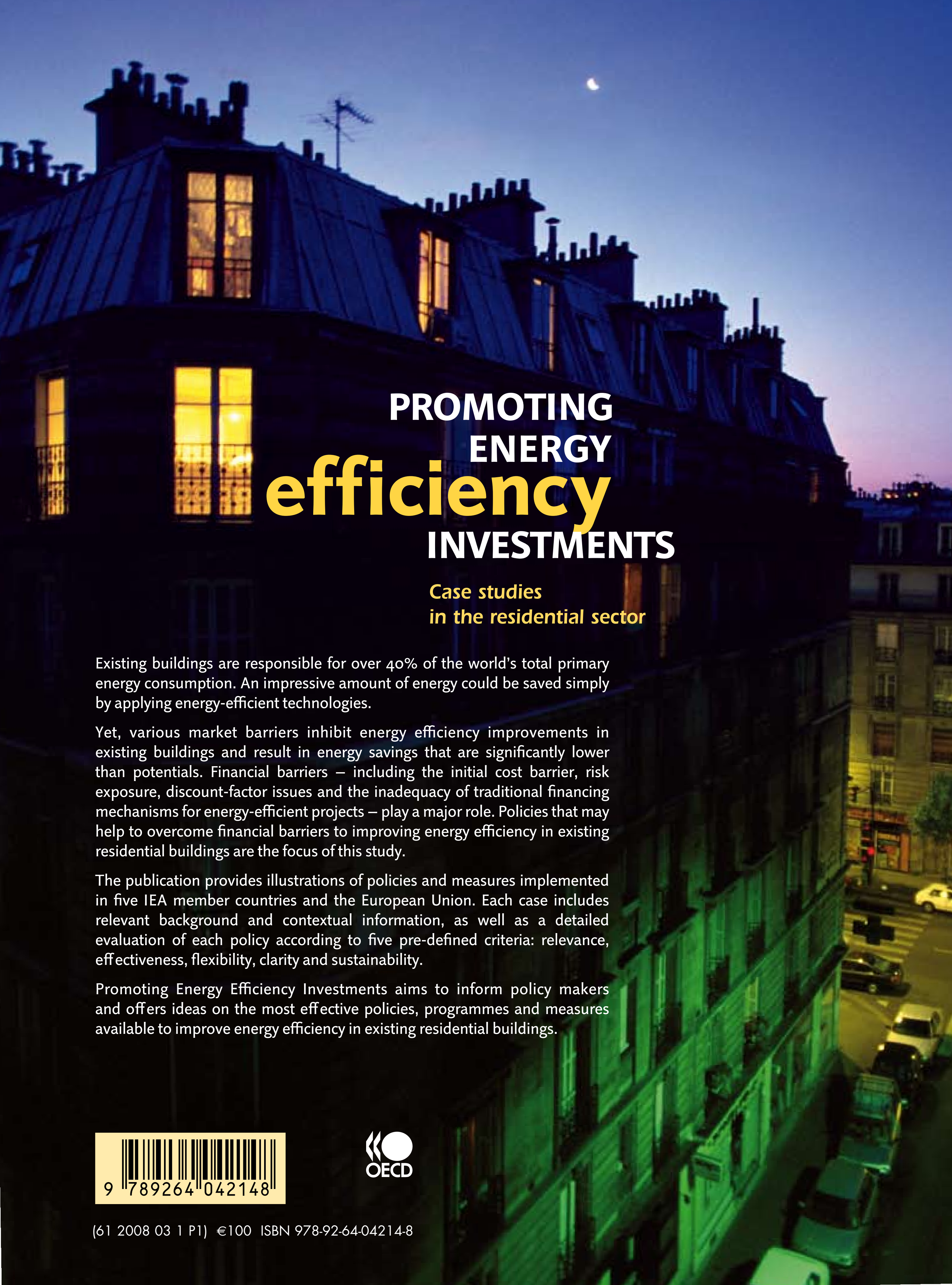

PROMOTING ENERGY efficiency INVESTMENTS

Case studies in the residential sector

Existing buildings are responsible for over 40% of the world's total primary energy consumption. An impressive amount of energy could be saved simply by applying energy-efficient technologies.

Yet, various market barriers inhibit energy efficiency improvements in existing buildings and result in energy savings that are significantly lower than potentials. Financial barriers – including the initial cost barrier, risk exposure, discount-factor issues and the inadequacy of traditional financing mechanisms for energy-efficient projects – play a major role. Policies that may help to overcome financial barriers to improving energy efficiency in existing residential buildings are the focus of this study.

The publication provides illustrations of policies and measures implemented in five IEA member countries and the European Union. Each case includes relevant background and contextual information, as well as a detailed evaluation of each policy according to five pre-defined criteria: relevance, effectiveness, flexibility, clarity and sustainability.

Promoting Energy Efficiency Investments aims to inform policy makers and offers ideas on the most effective policies, programmes and measures available to improve energy efficiency in existing residential buildings.

OECD

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PROMOTING ENERGY efficiency INVESTMENTS

Case studies in the residential sector

INTERNATIONAL ENERGY AGENCY

Agence Française de Développement

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-seven of the OECD thirty member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies.

The IEA member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. Poland is expected to become a member in 2008. The European Commission also participates in the work of the IEA.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.
The European Commission takes part in the work of the OECD.

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FOREWORD

The imperative to improve energy efficiency is stronger than ever. The willingness of political leaders to tackle this problem has been reaffirmed through Head of State meetings such as the G8 Summits at Gleneagles in 2005, Saint Petersburg in 2006, and Heiligendamm in 2007. More recently, the December 2007 UN Climate Change Conference in Bali reiterated the urgency of countries' need to cut their greenhouse gas emissions in a significant way. Energy efficiency must be one of the strategies employed to address the challenges of energy security, climate change and economic development.

On this road to a sustainable energy future, actions in the building sector can play a key role. Existing buildings are responsible for over 40% of the world's total primary energy consumption, and account for 24% of world CO_2 emissions. Yet, despite the proven cost-effective opportunities for reducing energy consumption through energy-efficient technologies, a large portion of the potential in the existing residential building sector remains untapped.

Numerous barriers are responsible for this persistent energy efficiency gap. Market barriers take many forms, including low priority of energy issues, difficulties in accessing capital, the presence of information asymmetries, and principal-agent problems (or split incentives). Financial barriers are also decisive in inhibiting progress towards more energy efficient buildings. Such barriers encapsulate a wide range of obstacles, including the initial cost barrier, risk exposure, discount factor issues, and the inadequacy of traditional financing mechanisms for energy efficiency projects.

This book provides policy makers illustrations of available policies and measures currently being applied in IEA member countries. It concentrates on policies which in their application have helped overcome financial barriers, using examples from the European Union (EU) and five International Energy Agency (IEA) member states: Japan, the United States (US), Germany, France and the United Kingdom (UK).

The study shows that policies to help overcome financial barriers to increased energy efficiency in buildings do exist, and that more systematic *ex-post* data collection should be encouraged to help policy makers design the most appropriate policy packages to tackle these issues.

We extend our thanks to the Agence Française de Développement, without whom this study would not have happened.

Nobuo Tanaka
Executive Director

TABLE OF CONTENTS

Acknowledgements 3

Foreword 5

List of tables 8

List of figures 10

Executive Summary 15

Introduction 19

Section I • KEY CONCEPTS

Chapter 1 • Energy efficiency potential in existing residential buildings 25

Chapter 2 • Market barriers to more energy efficient buildings 33

Section II • CASE STUDIES

Chapter 3 • Japan 47

Chapter 4 • United States of America 75

Chapter 5 • The European Union 111

Chapter 6 • France 145

Chapter 7 • Germany 183

Chapter 8 • The United Kingdom 223

Section III • CONCLUSIONS

Conclusion 255

Annex I • Summary Table of US Policies 263

Annex II • France 283

Annex III • Germany 289

Bibliography and data sources 291

LIST OF TABLES

Table 1 • Energy consumption of three different houses in a moderate climate............. 27

Table 2 • Insulation materials in decreasing order of efficiency 28

Table 3 • Cost-effectiveness of insulation measures in different climate zones 30

Table 4 • Overview of the stock of residential buildings in Japan................................. 51

Table 5 • Change of ownership status of houses in Japan (million households)............. 51

Table 6 • Kyoto Protocol targets of CO_2 emission and absorption 55

Table 7 • Residential energy efficiency policy targets corresponding to the Kyoto Protocol targets 56

Table 8 • Coverage of Top Runner programme... 61

Table 9 • Target fiscal year and effects of the Top Runner programme........................... 71

Table 10 • Selected housing facts in the US 77

Table 11 • Possible tax credits for energy-efficient home improvements (as of November 2005) 89

Table 12 • Weatherisation timeline.. 91

Table 13 • Overview of the park of residential buildings in the EU 115

Table 14 • Characterisation of the building stock in the EU15 by climatic zone, by building age and by type of building (in million m^2) 116

Table 15 • Overview on recent energy policy measures regarding the case of the European Union from the MURE database 124

Table 16 • Minimum levels of taxation applicable to heating fuels and electricity for non-business use 129

Table 17 • Budget and objectives of the Structural Funds 131

Table 18 • Overview of energy policy measures in the residential sector of France........ 156

Table 19 • Tax credit rates for existing buildings (older than 2 years) valid in 2005 and 2006 (primary residence)... 162

Table 20 • Overview of EE subsidy programmes targeting the existing residential building sector 166

Table 21 • Extra bonus of ANAH subsidies for energy efficiency improvements............ 167

Table 22 • Global energy efficiency goal and its breakdown to the different energy types (residential and tertiary sectors) 171

Table 23 • Break down of the number and the amount of grants regarding owner type and energy efficiency category 175

Table 24 • Final energy consumption 2004 (all sectors) 186
Table 25 • Age structure of dwellings in residential buildings in Germany 2002 187
Table 26 • Home ownership rate 1993-2002 189
Table 27 • Investments in products in residential buildings, 2004 190
Table 28 • Research, development and testing facilities 198
Table 29 • Overview on energy policy measures regarding the case of Germany 200
Table 30 • Maximal U-values for construction elements of existing residential buildings (mandatory if at least 20% of an exterior structural element of the same orientation is renovated) 204
Table 31 • Energy tax income between 1999 and 2005 (million EUR) 208
Table 32 • Impact of energy policy measures: savings in terms of reduced annual energy demand at the end of the respective evaluation period (savings of different measures are not cumulative) 215
Table 33 • Loan approvals between 2002 and 2005 of various programmes of the *KfW Förderbank* for existing buildings in million current EUR 218
Table 34 • Cumulative space of living with energy efficiency improvement promoted by the *KfW Förderbank*, in million m^2 219
Table 35 • Number of applications between 2002 and 2005 for various programmes of the *KfW Förderbank* 219
Table 36 • Decrease in energy intensity measured as TPES/GDP (toe per thousand 2000 USD) 226
Table 37 • Measurements of energy use by sector for UK and other IEA countries 226
Table 38 • Measurements of energy intensity by sector for UK and other OECD countries 227
Table 39 • Comparison of outputs against targets for phase I of the Community Energy programme 242
Table 40 • Summary of energy savings resulting from various policy measures 251
Table 41 • Summary table of policy evaluation 258
Table 42 • Overview on the stock of residential buildings and its energy consumption in France 284
Table 43 • Current and investment housing expenditures in France (billion EUR, current prices) 284
Table 44 • Technical energy efficiency requirements for tax credit in the case of existing buildings 285
Table 45 • Development of building codes in France 285

Table 46 • Responsible ministries for the building sector in the German *Länder* 289
Table 47 • Maximal U Values (W/m²K) for construction elements of existing residential buildings 290
Table 48 • Mean consumption of new residential buildings, constructed in compliance with the regulations.. 290

LIST OF FIGURES

Figure 1 • Energy savings due to energy efficiency since 1973 19
Figure 2 • Average household energy consumption by use in a moderate climate 26
Figure 3 • Example of project finance structure.. 42
Figure 4 • Final energy demand for each sector in Japan... 48
Figure 5 • CO_2 emissions by sector in Japan 48
Figure 6 • Residential energy demand by end-use in Japan... 49
Figure 7 • Residential energy source consumption.. 50
Figure 8 • Changes in residential sector energy consumption and number of households.. 50
Figure 9 • Renovation in the Japanese housing market.. 52
Figure 10 • New construction in the Japanese housing market.. 52
Figure 11 • Long-term average heating degree days in Japan... 53
Figure 12 • Structure of the Energy Conservation Law for the residential sector 59
Figure 13 • Organisation of NEDO subsidies to home efficiency 62
Figure 14 • Amount of subsidies offered to all houses and renovated houses 63
Figure 15 • Expected energy savings for all houses and renovated houses........................ 63
Figure 16 • Cost-effectiveness of subsidies (annual savings per subsidy amount).............. 64
Figure 17 • Ratio of houses with performance evaluation performed 65
Figure 18 • Schematic drawing of direct housing loans.. 66
Figure 19 • Number of houses with GHLC loans 66
Figure 20 • Framework of mortgage-backed securities: "Flat 35" 67
Figure 21 • Number of houses applying for Flat 35 68
Figure 22 • Evaluation method of CASBEE 69
Figure 23 • Transition of energy consumption by households 70

Figure 24 • US energy use by end-use sector, 2006 76
Figure 25 • US residential energy sources 2005 77
Figure 26 • Cooling degree days and heating degree days by census division 2005 78
Figure 27 • Evolution of State Energy Programs 86
Figure 28 • Funding for state-specific energy programs from different federal sources (without weatherisation and without federal residential tax credits) 87
Figure 29 • Funding for weatherisation programmes between 1977 and 2006 (current million USD) 92
Figure 30 • Final energy demand per sector in the EU25 (corrected for yearly climate variations) 112
Figure 31 • Final energy consumption for space heating in the EU25 1990-2004 (by fuel) 113
Figure 32 • Major driving forces for energy consumption in the building sector of the EU25 114
Figure 33 • Net impact of driving forces, energy efficiency and behaviour on the variation of space heating energy consumption per dwelling in the EU15 (% change per year) 115
Figure 34 • Long-term average heating degree days in the EU25 117
Figure 35 • Examples of national energy performance certificates 127
Figure 36 • Costs for energy performance certificates in Germany 128
Figure 37 • Impact evaluation of residential sector energy efficiency policies with the ODEX (heating and electric appliances) 137
Figure 38 • *Ex-post* evaluation of energy efficiency measures in the EU15 in the period 1990-2000 138
Figure 39 • *Ex-ante* evaluations of economic energy efficiency measures in the EU15 2000-2025 139
Figure 40 • Diffusion of low emission glazing and condensing boilers in EU countries (2004) 139
Figure 41 • Diffusion of insulation thickness (2004) 140
Figure 42 • Final energy demand (numbers in Mtoe and graphical representation in %) for space heating in the French residential sector 147
Figure 43 • Final energy demand (ktoe) per sector in France between 1990 and 2005 148
Figure 44 • Selected drivers of household energy demand in France 148

Figure 45 • Annual intervention budget of ADEME and its predecessors in Euro 2004 154
Figure 46 • Two indicators of the intensity of the French energy efficiency policy 155
Figure 47 • Development of the French tax scheme for principal residences: upper limits for tax deductions or tax credits for a couple with two children in EUR/2004 (left axis) and tax reduction or tax credit rates (right axis) 161
Figure 48 • Development of subsidy programmes for building improvement, in EUR/2004 165
Figure 49 • Share of households that conducted energy-improvement work 174
Figure 50 • Market penetration rate of coated glazing following regulation in France, Germany and the UK 175
Figure 51 • Energy efficiency gains in the household sector in France between 1990 and 2004, in % 176
Figure 52 • Final energy demand for space heating in the residential sector in France 177
Figure 53 • Breakdown of public effort (forgone income taxes) of building maintenance and retrofit tax schemes of principal residences (Euro 2004) 179
Figure 54 • Breakdown of final energy consumption into sectors; figures from 1970-1989 for the former FRG (tertiary sector and households together), 1990-2005 for Germany 184
Figure 55 • Total final energy consumption per capita and GDP per capita 185
Figure 56 • Consumption of final energy for space heating in residential buildings and in the service sector, with and without adjustment for climate influence 185
Figure 57 • Breakdown of space heating in residential buildings by type of energy 1990-2004 187
Figure 58 • Price for the kWh of final energy saved after the necessary refurbishment of a house and the base cost of refurbishment separated from the additional cost of insulation 189
Figure 59 • Overview on energy policy measures regarding the case of Germany from the MURE database 199
Figure 60 • Breakdown of sectorial final consumption by source in 1973 and 2004 224
Figure 61 • Domestic energy consumption (per person, per household and per unit of household income) 225

Figure 62 • Energy intensity in the UK and in other selected IEA countries, 1973 to 2010 (Toe per thousand USD/2000 and purchasing power parities) 225
Figure 63 • Energy savings by measure type as a percentage of total savings for EEC1 232
Figure 64 • Comparison figures of energy consumption evolution in the UK and OECD countries 249
Figure 65 • Number of dwellings in single- and multi-family houses in the French building stock (permanently occupied dwellings) 283

EXECUTIVE SUMMARY

Energy efficiency (EE) improves energy security, fosters economic gains, and helps to reduce human-induced carbon dioxide (CO_2) emissions. Policies designed to increase energy efficiency have already delivered significant benefits. Worldwide energy consumption would be 56% higher today than it would have otherwise been without the various EE policies that have been implemented since 1973 (IEA, 2007a). These three advantages and the general track record of energy efficiency policies have made EE a policy priority in many countries.

Existing buildings are responsible for over 40% of the world's total primary energy consumption, and account for 24% of world CO_2 emissions (IEA, 2006). Yet, despite the proven cost-effective opportunity to reduce energy consumption, a large portion of the potential for energy efficiency in the existing residential building sector remains untapped.

Numerous barriers are responsible for this persistent energy efficiency gap (IEA, 2007b). Market barriers take many forms, including low priority of energy issues, difficulties in accessing capital, the presence of information asymmetries, and principal-agent problems (or split incentives). Financial barriers are also decisive in inhibiting progress towards more energy-efficient buildings. Such barriers encapsulate a wide range of obstacles, including the initial cost barrier, risk exposure, discount factor issues, and the inadequacy of traditional financing mechanisms for energy efficiency projects.

Focus on financial barriers

This study concentrates on financial barriers. It provides illustrations of policies and measures which, when implemented, have helped overcome the financial barriers to energy efficiency in existing residential buildings. The publication includes case studies from the European Union (EU) and five International Energy Agency (IEA) member states: Japan, the United States (US), Germany, France and the United Kingdom (UK). Each case presents the policy and institutional framework within which policies are enacted. It then provides an overview of the policies and measures implemented, followed by an evaluation of their strengths and weaknesses.

As such, this study seeks to offer policy makers ideas on policies, measures, and programmes available to overcome financial barriers to increased EE in existing residential buildings. The main purpose is to inform policy makers of available options. Due to a lack of sufficient *ex-post* data, systematic quantitative analysis was not possible in all cases. The study therefore provides qualitative evaluation of each policy according to five pre-defined criteria (de T'Serclaes, 2007): i) relevance; ii) clarity; iii) flexibility; iv) impact; and v) sustainability. Moreover, for consistency and to allow readers to make comparisons across the case studies, the policies have been organised into four categories: regulatory measures; financial and incentive-based measures; voluntary agreements and partnerships; and information and capacity-building measures.

Lessons for policy makers

Although the purpose of the publication is mainly informational, five lessons can be drawn from the cases studied.

No silver bullet

First, no single policy category or policy measure can overcome the financial barriers alone. Policy packages that seek to address multiple financial barriers at the same time are likely to be more relevant, have greater impact, and be more sustainable. The German case is an illustration of the success of appropriate policy packages. The implementation of strong regulatory ordinance since the late 1970s combined with public-private partnerships led to a decrease from an average yearly household consumption of 280 kWh/m^2 in 1970 to an average yearly consumption of 180 kWh/m^2 in 2004. The US also offers an example of good policy package through a combination of direct funding for weatherisation in low-income households, improved regulations, and support for demand-side management programmes implemented by utilities. Such policy packages have been implemented successfully in certain states, such as California, where the state's energy consumption has remained relatively flat for the past 30 years. In Japan, the successful combination of regulatory and awareness campaigns led to an overall improvement of 28% to 69% of households meeting EE standards.

Public-private partnerships

Second, public-private partnerships offer the best opportunity to meet the five evaluation criteria. They allow different barriers to be addressed concurrently and increase the impact of a policy on market transformation. As such they allow more sustainable changes. An example is the efforts of the French government, which offers fiscal incentives for the use of specific "green" savings products. These have been used by banks such as the Banque Populaire to offer preferential loans to customers putting in place EE refurbishment projects.

Creating a market

Related to this, the goal of market transformation is the third policy lesson: increasing the energy efficiency of buildings in a sustainable manner requires the existence of a market for energy efficiency. This market is currently weak and perceived as too risky. It will require strengthening and increased certainty before private actors are willing to engage further. Private actors are pivotal to the market's development. This circular dynamic underlies the role played between public and private actors in market transformation. The EU is aiming to trigger such market transformation, through policies which combine regulations to be met by member states, as well as both voluntary agreements with manufacturers and regulations to improve the EE standards of equipment and appliances. It also seeks to liberalise the energy supply and services markets across the EU to encourage the creation of a market geared towards increased EE.

Strong political will

Such market transformation however will not take place without increased involvement from the private sector. Strong political will is required to trigger such increase in private participation. The fourth lesson drawn from the case studies, then, is the need for governments to create more favourable conditions for public-private partnerships by increasing certainty through risk-sharing instruments and the promotion of the systematic application of an international framework of measurement and verification protocol.

The importance of national context

Fifth, it is important to note the role of national contexts in determining the success and/or failure of any given policy. The specificities of the buildings stock — *i.e.* whether it is largely inhabited by owners or renters — as well as the energy profile or political structure of a country, are all key features to be considered when designing policy packages. Typically, an energy-dependent nation tends to need less information and capacity-building programmes. For example, the UK has certain policies which are implemented across regions, such as white certificate schemes, information programmes and voluntary agreements with manufacturers. Other policies are left to devolved administrations, such as those targeting EE improvements in low-income households as well as building regulations, to allow for social, economic, and physical differences to be accounted for. The success of the combination of different policies in Japan and the US for instance, shows the importance of adapting to national contexts.

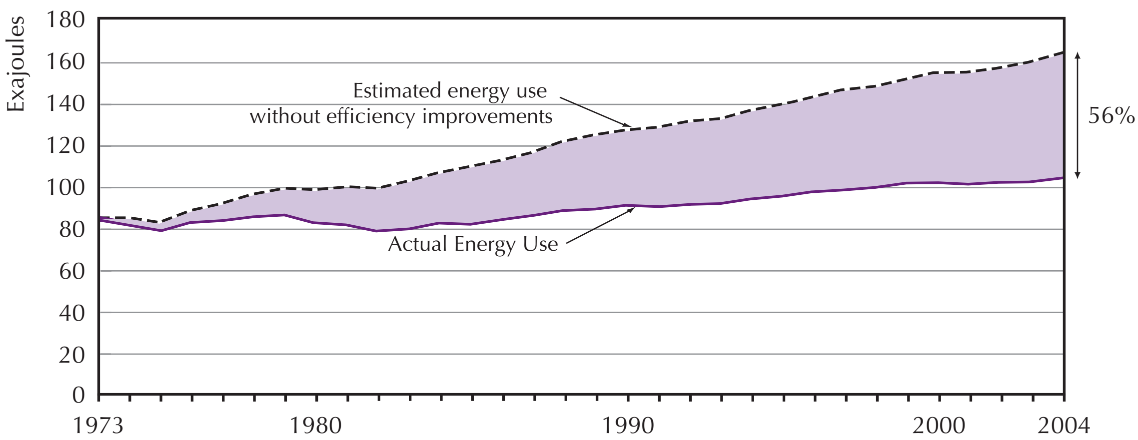
Overall, the study highlights the crucial need for policy makers to collect data in a systematic way at the end of each policy programme. Adequate *ex-post* data is still very scarce and renders comparison between measures and countries much more difficult. Such systematic data collection would enrich future policy analysis.

INTRODUCTION

Energy Efficiency (EE) means greater energy services — such as production, transport and heat — per unit of energy (*i.e.* coal, gas, electricity). Advantages associated with energy efficiency improvements include increased energy security — particularly with regard to reducing dependence on risk-prone fossil fuel energy sources — enhanced environmental protection, and reduced costs for energy services and other financial benefits. Further, through reducing energy use, EE also presents a viable option for the mitigation of carbon dioxide (CO_2) emissions. Although the initial cost of energy-efficient technologies can be higher than their less efficient counterparts, the majority of these technologies make economic sense when analysed on a life-cycle cost basis (IEA, 2003). The growing consensus on the need to mitigate human-induced CO_2 emissions (IPCC, 2007), as well as rising concern about high fuel prices has prompted increased willingness on the part of policy makers to promote EE.

Energy efficiency policies have enabled the achievement of important energy savings. Since the 1973 oil crisis, energy efficiency measures have led to a significant reduction of actual energy consumption (Figure 1).

Figure 1* • *Energy savings due to energy efficiency since 1973



Source: IEA (2007a), *Energy Use in the New Millennium: Trends in IEA Countries,* OECD/IEA, Paris.

Energy-efficient technologies exist and are cost-effective. The building sector in particular presents one of the biggest opportunities for cost-effective energy consumption reduction. In cold climates where most of the energy consumed in the buildings sector is for heating, energy use can be reduced significantly by improved insulation — reducing draughts and leakages — and more efficient heating systems (especially boilers). In hot climates, on the other hand, properly designed ventilation, adequate solar protection or building inertia and insulation can reduce the need to use air conditioning, thereby prompting energy savings.[1]

1. For a more detailed discussion of existing technologies, see Chapter 1.

Despite this proven cost-effective opportunity to reduce energy consumption, a large portion of the potential for energy efficiency in the existing residential building sector remains untapped.[2] Numerous barriers are responsible for this persistent energy efficiency gap. Market barriers include, for example, difficulty in accessing capital, the presence of information asymmetries, and principal-agent problems, also referred to as split incentives. Financial barriers are also decisive in inhibiting progress towards more energy efficient buildings. Such barriers encapsulate a wide range of issues, including the initial cost barrier, risk exposure, discount factor issues, and the inadequacy of traditional financing mechanisms for energy efficiency projects.

The aim of this publication is to provide a detailed overview of policies which have contributed to counter these financial barriers in five different countries. The absence of much literature on such barriers despite their paramount role in hindering progress in energy efficiency, justifies focusing on this issue. Although a brief qualitative evaluation of each policy tool will be provided through a set of five pre-defined criteria,[3] the main purpose of the publication is to present policy makers with a catalogue of existing instruments, policy types and programmes[4] to address financial barriers to EE in their countries.

The first section of the book provides background information on EE potentials in existing residential buildings, as well as existing technologies to meet those potentials. Chapter 2 consists of a brief summary of market barriers preventing the optimal deployment of these technologies, with a particular focus on financial barriers.

The second section of the book comprises case studies of Japan, the United States (US), the European Union (EU), France, Germany, and the United Kingdom (UK). For each case study, an overview of the legal, administrative and institutional conditions that may impact on the financing of EE improvements is provided. Policy goals, strategies and measures are then discussed and where possible, a summary of existing literature on the evaluation of such policies is provided. Finally, examples of particularly successful programmes and instruments in each case are highlighted according to a pre-defined list of criteria, described below. Each chapter presents one case study. Japan and the US are presented first, followed by the three cases from the European Union in alphabetical order. Each chapter follows the same three-part structure.

Categorisation of the policies

Policies which may help address financial barriers to improved energy efficiency in existing residential buildings can be classified in four categories:

2. Hereafter, reference to 'buildings' relates to 'household buildings'.

3. As explained here-below.

4. As such the publication builds on a previous paper on "Policy Responses to the Financial Barrier", providing a more detailed and systematic overview of the national contexts, energy profile and institutional frame work of each country.

Regulatory measures

These measures are government-created instruments that regulate actors' behaviours, generally by requiring performance of pre-defined standards or by commanding particular behaviours, such as reports on specific information. Such measures may indirectly address financial barriers by providing information useful for market creation and enhancement. They also make energy efficient choices mandatory. They include:

- building codes and standards;
- appliance and equipment standards;
- mandatory energy performance certificates; and
- other building sector regulations, such as technical regulations.

Financial and incentive-based measures

This category includes grants and subsidies, which are generally applied when governments consider that the market will not provide the optimal level of energy-efficient investments because of restricted access to capital. Fiscal cuts and credits also belong in this category and are similarly used to encourage actors to implement more EE investments. Examples of such measures include:

- income or other tax credits or reductions, VAT reductions on retrofitting investment or equipment, and pricing measures;
- grants and subsidies; and
- weatherisation programmes.

Voluntary agreements and partnerships

This category may include public-private partnerships, private sector agreements and preferential loans.

Preferential loans are generally initiated to attract customers to a particular scheme; these are often built through public-private partnerships where the government provides a fiscal incentive to the bank, which in turn offers a preferential interest rate to its customers.

Information and capacity-building measures

Such measures are generally non-regulatory and less interventionist. They may address financial barriers by building awareness and managing demand. They aim to foster demand for energy efficient products, and manage energy demand by providing services that enable EE improvements to be made. Examples of these measures include:

- auditing and information programmes;
- voluntary labelling programmes;
- research and development activities;
- demand-side management programmes.

In some instances, it may be difficult to place a policy in a single category, as the policy may include various measures with multiple underlying objectives. Governments may combine different policies that fall across multiple categories in seeking to promote, for example, specific technologies aimed at improving EE in existing buildings. Moreover, similar policies will not necessarily fall under the same category depending on the manner in which they are approached. For example, in the UK, demand-side management programmes take the form of white certificates, or government-determined energy savings obligations that must be met. These are included under regulatory measures. However, in California energy savings targets are not mandated. Rather demand-side management programmes are encouraged through state level financing and as such are classified as capacity-building measures.

Methodology

Due to a lack of *ex-post* data, systematic quantitative analysis of the impacts of policies was not possible in all instances. Nonetheless, qualitative observations are provided for each case study based on the following list of five pre-defined criteria (de T'Serclaes, 2007):

- **Relevance:** The extent to which the policies address financial barriers to energy efficiency.
- **Clarity:** The ease with which the policy is understood by actors, which affects the likelihood of effective implementation.
- **Flexibility:** The extent and ease with which the policy can be altered after its initial introduction, and therefore be adaptable to changing circumstances.
- **Impact and effectiveness:** The positive and negative changes produced by a policy measure, directly or indirectly, intended or unintended, and the success of the policy in increasing awareness and changing behaviours among different actors.
- **Sustainability:** The degree to which the benefits of the policy are likely to continue after the policy has ended; whether implementation of the policy or programme can help the market to evolve.

Some of the policies discussed are not solely aimed at addressing financial barriers to energy efficiency in the existing residential building sector. Responding to financial barriers may in fact comprise only one aspect of a policy's underlying objective. The scope of the policy evaluation is nonetheless placed on the impact on the energy consumption of the residential sector. Flexibility and clarity are important to ensure that the policy i) remains relevant and ii) is feasible. Unclear or overly complex policies increase the transaction costs for all actors involved, rendering their implementation less effective. Striking a balance between flexibility and clarity is often a challenge, as policies that change too frequently may become difficult to understand and implement. Meanwhile sustainability is important as it means the policy can integrate EE into markets relevant to financing energy efficiency in existing residential buildings. The effect of the policies will thus continue even after changes to regulation and government, since they will have succeeded in triggering market transformation. The sustainability of a policy can sometimes depend on the length of time it is implemented; a short-term policy, no matter how effective, may not be able to instigate the necessary market changes.

Within the cases discussed, even a policy measure that is considered successful rarely meets all five criteria. The purpose of the criteria is to evaluate all policies discussed in an objective and consistent manner, and shed light on their comparative strengths and weaknesses.

Section I • KEY CONCEPTS

Chapter 1 • ENERGY EFFICIENCY POTENTIAL IN EXISTING RESIDENTIAL BUILDINGS

Chapter 2 • MARKET BARRIERS TO MORE ENERGY EFFICIENT BUILDINGS

Chapter 1 • ENERGY EFFICIENCY POTENTIAL IN EXISTING RESIDENTIAL BUILDINGS

This chapter establishes the EE potential of existing residential houses and provides a short description of factors influencing energy consumption, as well as existing technologies to decrease this energy consumption. It provides some background information on energy consumption of a household, the factors which can influence it (*i.e.* climate), and a description of existing technologies to decrease energy consumption.

Energy consumption in residential buildings

Household energy requirements are closely linked to climatic conditions. Climate affects the amount of energy consumed to achieve a comfortable indoor temperature, the building materials used and the building design; for example, ventilation and insulation needs vary according to climate. Consequently, EE improvements are undertaken differently in different climates. In this context, three broad climatic zones are relevant: cold, moderate, and warm. On average a cold climatic zone experiences 4 500 heating degree days[5] (HDD) per year, a moderate one 3 500 HDD and a warm one 1 800 (HDD) (Ecofys, 2005). As an example, Finland and Sweden fall within a cold climate zone, France and Germany within a moderate one, and Greece and Spain within a warm one. A considerable portion of the energy resources is consumed for heating in order to achieve thermal comfort conditions in the buildings. As the energy demand increases due to thermal comfort requirements, energy conservation has been included on the agenda of developing countries. Buildings located in warm climate zones also expend energy for cooling to achieve comfortable indoor temperatures. While a range of climatic zones can exist within a single country, the cases studied fall on average within a moderate climatic zone.

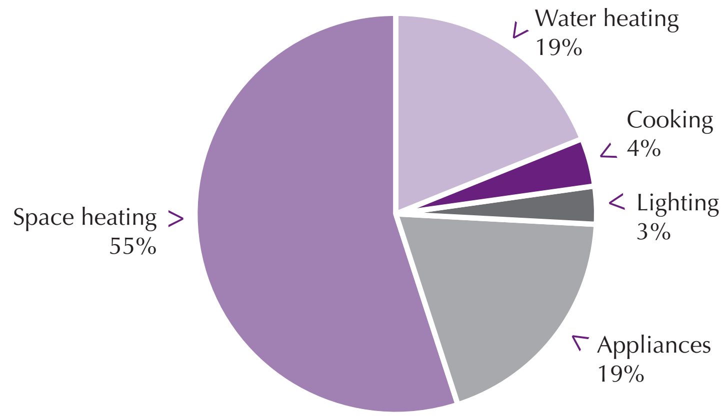
Figure 2 below provides an illustration of the average household consumption by use in a moderate climate.

The most important design parameters affecting indoor thermal comfort and energy conservation in building scale are orientation, building form and the optical and thermophysical properties of the building envelope. All of these parameters are related to each other and the optimum values of each parameter should be determined depending on their respective values. Building form is one of the most important components with respect to total heat loss of the whole building. The overall heat transfer coefficient (U-value) determines heat loss through the building envelope. Thermal performance of the building envelope surrounding a building is also influenced by the building form. Therefore, heat loss for different building forms should be determined related to U-value[6] of the building envelope.

5. *Heating (or cooling) degree days refer to the difference between a reference value (18°C), at which no heating or cooling is required for a comfortable indoor temperature, and the average outside temperature.*

6. *U-value describes how well a building material conducts heat. Methodologically, it measures the rate of heat transfer through a material of known thickness over a given area under standard conditions. The usual standard is at a temperature gradient of 24°C at 50% humidity in no wind conditions. The U-value is the inverse of the R-value, described further below (U= 1/R). The lower the U-value, the higher the efficiency.*

Figure 2* • *Average household energy consumption by use in a moderate climate



Source: IEA (2006), *Energy Technology Perspectives: Scenarios and Strategies to 2050,* IEA/OECD, Paris.

Building form is based on the shape factor (the ratio of building length to building depth), height and roof type. Different building forms may have the same volume, but different facade area.

Energy efficient technologies

A range of cost-effective technologies exists that can improve the efficiency of energy consumption in buildings, chiefly in relation to the building's insulation, envelope and windows. An overview of key technologies for each of these three areas and their cost-effectiveness is provided below.

Insulation

Insulation is a central aspect of managing a household's overall energy consumption. As shown in Table 1, different types of insulation materials and methods can make a difference on the order of one-to-three in a household's heating needs. More sophisticated changes could even take the difference from one-to-five. The table shows the impact of a range of measures, including insulation, ventilation, shutters, building orientation, and behavioural factors on energy consumption. All three houses have the same size (100 m^2) and same volume (250 m^3). House 1 is a 'classical' house. Its insulation is at a typical current building code minimum requirement level. EE is not at all factored in by its residents, or designers (*i.e.* no particular orientation or fenestration)[7]. House 2 is similar to the first one in all respects except for the orientation of the house and its use of shutters. In addition, some basic energy-efficient training has been given to its inhabitants (such as how to use shutters properly etc.). House 3 is a bio-climatic house. That is, it has proper ventilation, insulation, interior blinds, etc.

7. Fenestration refers to products that fill openings in the building envelope, such as windows, doors and skylights.

Table 1 • Energy consumption of three different houses in a moderate climate

	House 1	House 2	House 3
Surface	100 m^2	100 m^2	100 m^2
Volume	250 m^3	250 m^3	250 m^3
Winter temperature	19°C day 15°C night	19°C day 15°C night	19° day 15° night
Windows	16 m^2 Of which 3.2 m^2 South	16 m^2 Of which 11.2 m^2 South	28 m^2 Of which 22 m^2 South
Nights in winter	Shutters opened	Shutters closed	Shutters closed
Day in summer	Shutters opened	Shutters closed 85%	Shutters closed 85%
Wall insulation	7 cm inside	7 cm inside	10 cm external
Roof insulation	14 cm	14 cm	20 cm
Heating/Cooling Needs	**14 300 kWh**	**9 420 kWh**	**5 070 kWh**
	100%	**-34%**	**-65%**

Source: Salomon, T. and S. Bedel (1999), *La maison des négawatts,* Terre Vivante, Mens.

The two main types of insulation are external and internal. Although internal insulation has long been preferred mainly for aesthetic reasons, external insulation has proven to be almost twice as effective (Ademe, 2005). Insulation can also be part of the structure, when for example the building blocks themselves incorporate insulating material (*e.g.* cellular concrete or honeycombed bricks).

In addition, the material used as well as the thickness of insulation, will have an impact on the house insulation's properties.

Proper insulation is closely related to the inertia quality of the house, sometimes called thermal mass. High inertia, which is brought about through the use of heavy materials, will tend to keep the heat inside the dwelling and minimise internal heat variation. A low inertia house on the other hand, will experience rapid changes in temperature based on outside temperature or solar gain. Some insulation materials and some building options favour a high inertia while others do not (some examples are provided below). Insulation is important in all climatic zones, since it reduces heat transfer through the building envelope from both the inside and the outside. When the outside temperature is higher than an acceptable indoor temperature, insulation reduces cooling demand (Ecofys, 2005).

Envelope

Insulation materials are used on the building envelope. The envelope consists of the building's roof, walls, windows and doors, and thus controls the flow of energy between the building's interior and exterior. There are typically two kinds of insulation materials: "light" and "heavy". Light insulation materials can be grouped into three categories:

- Those with a mineral base: glass wool, rock wool, vermiculite, perlite, fibre-glass and expanded clay.
- Those based on honeycombed plastic material: expanded polystyrene, extruded polystyrene or polyurethane.
- Vegetable-based insulators: cork, cellular wool, linen tow, cotton and coco fibre.

The ratio of efficiency between mineral-based and vegetable-based insulators is of the magnitude of one-to-five.

Table 2 • *Insulation materials in decreasing order of efficiency*

Name	Lambda (thermal conductivity) in W/m.K[8]
Polyurethane	0.025
Extruded polysterene	0.029
Cork	0.036
Linen wool	0.038
Rock wool	0.04
Glass wool	0.04
Hemp wool	0.04
Expanded polysterene	0.04
Hemp	0.048
Vermiculite	0.066
Hemp + Lime	0.12

Source: Salomon, T. and S. Bedel (1999), *La maison des négawatts,* Terre Vivante, Mens.

Heavy insulating materials include thick honeycombed terracotta bricks, cellular concrete building blocks, wood, and hemp and lime walls. Such heavy insulation materials allow for a combination of good insulation with a sufficient thermal mass to improve the overall efficiency of the building. On the other hand, achieving sufficient inertia while using light insulation materials requires sound design options (*e.g.* external insulation or the inclusion of heavy material in building's inside structure).

Windows

The choice of windows is also very important in determining the energy efficiency of a building. Efficient windows with a high resistance to heat flow (high R-values)[9] are good in cold climates.

8. Watt per metre Kelvin, measuring heat flow rate per area times temperature gradient.

9. R-value is a measure of thermal conductivity, that is, the rate that heat is transferred through a material. It is used where thermal insulation is achieved by retarding the flow of heat through the material itself. The higher the R-value, the greater the insulation.

The window's resistance to heat flow is affected by a number of factors: the type of glazing material (glass or plastic); the number of layers of glass; the size of the air space between the layers; the filling between the layers of glass and coating; the thermal resistance or conductance of the frame and spacer material; and the "tightness" of the installation. The thermal resistance of a window is also influenced by the design of the window: efficient windows with many small layers of glass will typically have higher R-values (more efficient) than windows with fewer but larger layers. The thermal quality of windows has improved greatly in recent years. Today, multiple glazing, the use of rare gases (such as argon or krypton gas) between layers, as well as the choice of framing materials and glazing surfaces all improve a window's insulation capacity. Thermal conductivity of glazing products ranges from less than 1 $W/m^2.K$ to 6 $W/m^2.K$ (simple glazing). Today the best windows on the market insulate three times as well as their immediate predecessors (IEA, 2006).

Beyond the building envelope, direct changes in the conditioning (heating or cooling) of a household can also significantly improve its efficiency. For instance, there is a significant potential for savings through replacing traditional oil and gas heating systems (IEA, 2006).

As it is, inefficiencies in heating devices come from both the nature of the energy source, and the choice of the appliance. Dramatic progress in heaters (oil or gas) has been made for the past 60 years. Efficiencies have risen from around 60% to more than 80% in oil-fuelled heaters. Condensing gas boilers can achieve up to 97% efficiency. Besides encouraging more efficient heaters, the sizing of equipment is also important. In some cases, replacement of an old, inefficient, oversized boiler may reduce the total consumption by 30 to 35%. High efficiency condensing boilers, for example, convert at a minimum 88% of their fuel into heat, compared with 78% for conventional boilers (EST, 2006). Many options thus exist to improve the efficiency of heating in households.

Cost-benefits of the technologies

Better technologies cannot be adopted if they are not easily available and financially viable. The cost-effectiveness of most energy-efficient technologies in the building sector has been established extensively in the literature (see by way of example, Eurima, 2006; Ellis, 2007).

The most common criterion for determining the cost-effectiveness of a measure is the annualised mitigation cost in Euro per ton of CO_2 avoided. Such a measure accounts for the additional cost to companies, governments and end-consumers that measures to mitigate greenhouse gas (GHG) emissions are expected to produce. On a life-cycle cost basis, assessing the mitigation costs involves not only investments but also operational and maintenance costs (Eurima, 2006).

Capital cost refers to the cost of investment in the equipment. Depending on the context, two investment scenarios should be distinguished: one in which total investment costs cover energy efficiency alone (*i.e.* labour, applicable taxes, overheads and profits), and one in which refurbishments would have happened anyway and to which energy-related measures are added (*i.e.* which include only specific measures). The former are referred to as "independent" in Table 3 below, while the latter are referred to as "coupled". This table summarises the cost/benefit calculations by climatic zones for all EU building stock (*i.e.* both residential and commercial).

They are based on a public societal perspective: they reflect the compilation from studies conducted at a public level only. As such they are based on a fixed discount rate, here 4%. This discount factor might well be different if applied to individuals or firms.[10]

Table 3 below shows the cost-effectiveness of insulation in different climate zones.

Table 3 • *Cost-effectiveness of insulation measures in different climate zones*

Cold zone	**Wall external**	**Wall cavity**	**Wall interior**	**Pitched roof**	**Floor**
Mitigation costs (independent) (EUR/tCO_2)	585	-63	n/a	-6.1	179
Mitigation costs (coupled) (EUR/tCO_2)	146	-63	n/a		
Cost saved energy (independent) (cent/kWh)	14.6	-15	n/a	-1.5	4.4
Cost saved energy (coupled) (cent/kWh)	3.5	-1.5	n/a	n/a	n/a

Moderate zone	Wall external	Wall cavity	Wall interior	Pitched roof	Floor
Mitigation costs (independent) (EUR/tCO_2)	9	-187	n/a	-185	-79
Mitigation costs (coupled) (EUR/tCO_2)	-131	-187	-159	n/a	n/a
Cost saved energy (independent) (cent/kWh)	0.2	-4.3	n/a	-4.2	-1.8
Cost saved energy (coupled) (cent/kWh)	3	-4.3	-3.6	n/a	n/a

10. The ongoing debate as to the appropriateness of the discount rate is discussed Chapter 2.

Warm zone	Wall external	Wall cavity	Wall interior	Pitched roof	Floor
Mitigation costs (independent) (EUR/tCO_2)	-64	-208	n/a	-222	-148
Mitigation costs (coupled) (EUR/tCO_2)	-166	-208	-191	n/a	n/a
Cost saved energy (independent) (cent/kWh)	-1.3	-4.2	n/a	-4.5	-3
Cost saved energy (coupled) (cent/kWh)	-3.4	-4.2	-3.9	n/a	n/a

Source: Ecofys (2005), *Cost-Effective Climate Protection in the EU Building Stock,* Ecofys, Cologne.[11]

The analysis shows that notwithstanding climatic zones, insulation measures make financial sense from a life-cycle standpoint.

To summarise, technologies to improve the efficiency of building energy consumption exist and are cost-effective. This is particularly the case when they are adopted in the context of the natural retrofitting cycle. The scope of this publication focuses on all energy-efficient refurbishments of residential dwellings that result in EE improvements, though EE improvements associated with small electronic appliances are not addressed.

11. The terms "independent" and "coupled" refer to EE measures being taken independently of any work on the house, or coupled with work that would have been done anyway.

Chapter 2 • MARKET BARRIERS TO MORE ENERGY EFFICIENT BUILDINGS

The full advantage of energy efficiency potentials is hindered by the presence of obstacles in the market, often referred to as market barriers. Numerous studies have analysed the nature and occurrence of these barriers in detail (Brown, 2001; DeCanio, 1993; Sorrell *et al.*, 2004).

This chapter briefly describes the gap between the under-utilised technology potential for energy savings through EE and the actual utilisation of EE: the energy efficiency gap. It then turns to the description of the most significant obstacles to the deployment of energy efficient technologies in existing residential buildings — both barriers and failures. Here the chapter focuses on financial barriers a term which encapsulates a wide range of issues including the initial cost barrier, uncertainty, small size of the projects, risk exposure, discount rate issues, high transaction costs, and the inadequacy of traditional evaluation criteria.

The energy efficiency gap

The Intergovernmental Panel on Climate Change (IPCC) found that cost-effective energy efficiency improvements could contribute to half the potential emission reductions by 2020[12] (IPCC, 2001). More recently, the IEA World Energy Outlook 2007 (IEA, 2007a) and the IPCC 2007 Working Group III identify energy efficiency's significant potential to reduce greenhouse gas emissions over the next 20 to 30 years.

A range of technologies and options contributes to this potential. For example, if all conventional incandescent lamps worldwide were replaced by Compact Fluorescent Lamps (CFLs) roughly 2 880 PJ and 470 $MtCO_2$ emissions in 2010 could be saved, rising to 4 320 PJ and 700 $MtCO_2$ in 2030. Cumulatively this would reduce global net lighting costs by USD 1.3 trillion from 2008 to 2030, and avoid 6.4 Gt CO_2 emissions at negative abatement cost of USD -205 per tonne (IEA, 2007a). The potential cost-effective savings from improvements in heating, cooling, ventilation and hot water in the building sector, which accounts for approximately 40% of all energy use, is at least 20 EJ per year by 2030 (IEA, 2007b).

Yet evidence suggests that a significant proportion of energy efficiency improvement potential is not realised. The difference between the actual level of energy efficiency and the higher level that would be cost-effective from the individual's or firm's point of view is often referred to as the 'efficiency gap'. Many studies have documented the existence of this gap (Interlaboratory Working Group, 2000; Ecofys 2001; IPCC, 2001; Krewitt, 2006).[13]

The existence of the energy efficiency gap is often explained by the presence of "market failures" and "market barriers" to energy efficiency (IEA, 2007b).

12. Net capita, operating and maintenance costs.

13. Although there is some debate about the actual existence of the energy efficiency gap (See for example Sutherland [1991]).

Market barriers and failures

Low priority of energy issues

In many instances, energy efficiency is not a major concern for consumers or firms because energy costs are low relative to the cost of many other factors (such as labour costs). Consequently, there is little incentive to invest in energy efficiency improvements. Examples of this are well-documented. In the office space market in London, energy costs are equivalent to 1%-2% of rental costs (Guertler *et al.*, 2005).

Since energy costs are typically small relative to other costs, it is easy for consumers to ignore them. This may also mean that the benefits from energy savings to individuals may be outweighed by the transaction costs (*e.g.* costs of gathering information and perceived inconvenience of installing new equipment). Numerous studies demonstrate that consumers invest in upgrades of their buildings, appliances, cars, and other equipment for safety, health, comfort, aesthetics, reliability, convenience, and status reasons. Energy efficiency rarely is a high priority issue relative to these other factors.

It is important to note that, even though at an individual level energy costs may be insignificant, when summed over all individuals, energy can represent a significant cost to society. Governments may wish to promote energy efficiency as a cost-effective method for reducing energy use and achieving other policy goals such as improved energy security and environmental sustainability (IEA, 2007b).

This low priority given to energy efficiency can also have indirect consequences. Engineering fee structures are typically based on a percentage of the capital cost of the project, subcontract, or equipment installed. The fee structure then is such that designers who do extra work to design and implement innovative energy-efficient systems such as passive solar building that requires less installed equipment (such as HVAC), which end up cutting their clients' operating costs, are actually penalised by lower fees and profits results. This penalisation occurs in two different ways: i) engineers/architects are getting a percentage on a lower cost; and ii) they are doing more work for that smaller fee. In the end they are thus enduring higher cost for lower profits. In the words of a mechanical engineer of an ASHRAE- award building, "We had a negative motivation to do it right".[14] Overall then all the different parties will seek to maximise the net present value of a building's net income during the holding period and the potential resale value (Golove and Eto, 1996).

Fiscal regimes can contribute to this disincentive. American law for example allows all operating costs to be tax deductible. Capital costs however, have to be depreciated during 30 years. Buildings managers will tend to favour the latter with expected consequences for EE projects. Speculative builders overall tend not to consider operating costs at all because what they want is immediate resale. Hence, they will not consider the potential long-term advantages of carefully designed heating systems (Lovins, 1992). Furthermore, more than 12 states in the United States

14. In Lovins, 1992 p. 23.

charge sales tax on residential energy saving devices but not on residential fuels and electricity, while only one, Rhode Island, does the opposite (Brown, 2001).

Information failure

Information failure stands amongst the most important barriers to the deployment of energy-efficient technologies.[15] There are different forms of information obstacles: its asymmetric access, the mere lack of available information and its highly technical aspect which makes it difficult for non-experts to understand.

Competition and market liberalisation have been introduced recently in many energy markets. This heritage often means that energy markets are still sometimes framed in monopolistic patterns. Decisions are consequently often taken by large equipment manufacturers, which could theoretically try to inhibit the introduction by competitors of energy-efficient, cost-effective products (Hall *et al.*, 2005). This context also means that equipment manufacturers can choose not to share information with other players.

Another information obstacle exists in the lack of properly synthesised information describing financial options available to individuals investing in energy efficiency (Lovins, 1992). Information relating to EE is still difficult to get: people are not prepared to give it away and even when they do, consumers tend to mistrust it because they were previously misled by faulty technologies (Golove and Eto, 1996; Hall *et al.*, 2005).[16]

Beyond the lack of available information, its clarity to the average customer is also a major obstacle. It is often very difficult for non-experts to understand the small amount of information to which they have access. The ability to process and understand the technicality of the given information is also often seen as a challenge in and of itself: "Individuals and firms are limited in their ability to use- store, retrieve, and analyse- information" (Kempton and Montgomery, 1982).

Most actors in the building chain do not have adequate training and knowledge in energy efficiency (Brown, 2001). Suppliers, manufacturers, promoters, and financiers alike, tend to lack the necessary skills to adequately promote energy efficiency products to their customers. Financiers will tend not to be trained on the issues of energy efficiency, and thus will not naturally promote funding for such projects, and will not know what to answer when asked about it (Hall *et al.*, 2005). Interviews reveal that even once consumers express a willingness to implement EE, they often find it difficult to obtain qualified advice from financial experts. As will be seen in further details in the next section, energy expertise is almost nonexistent within financial institutions. Bankers rarely know of the existence of tools and special provisions for EE projects (WWF, 2005).

15. Please refer to Ramesohl and Dudda (2001) for a complementary view on the subject: their empirical study suggests that the lack of adequate technical expertise and guidelines is most often quoted by customers as the most important barrier to their implementation of EE projects.

16. A useful illustration of this idea is given by Golove and Eto on page 24 of their 1996 paper. Demonstrating that when two firms are involved it might well be that one will be able to benefit from the information sharing of the other, hence transaction costs would be much more efficiently reduced through institutional reforms and incentives.

The functioning of the building chain (*i.e.* energy suppliers, architects, project leader, programmer etc) can be viewed as a further barrier to energy efficiency development. Analysing the chain, it appears that behaving in the most economically rational way possible, individual agents of the energy market chain will end up running counter to energy efficiency. Australian studies (AGO, 1998) reveal that EE choices are generally not present at all in the building actors' minds. The actors are not wilfully trying to rally against EE, they simply do not feature it in their thinking (Lovins, 1995).

These failures affect energy efficient projects in various ways. First, they lead to a lack of customers' awareness of the benefits of energy efficiency - both financial and environmental. In the residential sector the perception that energy efficiency requires sacrifices has been persistent (Kempton *et al.*, 1985). The information failure also reinforces the challenge posed by behaviours of consumers, and habits which are difficult to shake off. Without proper information on options and possibilities for improvement, changes in consumer habits will be even slower (Golove and Eto, 1996).

Split incentives

Yet another important barrier to increased energy-efficient homes is specific to the building context: the split-incentive issue, also called the principal-agent problem (IEA, 2007c).

This refers to the notion that in most cases, the owner and occupier of a house (or apartment) is a different person. When the tenant is responsible for the energy-utility bills, it is in the landlord's interest to provide least-first-cost equipment rather than consider the equipment's energy efficiency. Often this means that equipment with relatively low energy efficiency is installed. Similarly, the tenant will not be willing to pay for energy efficient equipment that they cannot take with them. Investing in EE upgrades then, will not be a natural move for either actor.

Price distortion

Another characteristic of energy is that it is often considered a right which should be made available to everyone. As such, energy is often heavily subsidised. Excessive subsidisation of energy prices can distort the markets, and prevent consumers receiving accurate price signals that reflect the true marginal cost of the energy use (Levine and Hirst, 1994).

Box 1 • Externalities: definition

Externalities: The consequences or impacts of resource decisions that are not directly accounted for in the price paid for the resource. Benefits or costs generated as the result of an economic activity that do not accrue directly to the parties involved in the activity. The cost of natural resource depletion, pollution and other environmental and social factors are externalities that often are not factored into the market price of a product.

Energy price distortions are not only caused by subsidies and regulation, they are also the result of the lack of inclusion of externalities. It has been argued that current energy prices do not reflect their true societal costs, and that an accurate pricing should incorporate societal costs in the price of energy (Jakob, 2006).

Financial barriers

Access to capital: initial cost

The initial cost barrier refers to the fact that energy-efficient products tend to be more expensive than their less efficient counterparts. Although energy-efficient technologies make sense on a life-cycle cost standpoint, their higher initial cost often represents an insurmountable barrier for customers. Studies demonstrate that, even when consumers are assured they are buying a longer-life product (*i.e.* through appropriate labelling and information), they tend to stick to the least efficient product, because of the low initial cost (Brown, 2001). Although economic theory states that the market should provide capital for all investment needs at a risk-adjusted price, empirical studies reveal that low-income borrowers and small business owners have extreme difficulties in accessing capital. For some lower-income sections of the community, the difficulty obtaining the initial capital may be insurmountable.[17]

Uncertainty

Uncertainty associated with energy savings

There are still challenges in the methods used to quantify energy savings. It is difficult to evaluate ancillary benefits (*i.e.* health benefits of projects) (Jakob, 2006). While systematic *ex-post* evaluation is too costly, the different methods existing for *ex-ante* evaluation maintain a certain level of uncertainty, and contribute to create a fear of hidden risks in energy-efficient projects.

Lack of standardised measurement and verification protocol

The absence of standardised measurements and verifications protocol ("M&V") has been identified as having major negative impacts on EE projects (Ramesohl and Dudda, 2001).[18] A direct consequence of such absence is the need for financiers to spend more time on the evaluation of every single energy-efficient project, compared to the average time they will spend on other investments. Moreover, both investors and customers still get no certainty on the level of energy savings to be achieved; as such they tend to shy away from EE investments.[19]

17. *Although again market instruments do exist, the context prevents them from adequately being applied here. Here one market solution would be micro-credit or leasing. The next section will analyse in detail why these solutions are difficult in this context.*

18. *The International Performance and Verification Protocol (IPMVP) does seek to establish an international framework highlighting the best practices of energy savings' methods, however it is still not widely adopted.*

19. *This aspect will be analysed further in a coming section.*

This lack of standardisation in the measurement and verification protocol also has indirect consequences: it further increases the transaction costs related with EE projects.

Risk associated with energy efficiency projects

Risk exposure

The ratio of the risk exposure to the return on investment of a project is an important indicator of that investment's validity for a financier. There are two common ways to factor in risk in the evaluation of a project: one consists in applying a high discount rate when evaluating the project, while the other calls for a very high return on investment that compensates the risk. Energy efficiency projects however often do not meet either criteria. Commercial bankers typically pick investments which are safest and grant medium return on investments. Speculators or hedge fund managers on the other hand are more likely to take on risky investments and will be ready to spend more time analysing a specific situation, should the return be worth it.

Unfortunately, energy-efficient investments in individual buildings do not fulfil either criteria: they are not large enough to attract speculators and are perceived as too uncertain for commercial bankers.

Discount rate

A key issue with respect to evaluation method is the nature of the discount rate applied. Scholars disagree on the appropriate level of the discount rate which should be applied to EE projects (Thompson, 1997). Although many argue that the discount rate is currently too high, others consider that it is justified on account of the riskiness of the investments.

Depending on one's standpoint, energy-efficient investments can be viewed as extremely risky or not risky at all. Energy efficiency investment projects are a safer option when considering that they reduce individual's exposure to the volatility of fuel price — which is by far the most important risk/in an energy project.

In that sense, one could imagine the need for a paradigm shift in the perception of EE investments by investors: energy-efficient investments could be thought of as hedging tools against the volatility of fuel prices (Cusatis and Thomas, 2005; Kromer, 2006; Mills *et al.*, 2006). Such perspective would trigger completely different evaluation methods. In the meantime, the uncertainty surrounding the appropriate evaluation method contributes to shy away investors from EE projects. The prevailing traditional view however is still to consider EE projects as risky investments, and as such to apply high discount rate which undermines their value.

Small size

The relatively small size of energy-efficient projects compared to other investments further reinforces the increased transaction costs related to EE projects. The high uncertainty surrounding energy savings measures, the high risk associated with the projects, the difficult replicability of projects, and the small size of EE projects all contribute to higher transaction costs for the projects. As such investors tend to turn to other projects which are more easily replicable.

Information failure: unfamiliarity of financiers with EE investments

Evaluation issues

The information failure is present also in the financial sector. The absence of EE awareness among financiers is an important barrier to increased energy efficiency investments.

When choosing between investments, a financier typically looks at three factors: the risk exposure of the project, the time for the return of investments (or payback time); and the rate of the return on investment.[20] It is common practice for investors to refer to the payback time as an indicative value of their investments (*i.e.* the time it will take them to earn back their initial investment). As such, EE projects do not rank high on financiers' agendas since projects tend to have a longer payback period than more classical investments (Golove and Eto, 1996).[21]

Effort should be placed on demonstrating the inappropriateness of such an indicator, since amongst other things it does not take into consideration benefits accrued after the payback time.[22] This measure is particularly inappropriate in the building sector context since buildings' lifetime usually exceeds 30 years. Benefits will thus accrue way beyond investments' payback time. Referring to payback time as the only reference point of the investment validity also prevents capturing the importance of the public good aspect of energy efficiency. Despite its inappropriateness, reference to the payback time is still common and as such is an obstacle to energy efficiency projects.

Within this evaluation issue, the quantification of ancillary benefits in EE projects is another problem. Standard evaluation tools (*i.e.* payback period or net present value) are not adapted to energy efficiency investments, because they do not take into account accrued interests after the payback time, nor do they take into account a quantification of ancillary benefits such as increase in overall well being, health conditions, or job improvement in the cost/benefit analysis (Jakob, 2006).

Although these two criteria present very different issues, they both fail to evaluate energy efficiency projects accurately. It can be argued that the information failure in the financial sector leads to an inadequate use of traditional evaluation criteria. Until an agreed way of quantifying ancillary benefits is found, energy efficiency investments will remain misunderstood by financiers. Both investment criteria and financiers' lack of knowledge of EE specificities are obstacles to customers' access to capital in EE projects.

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20. *Return on Investment (ROI) is the ratio of money gained or lost on an investment to the amount of money invested. The amount of money gained or lost may be referred to as interest, profit/loss, gain/loss, or net income/loss. The money invested may be referred to as the asset, capital, principal, or the cost basis of the investment. It is not the same thing as time, or internal rate of investment.*

21. *Martin (1998) emphasises that in 40% of cases, retrofitting measures have payback times of over 70 years, when typical industrial projects have on average a payback time of 15 years.*

22. *Philibert (2006).*

Adapting criteria

Another drawback in investment criteria is their failure to adapt to energy-efficient specificities. Although credit capacity and risk profile of customers should be improved through their purchase of energy-efficient equipment (since it improves the borrower's net cash flow), the market does not respond adequately: financiers fail to factor in this increased credit capacity.

Difficult replication increases the transaction costs

Another important decision factor for financiers is the replicability of the business model under consideration. Commercial bankers will naturally be keen on all investments which are easily replicable, and for which evaluation is standardised. The quick overview provided in this section has shown that EE projects are not easily replicable, and suffer from a lack of standardisation methods.

Financial barriers then, in diverse forms — initial cost barrier; the nature of the financier; lack of consensus on proper methods of evaluation — remain a significant obstacle to the natural uptake of more energy efficiency in the building sector. Overcoming these barriers will not be achieved by the market alone. As has been explained, price distortions, perverse actors' incentives, and information failures, among other barriers still prevent consumers behaving in a socially optimal way.

Policies and programmes have been applied by both the public and the private sector to overcome these barriers. This study focuses on financial barriers. Before turning to the different policies and programme examples from IEA member countries, the study will first review classical financial approaches and explain their inadequacies in dealing with the investments considered here.

Traditional financial approaches

Leasing requires larger scale

The market's common way of dealing with initial cost barrier is leasing. There are two different kinds of leasing: operational and financial leases. The former generally concerns shorter-term leases, and may be cancelled. The latter by contrast cannot typically be cancelled and will transfer all the risk to the lessee.

Leasing is suited to situations where physical assets form the greater bulk of the expenditure rather than labour services, and where continued use of the asset may be denied to the ultimate owner in the event of default. The transaction costs involved in leasing on a small scale would be high, relative to consumer credit,[23] and there would be greater risk for the lender, and cost for the borrower, in projects with a low component of physical assets. Hence, leasing is not an appropriate instrument in cases of small-scale retrofitting projects in buildings.

23. Consumer credit is typically based on consumers' income and wealth, as well as his/her securities. Compared the loan size, transaction cost (both in terms of money and time) will not necessarily be worth it for an individual consumer.

Loans require more certainty

Loans are another possible financial solution. The general volume of lending and level of interest rates will depend on the demand and supply of money according to macro-economic conditions in the economy, which will vary from time to time. However, it is useful to understand the factors which individual lending institutions take into account when offering loans.

The principal motivation for a lender is to earn a return on financial capital. They do so by advancing the money to a borrower, under conditions which ensure the return of the capital at, or by the end of the loan. Lending money to governments or banks is associated with near-zero risk of loss of capital, but provides the lowest returns.

A typical financial project is divided between debt and equity financing. Debt is usually a conventional commercial bank loan to which a customer pays interest (*i.e.* thereby ending up paying for the loan and the price of the debt). Lenders normally charge a pre-determined rate of interest that is set by adding an interest margin to the bank's standard inter-bank lending rate. This is the bank's 'basis point margin' and represents the bank's return on investment or income.

As such, lenders require information about the borrower's income capacity before making the loan. Lending on an unsecured asset involves greater risks, and lenders will require higher interest rates. Lenders will have incentives to maximise the charge to borrowers, but be constrained by the opportunity available to borrowers to seek loans from other sources.

Lending money to individuals and firms carries a more significant risk and therefore lenders will require a higher rate of interest and possibly other collateral security in order to provide the loan. As such the uncertainties surrounding energy savings projections, do not lend themselves well to typical loan financing.

Project financing requires large scale and more certainty

Project finance, or off-balance sheet payment,[24] by contrast to debt financing, will rely on a project's cash flow expectations, not on an individual's credit-worthiness. The principle behind project financing is to spread the risk among the different actors. A typical project finance structure will include a wide array of contracts between the different actors that will transfer the risk and allow an adequate risk coverage and division.

Customers who have strong balance sheets will not have to resort to project finance. Gearing (the ratio of debt-to-equity) is much higher in project finance than in "on balance sheet" financing. A project with 70-80% debt and 20-30% equity is common in project financing. Compared to on balance sheet finance, banks will usually be willing to extend the length of the project finance loans to almost 15 years (because they will have much more control over the project).

Another particularity of project financing is that it transfers the risk away from the financiers and spreads it amongst the different actors. Through contracting and because risk is divided

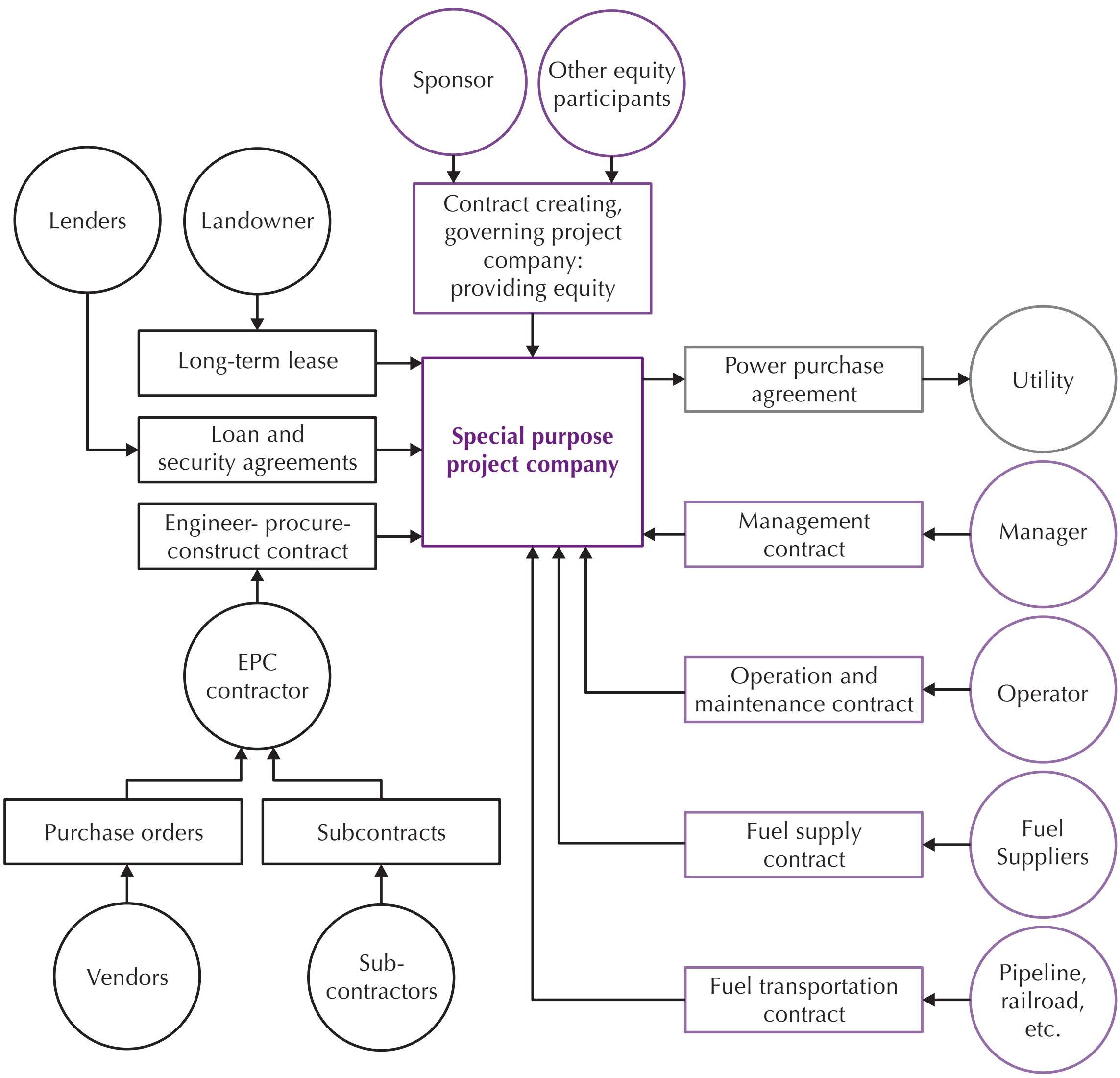
24. Referred to as such, because it is often structured in a way which prevents any sponsors from bearing the entire risk alone. If structured properly, the risk-sharing feature allows the project sponsors to avoid listing the project on any of their corporate balance sheets.

between the different sponsors of the project, project financing ensures that there are different outcomes in case of non-payment.

Again, the uncertainties in the exact savings that will be achieved in a given energy efficiency project, plays against EE projects. Moreover, the relatively small size of EE projects will also tend to disadvantage them when considering project financing.

Figure 3 below illustrates a project financing structure. The complex array of contracts among the different actors is well represented. The diagram demonstrates the complexity and heavy transaction costs that are characteristics of such a scheme, and demonstrates why it is not appropriate for small-scale projects.

Figure 3 • Example of project finance structure



Project finance relies mostly on future cash flows by contrast to individual's credit worthiness. As such it could appear as a good mechanism for EE investments. However, the large transaction cost and intricacies of project financing imply a very high threshold investment price. Typical PF deals are not considered under USD 20 m.[25] As such, this deal structure is unsuitable for the EE investments under consideration in this study.

Overall then, EE investments are particularly difficult to finance for several reasons:

- the highly illiquid and irreversible nature of their commitment, which increase their riskiness;
- their small size compared to typical industrial projects; and
- the difficulty of reproducing these projects.

These factors explain the challenge in finding ready-made adequate financing instruments for energy-efficient investments.

25. An investment banker at Merrill Lynch.

Section II • CASE STUDIES

Chapter 3 • JAPAN

Chapter 4 • THE UNITED STATES

Chapter 5 • THE EUROPEAN UNION

Chapter 6 • FRANCE

Chapter 7 • GERMANY

Chapter 8 • THE UNITED KINGDOM

Chapter 3 • JAPAN

Introduction

Japan's most recent Energy White Paper emphasises the danger of climate change. Energy efficiency measures in the residential sector, among others, have therefore taken on new importance, as carbon dioxide (CO_2) emissions from this sector have increased by a substantial 36.7% since 1990 (METI, 2007). Moreover, a Cabinet Meeting Decision in June 2007 integrated environmental and energy policy within a more ambitious aim of transforming Japan into a "leading environmental nation". This vision includes a low-carbon society, where sustainable energy use forms a part of all economic activity, rather than constrains it (Government of Japan, 2007). Energy efficiency (EE) policies targeting the existing residential building sector have long been conventional, involving improving EE in building envelopes and appliances. However these more recent policy goals emphasise the creation of new business models in manufacturing, energy production, building, and energy services sectors, the integration of the environment and the economy, and the utilisation of various policy measures.

The following chapter first provides an overview of the energy profile and particular national context shaping the residential building sector in Japan and the potential for EE improvements. Overarching policy goals and strategies are also outlined. It presents individual policy measures as well as a brief evaluation.

National context and policy framework

National context and energy profile

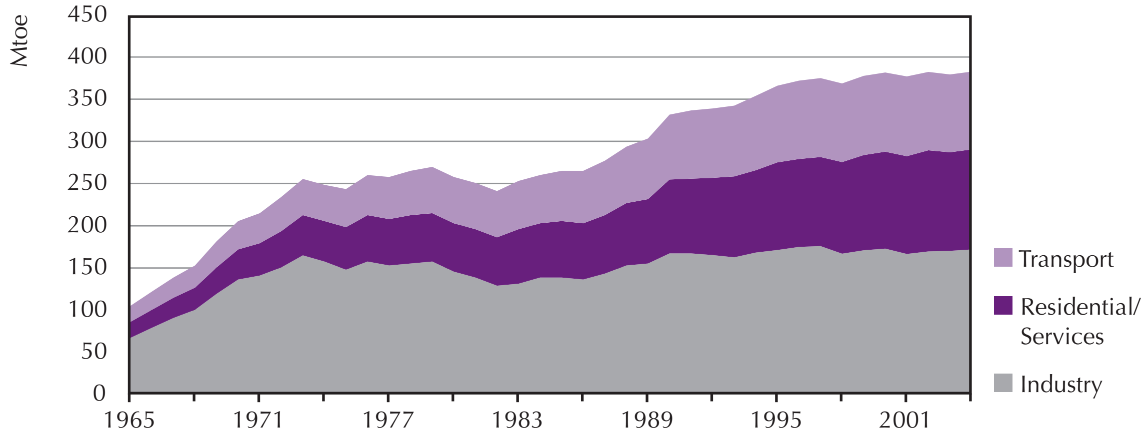
The following sections provide a short overview of the national context for the Japanese building sector such as climate indicators, the macro-economic and energy economic background as well as the housing market in Japan.

Macro-economic and energy economic background

In Japan, the rise of total energy consumption had outstripped the rise of GDP before the oil crisis in the 1970s. The oil crisis of the 1970s changed the situation to accelerate the development of energy-efficient products, and efforts to improve energy efficiency in the industrial sector. However, after the 1980s, energy consumption once again increased due to relatively low oil prices and changes in lifestyle, such as the pursuit of greater comfort. The residential and service sectors accounted for about 30% of total energy consumption in 2004 as shown in Figure 4. There was a 35% increase in energy consumption in the residential and service sectors between 1990 and 2002. This figure is higher than the growth in industry and transport sectors, which are 13% and 20% respectively for the same period.

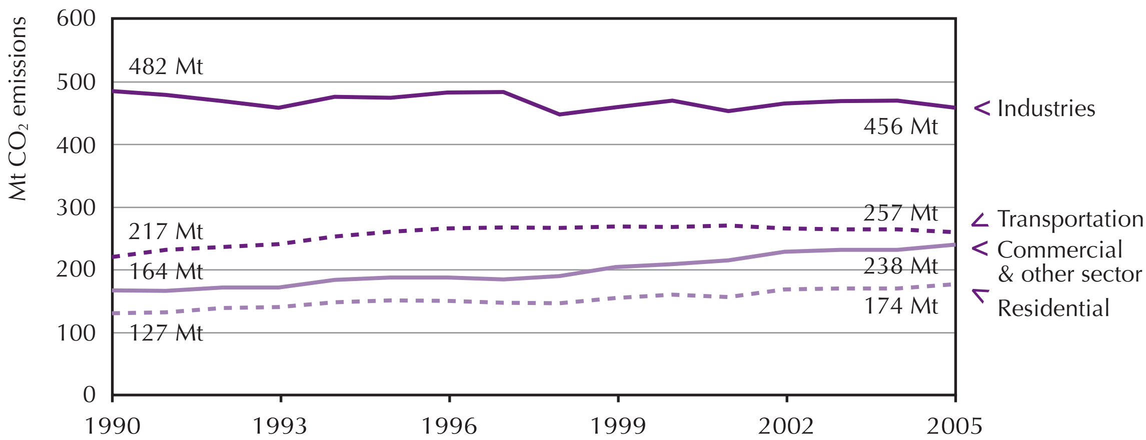
Carbon dioxide emissions from each sector from 1990 to 2004 are indicated in Figure 5. It can be seen that CO_2 emissions from industry and transportation sectors decreased, or that the margin of increase during this period was small. On the other hand, the energy consumption of the residential and service sectors grew by 32% and 38% respectively during the same period, with CO_2 emissions rising alongside. In 2005 the residential sector represented 18% of total final energy consumption. This increasing trend in consumption is in part due to increased penetration of electrical appliances. The increase in energy use for both residential and service sectors points to the need to introduce new, more effective energy efficiency measures.

Figure 4 • Final energy demand for each sector in Japan



Source: Calculations based on data from METI (2006) *Energy White Paper,* METI, Tokyo.

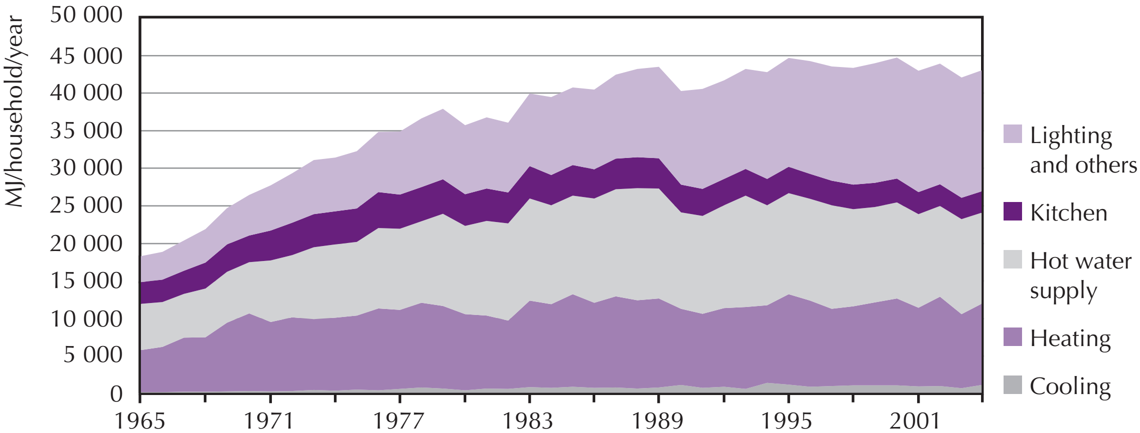
Figure 5 • CO_2 emissions by sector in Japan



Source: Greenhouse Gas Inventory Office of Japan (2007), The GHG Emissions Data of Japan (1990-2004).

For the residential sector, energy consumption is classified into five categories: cooling, heating, hot water supply, kitchen, and lighting and others. Figure 6 indicates the past record of energy consumption by category at the household level from 1965 to 2004. In 1965, shares of each category, in decreasing order, were 34% for hot water supply, 31% for heating, 19% for lighting and others and 0.4% for cooling respectively. With the diffusion of appliances with high capacity and multiple functions, the share for lighting and others have increased as has cooling demand. Accordingly, shares for heating, kitchen and hot water supply have declined. In 2004, the shares for each category in decreasing order were 37% for lighting and others, 28% for hot water supply, 25% for heating, 7% for kitchen and 2% for cooling. It should be noted that demand for cooling increased in 2004 due to a record-breaking hot summer in that year.

Figure 6 • Residential energy demand by end-use in Japan

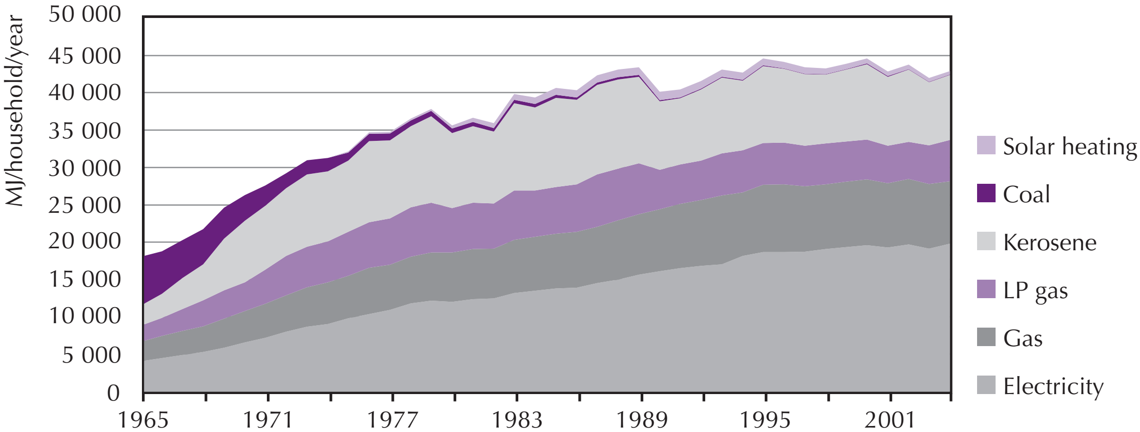


Source: Calculations based on data from METI (2006) Energy White Paper, METI, Tokyo.

Figure 7 shows the contribution of each energy source to the energy consumption for an average household. Coal was the dominant source of household energy consumption, accounting for one-third of all energy consumption until mid-1960s. During the 1970s, kerosene, electricity and gas served as major energy sources for households, accounting for one-third respectively. Coal was substituted by kerosene to reduce its share to only 3%. Thereafter, electricity became more dominant due to the introduction of high capacity and multifunctional appliances in Japanese households. At present electricity is the most used energy source, regarded as safe and useful, and occupied a market share of 46% in 2004.

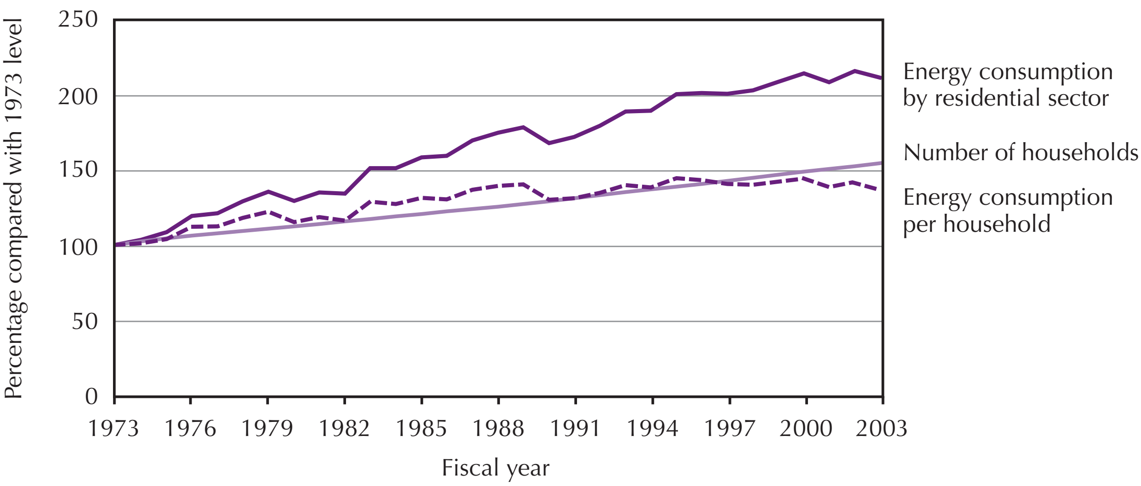
Energy consumption per household peaked in the mid-1990s and started to decrease slightly due to energy conservation measures such as improvement in the thermal insulation of houses and increasingly efficient home appliances. However, total energy consumption in the residential sector increased substantially until the mid-1980s, and a slight increase was maintained until 2003 (Figure 8). This was mainly caused by an increase in the number of households in Japan during the same period. The number of households rose by 154% compared to 1973, due to a shift to smaller size, sometimes single-person households (IBEC, 2006c).

Figure 7 • ***Residential energy source consumption***



Source: Calculations based on data from METI (2006) *Energy White Paper,* METI, Tokyo.

Figure 8 • ***Changes in residential sector energy consumption and number of households***



Source: Calculations based on data from METI (2004) *Energy White Paper,* METI, Tokyo.

Housing market

The specificity of Japan's housing market helps to explain the barriers, financial and others, to energy efficiency improvements in Japan's housing sector. This section provides an overview of building types, ownership status, the occurrence of renovation and enlargement of houses, and the records of annual new construction. Statistics on construction and renovation of buildings are important since they indicate opportunities to improve energy conservation of existing housing envelopes.

The types of buildings as of 2006 are classified by the period of their construction (Table 4). In Japan, more than half of dwellings are classified as individual houses, though the ratio of apartment buildings has increased for more recent construction.

As for the ownership of houses, change in ratio of owner occupiers to tenants every five years from 1978 to 2003 is indicated in Table 5. The house ownership ratio has remained at about 60% for the last 30 years with small fluctuations.

Table 4 • Overview of the stock of residential buildings in Japan

(Unit: million households)

	Detached houses	Apartment buildings	Others
Built before 1980	11.3654	5.3407	0.0376
Built between 1981 and 1990	5.9552	5.1605	0.0806
Built between 1991 and 2000	5.9402	6.5306	0.1103
Built after 2001	1.2959	1.4398	0.0026
Total[1]	**24.5567**	**18.4716**	**0.2311**

[1] *the number of houses as of 2003 excluding houses of unknown construction year.*

Source: Statistic bureau (2006), Statistics of Japanese lands and houses.

Table 5 • Change of ownership status of houses in Japan *(million households)*

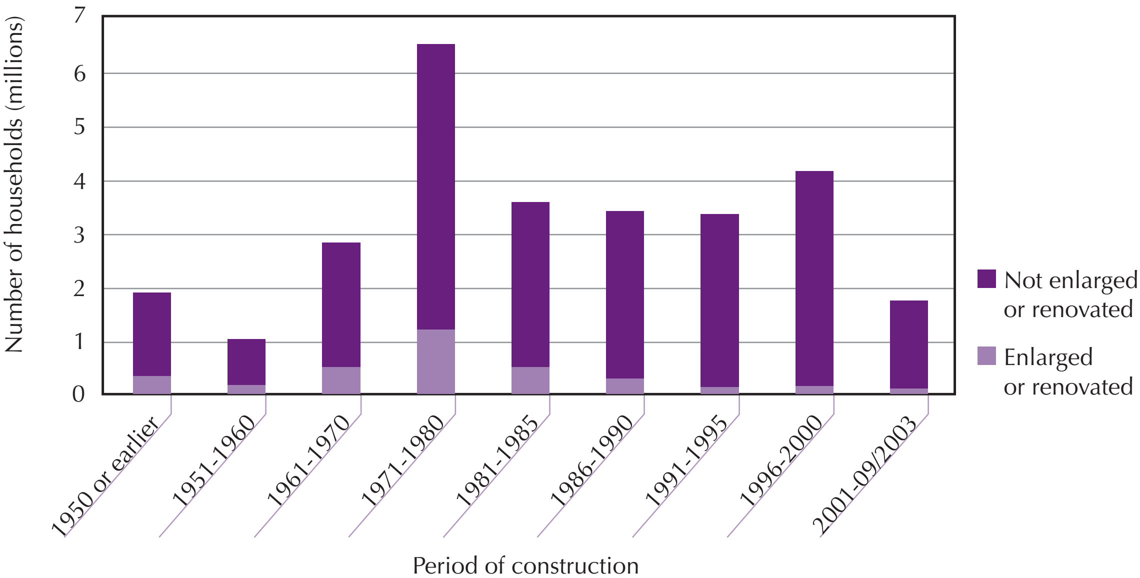
Status of house ownership	1978	1983	1988	1993	1998	2003
Total number of households[1]	**32.19**	**34.71**	**37.41**	**40.77**	**43.92**	**46.86**
Owner occupier	19.43	21.65	22.95	24.38	26.47	28.67
Tenant	12.69	12.95	14.02	15.69	16.73	17.17
Social tenant	*2.44*	*2.65*	*2.80*	*2.88*	*2.95*	*3.12*
Private tenant	*8.41*	*8.49*	*9.67*	*10.76*	*12.05*	*12.56*
Issued houses	*1.84*	*1.82*	*1.55*	*2.05*	*1.73*	*1.49*
Ratio of house ownership[2]	**59.9**	**62.0**	**61.1**	**59.6**	**60.0**	**60.9**

[1] *households of unknown ownership included* [2] *(owner occupier ÷ total households)*100.*

Source: Statistic bureau (2006), Statistics of Japanese lands and houses.

Figure 9 indicates the occurrence of renovation and enlargement of houses constructed in each five or ten year period for owned houses between 1999 and 2003. During this period 13% of all houses underwent renovation. It should be noted that these cases include not only enlargement and major renovation, but also small renovations of bathrooms and toilets needed by aging dwellers, which might not contribute to improving the house's energy efficiency and conservation.

Figure 9 • *Renovation in the Japanese housing market*

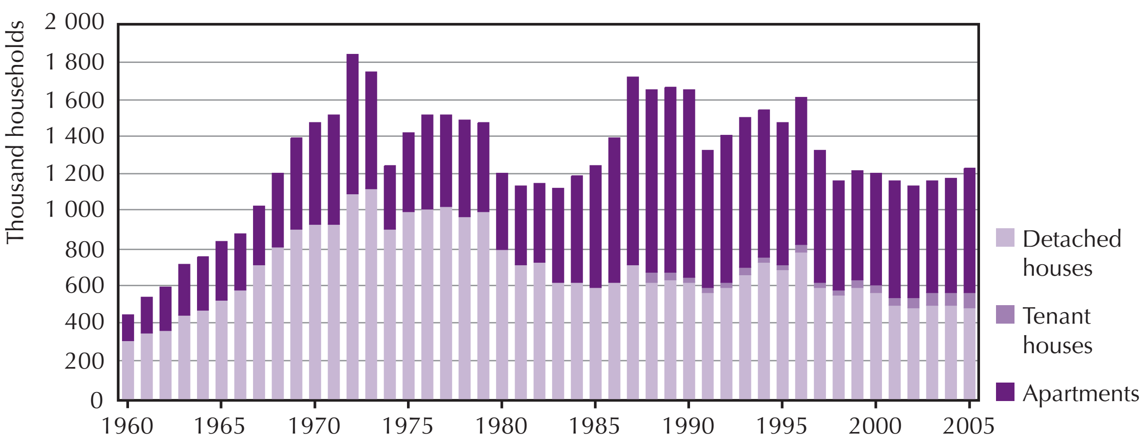


Source: Statistics Bureau (2006), Statistics of Japanese lands and houses.

The current average lifetime of Japanese houses is 30 years, compared to 44 years for houses in the US, and is less than half that of houses in the UK (IBEC, 2006b). This points to the construction and renovation potential of the Japanese housing stock, which is renewed more often than in the US and the UK.

Figure 10 indicates the annual records of house construction by house types from 1960 to 2005 in Japan. This shows that about 1.5 million houses have been newly constructed from the 1970s to 1990s. However, the construction of houses has decreased to around 1 million in the past ten years. This indicates the turnover rate of the housing stock is now lower than in the past.

Figure 10 • *New construction in the Japanese housing market*



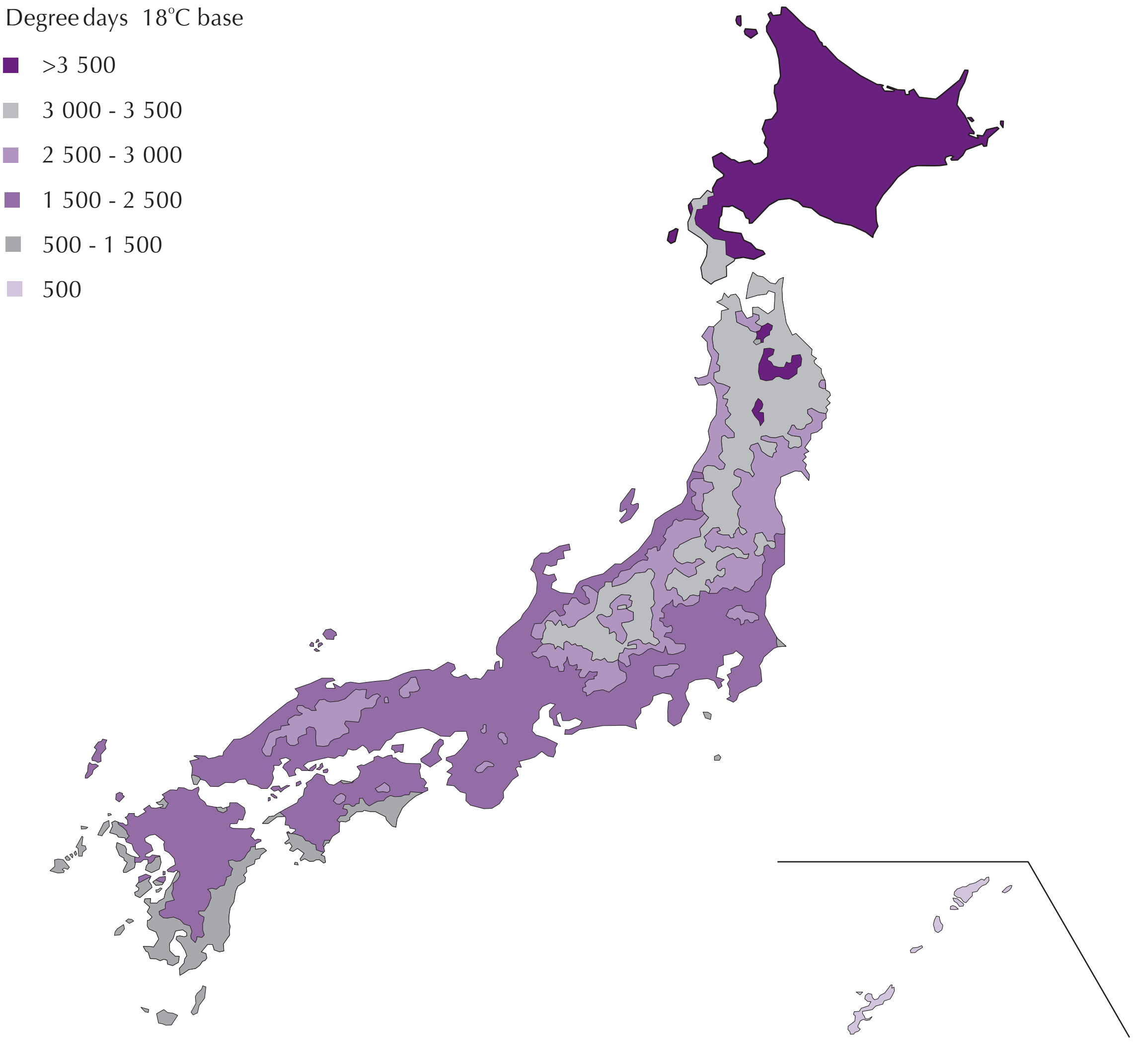
Source: IBEC (2006b), Supplement material for CASBEE 4th open seminar. After 1988 tenant houses and apartments are classified into different categories.

During the 1960s and 1970s detached house construction dominated new buildings. Starting in the 1990s, apartment building construction rose to a level equivalent to that of individual houses.

Climate indicators (heating and cooling degree days)

Buildings in Japan are exposed to large variations in climatic conditions ranging from sub-tropical in Okinawa (in the southern tip of Japan) with less than 500 (average long-term) heating degree days, to sub-arctic in Hokkaido (in the northern tip of Japan) with more than 3 500 heating degree days (Figure 11 below). Severe climate in northern regions provides a strong incentive to improve the thermal performance of buildings for reasons of comfort.

Figure 11* • *Long-term average heating degree days in Japan



Source: IBEC (2006a), Seminar Material for Design and Construction of Energy Conservation Houses.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Policy and institutional framework

Policy framework

As a part of comprehensive efforts to reduce greenhouse gas (GHG) emissions, the Law Concerning the Rational Use of Energy, known as the Energy Conservation Law, was established in 1979 just after the second oil crisis. The Energy Conservation Law has been reinforced through revisions in 1999 and 2006. Many measures implemented for energy conservation were based on this Law. As for energy efficiency in housing, the Law stipulates measures on building envelopes and the performance of appliances.

The Energy Conservation Law has led to the development of codes for insulation thickness and solar radiation prevention for buildings, and the reporting of energy conservation measures for buildings to municipal offices. In planning for energy conservation in the residential sector, improvement in the energy efficiency of home appliances is also an effective measure. To that effect, the Top Runner programme was introduced in the 1999 revision of the Energy Conservation Law and aims to improve the energy efficiency of appliances. At first the Energy Conservation Law covered refrigerators and air conditioners, but the coverage has expanded to other appliances. The Top Runner Standard programme was established to stimulate technological improvement in each fiscal year through minimum energy performance standards for appliance manufacturers and importers. The 2006 revision imposed reporting obligations on owners of buildings over 2 000 m^2, including residential buildings. Energy suppliers must also provide information on energy conservation measures to consumers, and for appliance retailers to provide information to consumers regarding the energy efficiency of their products.

In June 1998, the Japanese government agreed on a *Guideline for Measures to Prevent Global Warming*. This was followed by revisions of the Energy Conservation Law and the establishment of a Law Concerning the Promotion of Measures to Cope with Global Warming. The Law defined global warming, the targeted greenhouse gases and identified responsibilities for businesses and citizens in meeting the aim of mitigating global warming.

In March 2002, the government agreed on "the General Principle to Promote Measures to Counter Global Warming". The General Principal presents a broad picture of measures needed to meet Japan's Kyoto protocol target, and is made up of over 100 measures and action plans. What needs to be stressed here is that the Guideline sets a reduction goal for each greenhouse gas.

Since Japan ratified the Kyoto Protocol in June 2002, it has been actively promoting the implementation of measures to reduce GHG emissions, including measures for energy conservation and new forms of energy, based on the Outline for Promotion Effects to Prevent Global Warming (2002). The government evaluated and reviewed the outline in 2004. The Law Concerning the Promotion of Measures to Cope with Global Warming stipulates that a plan for reaching the target should be established when the Kyoto Protocol comes into effect. The April 2005 Kyoto Protocol Target Achievement Plan was established to implement the Protocol's coming into force in February 2005.This plan replaced the Outline for Promotion of Efforts to Prevent Global Warming as a result of its evaluation and review in 2004. The goals of this plan are to fulfil the commitment of 6% reduction and to further reduce GHG emissions globally and continuously over the long term.

The March 2007 Basic Plan for Energy paid increased attention to EE measures in the commercial, residential and transport sectors. This revision was based on targets set in the May 2006 New National Energy Strategy, which includes the aim of improving energy consumption efficiency by 30% by 2030 compared with 2003.

Following this, Japan has produced yearly White Papers, known as "Annual Reports on the Environment", since 2003. These provide an overview of environmental policy measures taken and identify new policy goals. The latest policy outline is the "2007 Annual Report on the Environment and Sound Material-Cycle Society", and places an emphasis on the environmental sustainability of the Japanese economy.

Energy policy goals

In order to meet the greenhouse gas reduction target of 6% set by the Kyoto Protocol, an emissions target is established for each category of GHG for the 2008-12 period. As for CO_2 emissions caused by energy consumption, the established target limits the increase of 0.6% compared to the 1990 level, as shown in Table 6. More than 90 % of GHG emissions in Japan consist of CO_2, of which approximately 90% is emitted from combusting fossil fuels, which means that nearly 80 % of GHG emissions originate from energy use. While GHG emissions for the industrial sector decreased between 1990 and 2005, those in the residential, transport and commercial sectors all increased. Residential sector CO_2 emissions increased by 36.7% between 1990 and 2005, and will need to be decreased by 29.2% in order to meet the government emissions target for 2010 (MOE, 2007). Therefore, effective energy conservation policies for these sectors are essential in resolving environmental problems.

Table 6 • Kyoto Protocol targets of CO_2 emission and absorption

Classification	Targets	
	CO_2 emissions in 2010 (MtCO_2)	**Comparison to 1990 level** (%)
Global warming gases	1 231	- 0.5
CO_2 emissions from energy consumption	*1 056*	*+ 0.6*
CO_2 emissions from non-energy consumption	*70*	*- 0.3*
Methane	*20*	*- 0.4*
Dinitrogen monoxide	*34*	*- 0.5*
Fluorinated gases	*51*	*+ 0.1*
Land-use change and forestry	- 48	- 3.9
Kyoto mechanisms	- 20	- 1.6
Total	**1 163**	**- 6.0**

Source: MLIT (2005), Material for seminar on energy conservation corresponding to the revision of the Energy Conservation Law, MLIT, Tokyo.

In order to meet the target of mitigating global warming, the Japanese government set the energy efficiency standards in 1980 stipulated in the Guideline for the House Owners about Rational Use of Energy, based on the Energy Conservation Law enacted in 1979. The standards were revised in 1992 and 1999 respectively. The Guideline consists of several standards and notices with supporting measures for their implementation. As concrete measures, owners of residential buildings with a total surface area of over 2 000 m^2 are obliged to report energy efficiency actions. The diffusion of a labelling programme for houses and support for the construction and renovation of houses meeting the standards are also conducted. With these measures, targets for the energy conservation of building envelopes of houses and policies enacted are shown in Table 7. The policies aim to increase the ratio of newly constructed houses meeting the 1999 standard to 50% in 2008. Achieving this target would reduce CO_2 emissions by about 8.5 million tons.

Table 7 • Residential energy efficiency policy targets corresponding to the Kyoto Protocol targets

Indicator for target achievement	Ratio of newly constructed houses meeting 1999 energy efficiency standard: 50% in FY2008
Policies taken to achieve the target	• Urging developers to take energy efficiency measures with the obligation of reporting energy conservation measures in large scale construction and renovation based on the Law Concerning the Rational Use of Energy • Developing and diffusing the Comprehensive Assessment System Building Environmental Efficiency (CASBEE) based on the Law Concerning the Promotion of Housing Quality Warrant • Providing financial support for the improvement of energy efficiency in houses constructed through grants from municipal offices • Encouraging energy efficiency investments in houses using securitisation to offer low-interest loans • Encouraging the development of leading technology by private developers through the subsidy programme on leading building and housing technologies • Raising the capacity of technicians working for the planning and construction of houses
Effect in reduction of CO_2 emissions	About 8.5 million tons of CO_2

Source: MLIT (2005), Material for seminar on energy conservation corresponding to the revision of the Energy Conservation Law, MLIT, Tokyo.

As for home appliances, based on the Guideline for Measures to Prevent Global Warming, targets have been set for each appliance for the coming four to eight years in order to maximise the diffusion of these energy-efficient appliances by 2010.

Strategies

In order to achieve the goal of 6% GHG emission reduction set by the Kyoto protocol, the Japanese government decided to design policies and measures covering both the supply and demand of energy by combining mandatory and voluntary measures. The Energy Conservation Law forms the basis of these policies and measures.

The basic strategies for reducing CO_2 emissions in the residential sector involve research, development, regulation and marketing assistance for energy-efficient appliances, and strengthening of the thermal insulation performance of houses and buildings. Energy efficiency in the residential building sector can also be included under cross-sectoral measures, which aim to both reduce GHG emissions and contribute to establishing "low-carbon socioeconomic mechanisms" which affect urban and regional structures (MOE, 2007).

The Japanese government has established the Energy Conservation Law as the basis of mandatory codes for promoting energy conservation. Among the mandatory measures implemented based on the Law are the Top Runner Standard programme for home appliances and mandatory reporting of energy conservation measures in large-scale residential buildings. While buildings with a floor area over 2 000 m^2 account for 1% of the total Japanese building stock, they account for 30% of the stock in terms of floor area. Therefore, this approach to constrain the coverage for buildings with floor area of 2 000 m^2 or more is cost-effective if administrative costs are considered.

As for voluntary measures, the Japanese government also encourages the construction of more energy-efficient houses and the purchase of energy-efficient appliances through the increase of public awareness on the issue of home energy conservation. A labelling programme, the reduction of loan interest rates working with mortgage-backed securities for more energy-efficient houses, and grants offered to municipal governments for their construction or renovation of houses, all play important roles in encouraging both the general public and municipal governments. In estimating the energy conservation performance of houses, standards on thermal insulation and sun radiation shielding stipulated in the Energy Conservation Law are to be used as indicators. As initiatives in private sectors, utilities offer programmes to reduce the interest of loans for the construction and renovation of houses through cooperation with private banks. Certain programmes also reimburse part of the purchase cost of energy-efficient appliances.

Actors

Government ministries

Energy policy affecting energy efficiency in the existing residential sector is managed by three ministries. These are the Ministry of Economy, Trade and Industry (METI), and primarily its Agency for Natural Resources and Energy (ANRE). METI is involved where rational use of energy is concerned, including in buildings, and works with manufacturers and importers regarding the energy efficiency of appliances. The Ministry of Land, Infrastructure and Transport (MLIT) makes recommendations for and enforces building standards. The Ministry of Environment (MOE) does not directly deal with issues of energy efficiency in buildings, but conducts evaluations and issues White Papers summarising measures taken and new initiatives.

Incorporated administrative agencies

The New Energy and Industrial Technology Development Organisation (NEDO) was established by the Japanese government in 1980 to develop new oil-alternative energy technologies. In 1993 NEDO's activities were expanded to promote new energy sources and energy conservation technology. Since 1999 it runs projects to subsidise the introduction of energy-efficient equipment to residential buildings. Following its reorganisation as an incorporated administrative agency in October 2003, NEDO is now also responsible for R&D project planning and formation, project management and post-project technology evaluation functions; these include introduction and dissemination of EE technologies for highly-efficient building systems (NEDO, 2007a). Another incorporated administrative agency under control of the Ministry of Finance, the Japan Housing Finance Agency (JHF), specialises in securitising housing loans.

Other actors

Finally, the Energy Conservation Center Japan (ECCJ) is responsible for disseminating information on energy conservation. Advertisements in the media have been sponsored by ECCJ since the 1970s. It subsidises various promotional campaigns to inform the general public as well as commercial and industrial stakeholders on energy efficiency programmes and policies.

Policy instruments

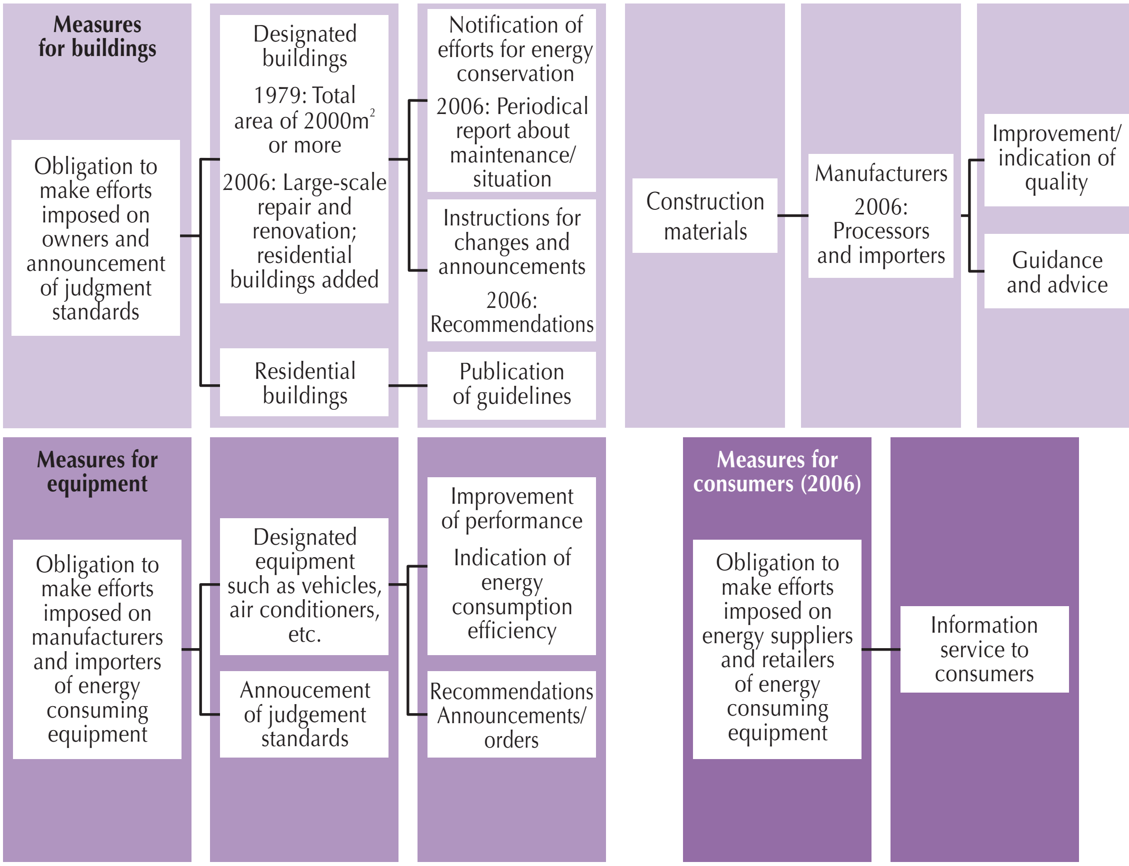
The Energy Conservation Law enacted in 1979 was amended for reinforcement in 1983, 1993, 1998, 2002 and 2005. In the 1998 amendment, the Top Runner Standard programme was adopted in order to strengthen measures for the residential and commercial sectors. The last amendment of the Law took effect in April 2006 (ECCJ, 2005).

The Law aims to contribute to the sound development of the national economy through implementing necessary measures for the rational use of energy in buildings and equipment. At the same time it seeks to ensure the effective utilisation of fuel resources that would also meet the economic and social needs of energy use in Japan.

Figure 12 shows the structure of part of the Energy Conservation Law concerning energy conservation in the residential sector. It contains codes for building envelopes and appliances, and measures to raise the public awareness of residential energy conservation issues.

An overview of policies stemming from the Energy Conservation Law follows in the section below, using the policy classification developed in the introductory chapter.

Figure 12 • Structure of the Energy Conservation Law for the residential sector



Source: ECCJ (2006), *Japan Energy Conservation Handbook 2005/2006*.

Regulatory measures

Codes and standards for building envelopes

Concerning the energy efficiency of buildings, the Energy Conservation Law had targeted construction and enlargement of commercial buildings with a floor area of more than 2 000 m². With the 2005 revision the Law covered renovation, construction and enlargement of residential buildings with a floor area of more than 2 000 m².

Developers who construct, enlarge or renovate buildings with a floor area of 2 000 m² or more have to report the energy conservation measures for the buildings concerned to municipal offices. Prior to the revision this was undertaken on a voluntary basis. Based on the Law, municipal offices of jurisdiction may, whenever necessary, give guidance and advice on building design and construction to the owners of these buildings, while taking into account the standards established by the Law. In addition to these rules, METI can if necessary give insulation and other construction material manufacturers guidance and advice for improving the insulation properties of their construction materials.

Measures taken to strengthen the thermal insulation and air-tightness of buildings are effective. Since Japan mostly has a hot and humid climate, it is also important to effectively shield the solar radiation coming into houses in the summer time. In order to ensure proper and effective implementation of such measures, METI and the Minister of Land, Infrastructure and Transport (MLIT) establish and announce standards which building owners should refer to in making decisions for rationalising energy use in their buildings. These energy efficiency standards in building codes are voluntary. An example is the development of thermal insulation standards from 1980 to 1999. With the revision that took place in March 1999, the thermal insulation performance of Japanese houses has become equivalent to European ones. In order to adhere to the most recent standard, wall insulation thickness has to be three times thicker than houses constructed in 1980 in Tokyo metropolitan areas. These standards are often used for the rating of houses relating to energy conservation performance, by classifying houses meeting the 1999, 1992 and 1980 standards as highest class 1, class 2 and class 3 respectively. Houses not meeting any of the standards are classified as the lowest class 4.

Codes and standards for appliances

In order to diffuse appliances that are highly energy efficient, the Energy Conservation Law makes it obligatory for manufacturers and importers to ensure their products meet energy-saving target standards. Mandatory energy performance standards (MEPS) were first introduced for refrigerators and room air conditioners under the Law as early as 1979. The Japanese government launched the Top Runner programme based on the amended Law in 1999. The programme sets energy efficiency performance targets for categories of machinery and equipment, based on the level of the most energy-efficient product commercially available at the time the target is set. For each manufacturer and importer, the Top Runner programme requires that the weighted average efficiency of all units shipped within the same category meets the standards for that category by the target year decided for each category. Target fiscal years are set four to eight years ahead per product. The programme requires close collaboration with industry, as it imposes technical and economic constraints on manufacturers. Deliberations on programme standards and targets are conducted within METI by the Advisory Committee for Natural Resources and Energy, made up of both industry and consumer representatives, academics, researchers and local government experts. Non-compliance with the targets results in investigation and recommendations, with these possibly becoming publicly known and mandatory. However this is done on a case-by-case basis, taking into account the appliances and their impact on energy consumption, particular circumstances, as well as the size and capacity of the individual manufacturer. To date, METI has not undertaken any enforcement actions.

While the programme targets manufacturers and importers, consumers are also made aware of product EE through mandatory labelling of products by manufacturers. Non-compliance with this requirement is sanctioned for all manufacturers through cutbacks in shipping volumes according to production and import volume (ECCJ, 2006).

Both the coverage and entry years of each product into the programme are indicated in Table 8.

Table 8 • ***Coverage of Top Runner programme***

Year product designated	Product type	
1999	Passenger vehicles	Computers
	Air conditioners	Magnetic disk units
	Fluorescent lights	Freight vehicles
	TV sets	Electric refrigerators
	Video cassette recorders	Electric freezers
	Copying machines	
2002	Space heaters	Oil water heaters
	Gas cooking appliances	Electric toilet seats
	Gas water heaters	Vending machines
	Transformers (molded)	
2003	LPG passenger vehicles	
2006	Microwave oven	DVD player
	Electric rice cooker	
Total number of products designated as of July 2006	**21**	

Source: ECCJ (2006), *Japan Energy Conservation Handbook 2004/2005*.

Financial and incentive-based measures

Grants for municipal governments

Government grants are offered to municipal governments, providing them with the means to raise the quality of housing. Improved home energy conservation levels, such as through increased insulation thickness, is one way of improving the quality of houses. The grant is offered to two types of projects. The first are mainstay projects which assist with the construction and renovation of social houses owned by municipal governments, and the second voluntary projects proposed by each municipal government, including financial assistance from private firms. Though a budget of JPY 152 billion (USD 1.28 billion) was assigned for the grant in FY2006, the actual portion of grants spent for energy conservation is unidentified. Given the variety of projects involved with the construction and renovation of houses, identifying the grant amounts used specifically for improving energy efficiency in residential buildings is difficult. The usage of grants depends mainly on the political decision of each municipal government. Therefore, it is important to provide municipal governments with evaluation tools that help them integrate energy efficiency improvements in their grant-funded investments. The CASBEE, an evaluation tool discussed further in this chapter, is used by municipal governments in various cases for this purpose (MLIT, 2007).

New energy and industrial technology development organisation (NEDO) subsidies

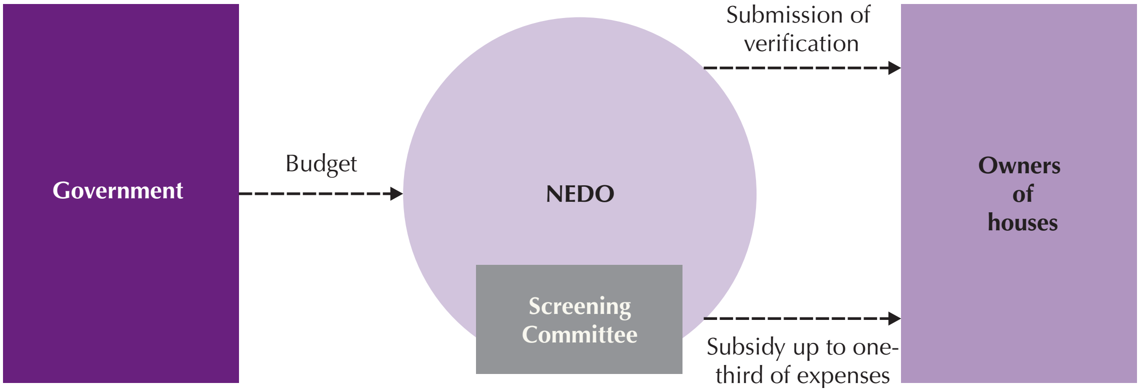
In its efforts to suppress the increase of energy consumption in the residential and business sectors, accounting for one-quarter of Japan's overall energy consumption, NEDO subsidises the introduction of energy-efficient equipment to residential buildings. Their target for improved EE in residential buildings by 2010 is to reduce energy consumption by the equivalent of 3 million litres of crude oil.

The NEDO project to subsidise energy-efficient houses began in 1999. Subsidies cover up to one-third of expenses needed to install energy-efficient appliances and efficient renewable energy systems, such as photovoltaic cells. These apply to both newly constructed and existing houses. Subsidies are also offered for house renovation to meet thermal insulation standards required by the Energy Conservation Law. Among energy-efficient appliances adopted for the subsidy project are electric/gas heat pumps, ultra high insulation windows and gas cogeneration systems.

In order to qualify for the subsidies, energy consumption must be reduced by 15% for newly constructed houses and by 25% for renovated houses, compared to the standard energy consumption without energy efficiency improvement work. The NEDO also requires homeowners to report their energy consumption for three years after the renovation or construction of houses. They are also required to answer questionnaires conducted by the NEDO. A schematic drawing of the subsidy project, with the flow of funds and information, is depicted in Figure 13.

NEDO also offers subsidies to municipal governments to introduce new energy sources and energy conservation measures, and the budget for FY2007 amounted to JPY 1.33 billion (NEDO, 2007). For example, the Iwate prefecture in the North of Japan uses funds received from the national government to promote the purchase of energy-efficient residential appliances by reimbursing a portion of their cost (Ashina and Nakata, 2007).

Figure 13 • Organisation of NEDO subsidies to home efficiency

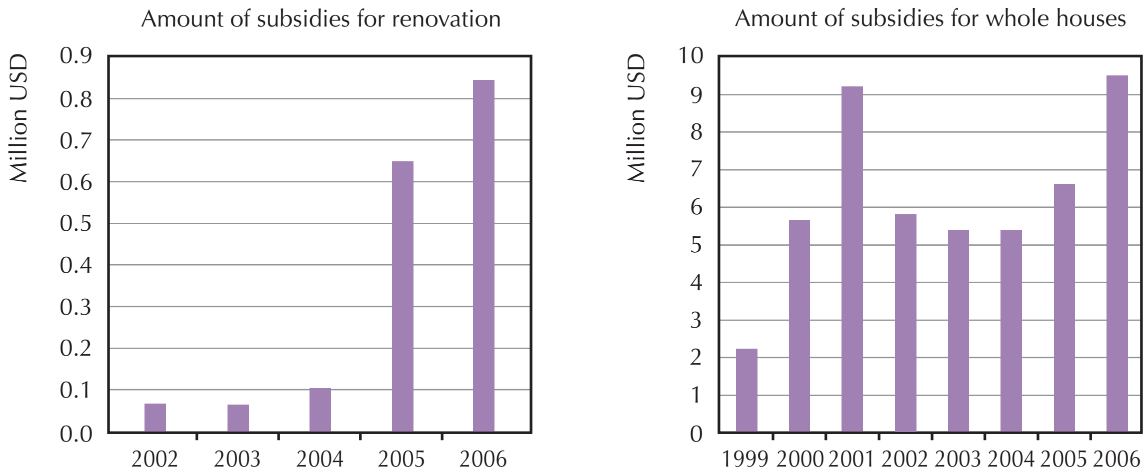


Source: NEDO (2006a), Assistance to energy conservation by NEDO.

Actual amounts of subsidies for all houses (including both construction and renovation) and for only renovation are indicated in Figure 14. Between 1999 and 2006, USD 49.8 million were offered to homeowners for EE improvements, with USD 2.90 million offered for renovation between 2002 and 2006. At present, a relatively small percent of subsidies are used for the renovation of existing houses, this scheme still being in a preliminary phase.

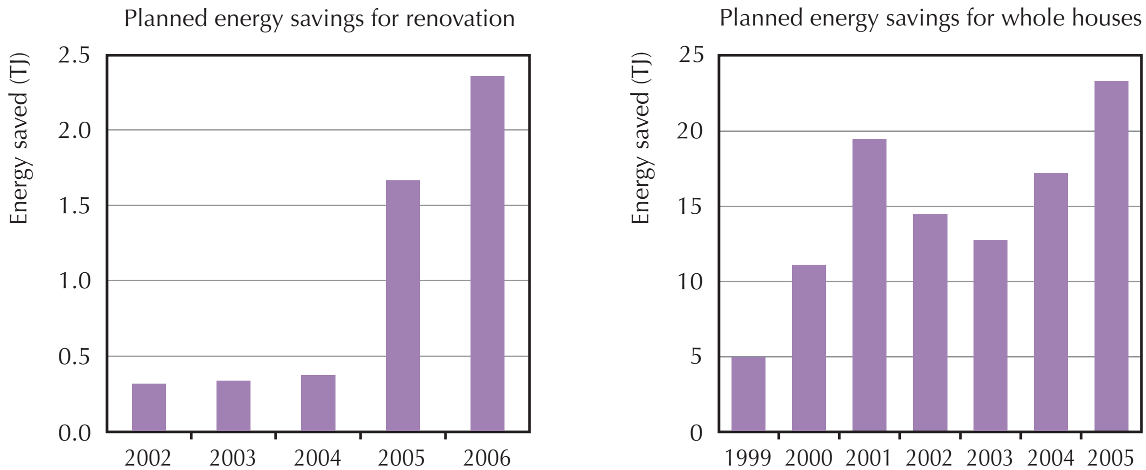
Expected energy savings submitted at the time of application for the subsidies from homeowners are depicted in Figure 15. Energy consumption was planned to be suppressed by 135.2 TJ for whole houses between 1999 and 2006. Actual reduction of energy consumption is considered to be close to planned figures through the observation that the achievement rate in 2005 was 89% (NEDO, 2006b). As for house renovation where solely energy efficiency measures were undertaken, the energy consumption was expected to be reduced by 5.0 TJ between 2002 and 2006.

Figure 14 • Amount of subsidies offered to all houses and renovated houses



Source: Calculations based on data from NEDO (2006b), Fact sheet of NEDO Projects and personal communication with NEDO staff member.

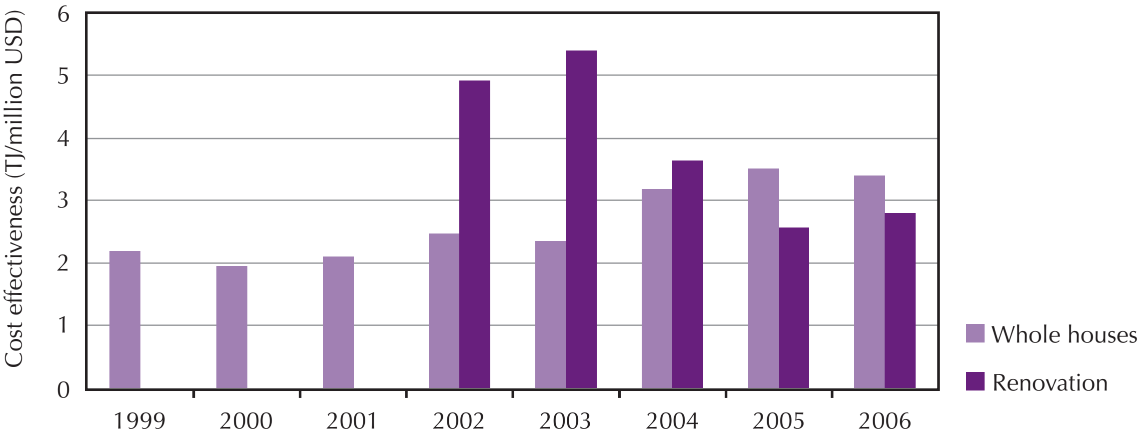
Figure 15 • Expected energy savings for all houses and renovated houses



Source: Calculations based on data from NEDO (2006b), Fact sheet of NEDO Projects and personal communication with NEDO staff member.

Figure 16 indicates the cost-effectiveness of subsidies for whole and renovated houses. Comparing the annual reduction in energy consumption per subsidy given between whole houses and renovated houses suggests that equivalent or more cost-effective energy savings were achieved for renovated houses. Between 2002 and 2004, it appears that subsidies used to renovate existing houses were more cost-effective, though the overall amount of renovation undertaken remained small.

Figure 16* • *Cost-effectiveness of subsidies (annual savings per subsidy amount)



Source: NEDO (2006b), Fact sheet of NEDO project.

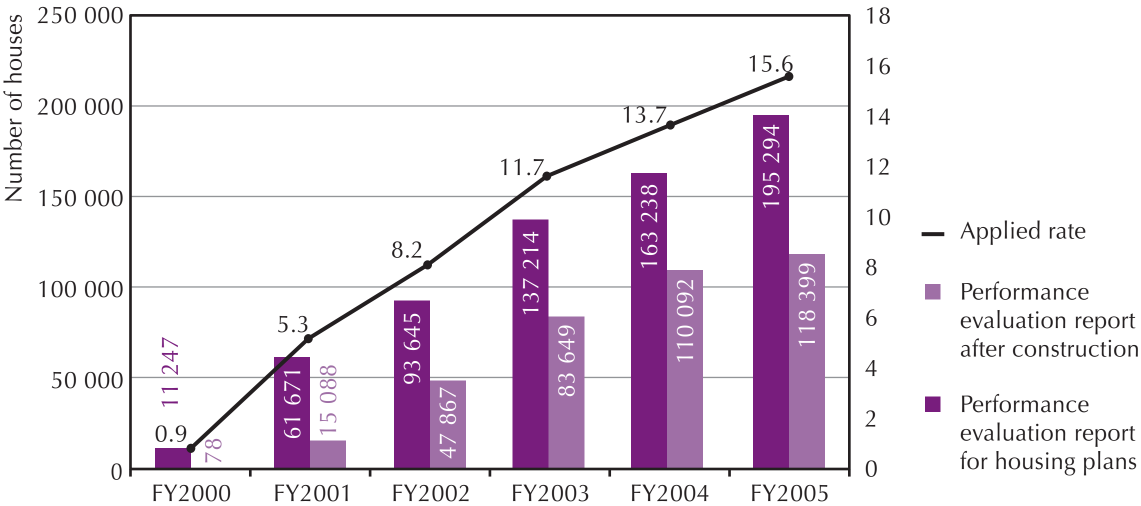
Voluntary agreements and partnerships

Labels and certificates for building envelopes

As a means of certifying various housing qualities, such as robustness, safety and energy efficiency, the Performance Evaluation and Certification System for Houses was established. The evaluation is performed by designated independent facilities during the building design or construction phase for 32 items within ten categories, including energy conservation performance. The system contributes to certifying the energy efficiency of building envelopes and increasing public awareness of the energy efficiency of buildings. It uses specially designed logos showing houses that have undergone certification. Each logo is presented for houses which have undergone evaluation in their design or construction stage, or for existing houses which have been evaluated. The system is voluntary and to be used by homeowners or housing developers.

Thermal insulation and air-tightness are among the items to be evaluated. For thermal insulation performance, houses are categorised into the previously mentioned four classes based on the thermal insulation standards met. During the purchase of a house, the relevant energy performance can be easily verified through the performance evaluation results shown on the label.

Figure 17 • ***Ratio of houses with performance evaluation performed***



Source: Matsuo (2006), "The role of indicators in policy design and best practices in Japan", presented at IEA Workshop Energy Efficiency in Buildings: Meeting the G8 Gleneagles Challenge, Paris, 27-28 November 2006. The figures presented at the workshop were prepared with the cooperation of Professor Marakami of Keio University.

Figure 17 indicates the ratio of houses which have undergone evaluation in the past five years, a figure which has risen throughout this period. This figure shows that public awareness regarding housing quality has also increased, even though this does not only concern energy conservation performance.

Low-interest loans for residential buildings

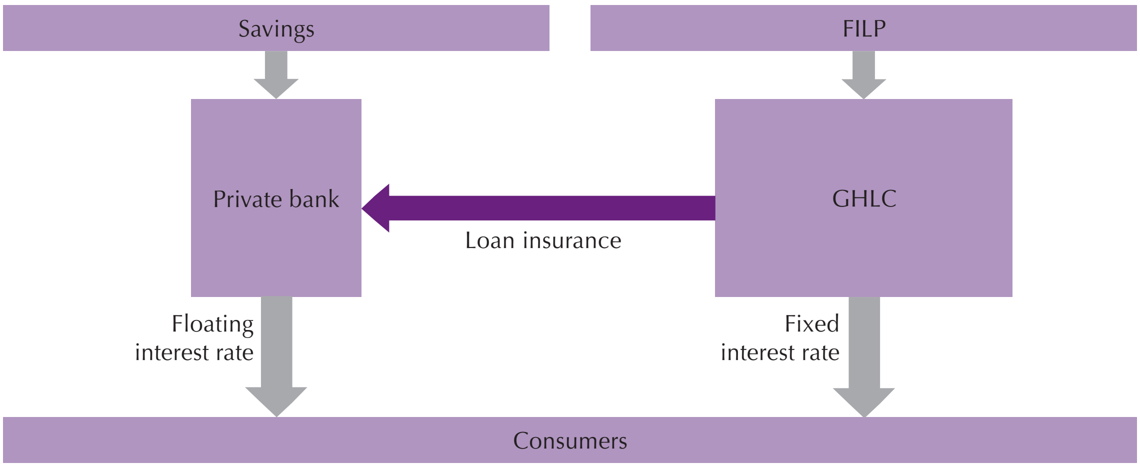
Financial assistance in the form of a low-interest rate loan has been supported by the Government Housing Loan Corporation (GHLC), which following structural reform in April 2007 became the Japan Housing Finance Agency (JHF). This is an incorporated administrative agency wholly owned by the government. The assistance has been addressed to houses whose floor area is less than 2 000 m². For these houses, standards for energy conservation have been a voluntary target, with financial incentives offered by the JHF.

GHLC conducted direct housing loans to the general public, with funding from a government loan provided by the Fiscal Investment and Loan Programme (FILP) established since 1950 as shown in Figure 18. The JHF now passes on the risk of long-term fixed rate housing loans to capital markets via securitisation.

The GHLC had offered the loan for houses to meet certain technical requirements and accounted for 30% of houses constructed in Japan after World War II. This shows that GHLC's role in housing policy has been significant, and has substantially improved the housing quality in Japan.

In 1996 the GHLC started to offer an extra loan for houses meeting energy saving performance, earthquake resistance performance or elderly and handicapped performance technical standards set by the GHLC. For energy performance, all the houses for which the loan was requested had to meet at least the 1980 thermal insulation standard. On top of that, an extra loan of USD 8 550 for houses meeting the 1992 energy efficiency standard, and USD 2 137 for houses meeting the 1999 energy efficiency standard was offered.

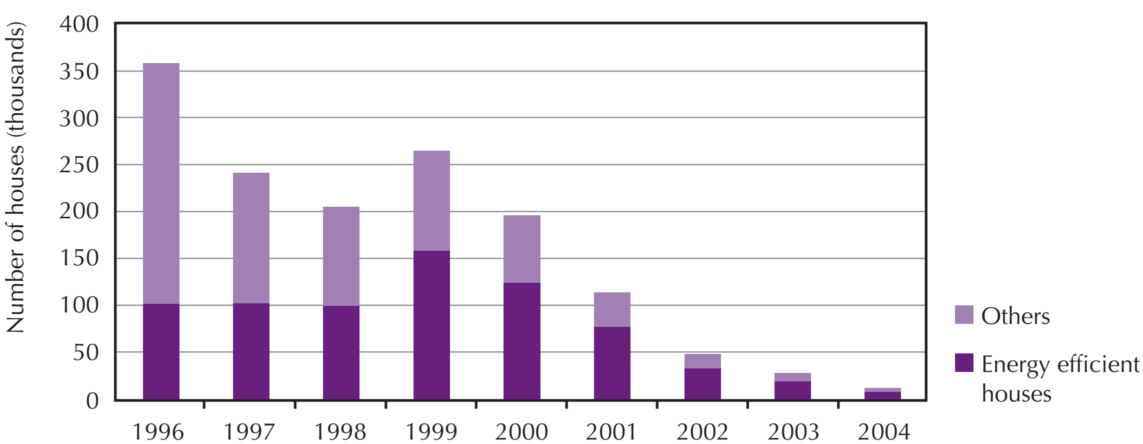
Figure 18 • Schematic drawing of direct housing loans



Source: JHF (2007a), "Overview of JHF", www.jhf.go.jp/english/about/pdf/main_1.pdf.

Figure 19 indicates the number of houses constructed using the loans each year. Percentage of houses meeting either of the energy efficiency standards increased from 28.5% in 1996 to 67.1% in 2004. Following structural reform, the housing loan initiative was transferred to an independent administrative agency. Thereafter the direct loan was replaced by "Flat 35" which started in 2003 and is managed by the newly established JHF.

Figure 19 • Number of houses with GHLC loans

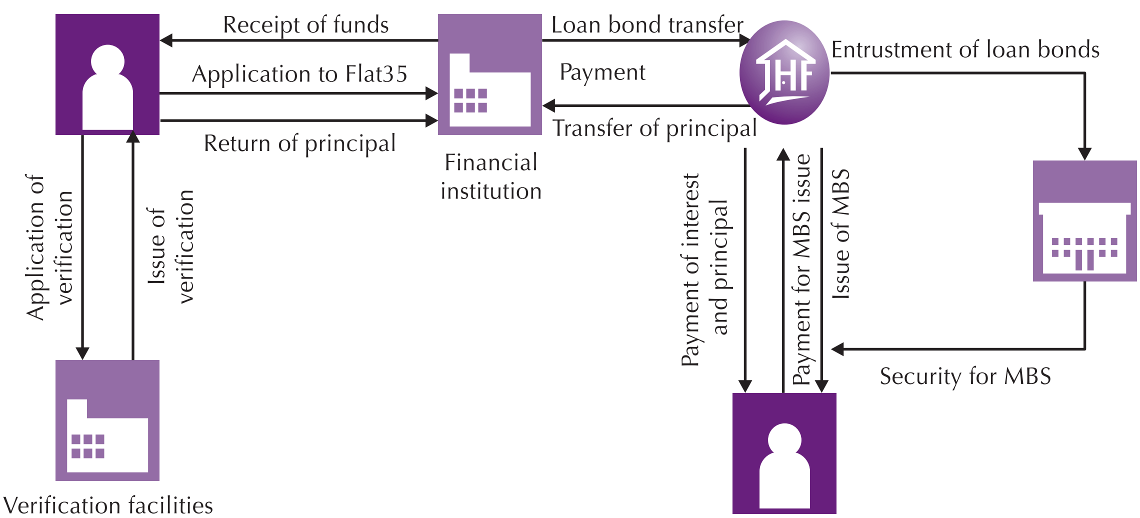


Source: JHF (2007b), personal communication.

The JHF no longer provides direct housing loans to the general public and its main business is securitisation, enabling private institutions to provide long-term fixed rate housing loans. The JHF started underwriting a long-term and fixed interest rate loan called "Flat 35" whose loan limit is JPY 80 million for new and existing houses. Conditions of the loan depend on the quality of houses, with energy conservation performance one of the items evaluated. The standards established by the Energy Conservation Law are indispensable to evaluate the EE performance of houses and therefore determine loan amounts. All the houses applying for the loan have to at least meet the 1980 thermal insulation standard. For houses which meet the 1999 standard, the interest rate is lowered by 0.3% for the first five years (JHF, 2007a).

Figure 20 indicates the framework of the Flat 35 operated by the JHF. Owners of houses who wish to take out a loan apply to financial institutions (in many cases, private banks) with certification of housing quality issued by independent verification facilities. After lending to homeowners, financial institutions transfer the loan bonds to the JHF. Financial institutions get paid in return with loan bonds from the JHF, who issue mortgage-backed securities to investors. Investors are paid back, with interest accruing from loan and principal which they have invested. The Japanese government secured a budget of JPY 10 billion (USD 8.5 million) and JPY 30 billion (USD 25.6 million) to finance the JHF in 2005 and 2006 respectively.

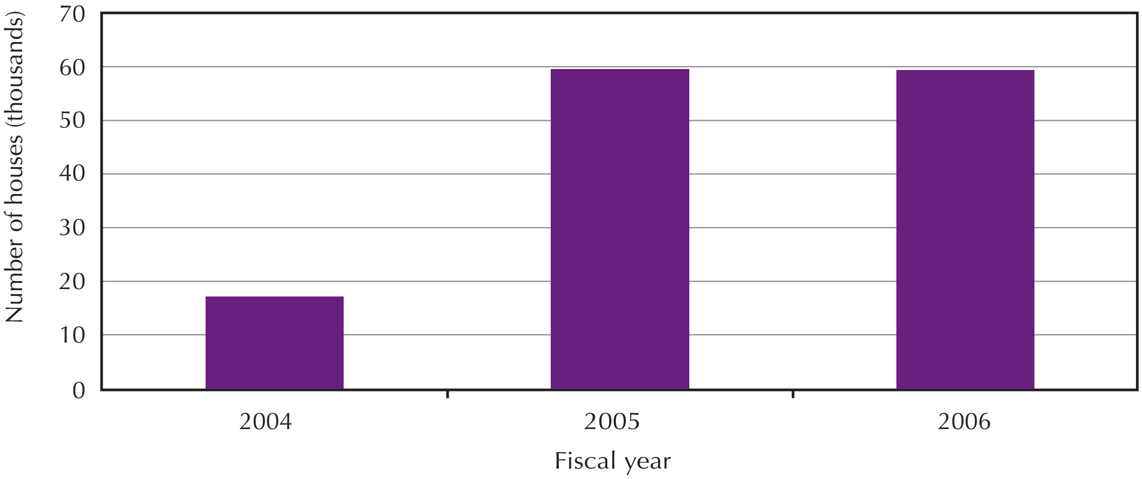
Figure 20 • Framework of mortgage-backed securities: "Flat 35"



Source: JHF (2006), *Disclosure Booklet: Details and features of line of business.*

Figure 21 indicates the number of households which applied for Flat 35 for their construction or renovation between 2004 and 2006. Both newly constructed and renovated houses whose performances meet energy saving, earthquake or barrier-free standards set by the JHF were involved in this figure. Until 2006, the Flat 35 had been offered to houses to meet at least one of energy saving, earthquake or barrier-free standards set by the JHF. In 2007, durability and flexibility of houses was added to the three requirements. This standard includes the ease with which a house can be remodelled. From 2008, the condition of loan offering will be tightened for two of the four standards to be met (JHF, 2007a).

Figure 21 • ***Number of houses applying for Flat 35***



Source: JHF (2006), *Disclosure Booklet: Details and features of line of business.*

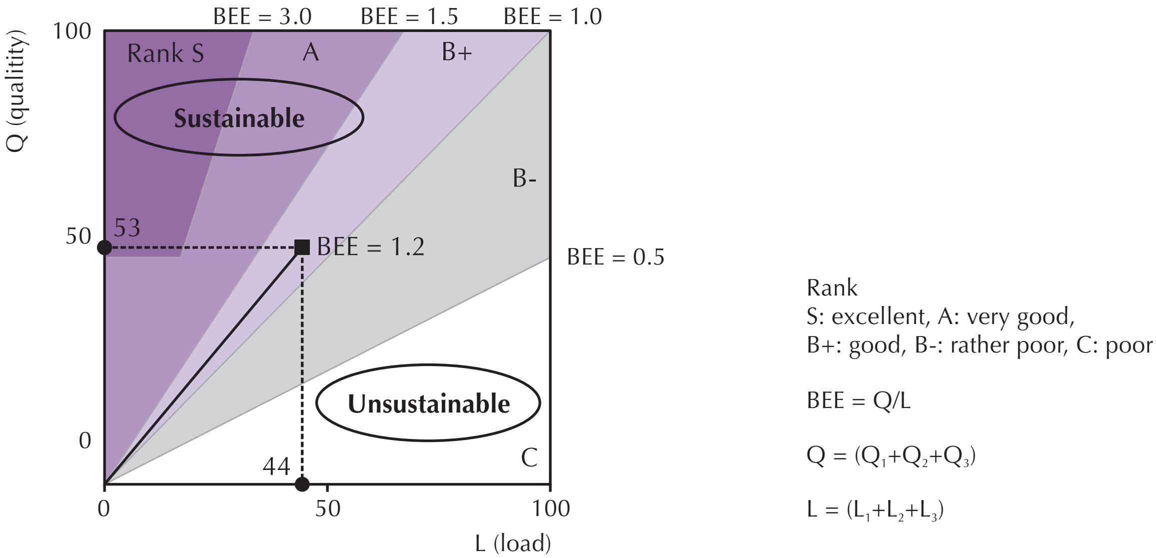
Information and capacity-building programmes

Comprehensive assessment system building environment efficiency (CASBEE)

Proper assessment of buildings and disclosure of the assessment results are essential for the creation of markets for sustainable housing. The disclosure of information also encourages building owners and designers to supply high-quality sustainable buildings. As an assessment tool of energy conservation of buildings, the Comprehensive Assessment System Building Environmental Efficiency (CASBEE) based on the concept of Building Environment Efficiency (BEE), which is a comprehensive indicator for high-quality and high-comfort buildings with low environmental loads, has been developed in Japan. With the CASBEE, energy conservation is the most important evaluation item and life-cycle assessment of buildings can be conducted, as is indicated in Figure 22. Each building is estimated and classified into five categories ranging from C (poor) to S (excellent), which reflects the quality of buildings themselves (Q), indicated by a vertical axis, and the environmental load imposed by buildings (L), indicated by a horizontal axis.

The Minister of Land, Infrastructure and Transport (MLIT) is promoting the usage of the CASBEE for new and existing construction through the establishment of a CASBEE certification programme. In terms of results, the CASBEE has been adopted by several municipal governments as the tool for offering information on energy conservation to consumers (JSBC, 2006). This movement could encourage developers to supply more energy-efficient buildings and contribute to the development of markets for sustainable and energy-efficient buildings. CASBEE was originally prepared for large-scale buildings, and its coverage has been expanded to small-scale detached houses since 2007 for voluntary use by homeowners and developers. It was necessary to expand its coverage since detached houses account for about half of the total housing stock, and about 500 000 new detached houses are constructed every year. This expansion of CASBEE's coverage was conducted as a joint initiative, with the cooperation of private, academic and government participants under the auspices of MLIT.

Figure 22 • Evaluation method of CASBEE



Source: Matsuo (2006), "The role of indicators in policy design and best practices in Japan", presented at IEA Workshop Energy Efficiency in Buildings: Meeting the G8 Gleneagles Challenge, Paris, 27-28 November 2006. The figures presented at the workshop were prepared with the cooperation of Professor Marakami of Keio University.

Utility programmes

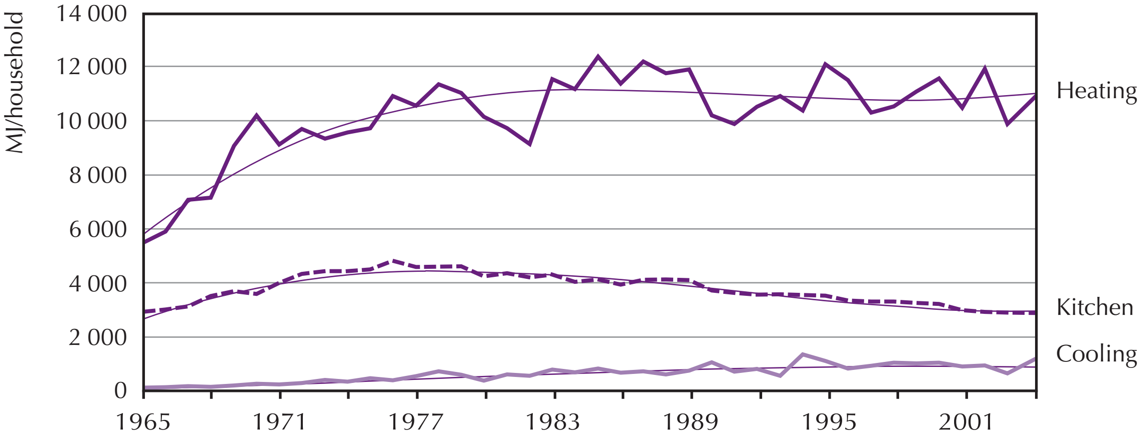
Private firms also propose incentives to implement energy conservation improvement measures in households. Utilities motivate consumers to construct or renovate houses by offering low-interest loans through tie-ups with private banks. These programmes are offered when consumers plan to renovate existing houses to use electricity or cogeneration systems. Utilities also offer a reimbursement programme for consumers to install energy-efficient appliances, such as hot water supply systems adopting heat pump technologies. NEDO provides subsidies to energy service providers to work with local governments in providing energy conservation services in households and buildings. The programme budget for FY2007 was JPY 1.16 billion (NEDO, 2007b).

Impact analysis and evaluation

Total energy consumption in the residential sector increased by around 12% during the last decade, largely due to the increase in the number of households and the living space per person. The policies and measures for housing envelopes have until now been mainly directed at new construction. Considering the recent lower turnover rate of houses, it is indispensable to implement policies and measures targeting the existing housing stocks in order to improve further the efficiency of the whole residential sector.

The macro change in energy consumption from 1965 to 2004 for heating, cooling and kitchen per household is illustrated in Figure 23. It shows that heating demand increased from 1965 until the beginning of 1990, to remain around 11 GJ/household per year thereafter. Energy consumption in kitchen use decreased gradually during this period. This suggests that policies and measures taken within the past decades in Japan, including financial measures, have been effective. A brief evaluation of the various policies described in this chapter is presented below, drawing on the criteria developed in the introduction.

Figure 23* • *Transition of energy consumption by households



Source: Calculations based on data from METI (2006) *Energy White Paper,* METI, Tokyo.

Regulatory measures

Building standards

The measures with strong impact thus far have been regulatory measures. Increase in heating and cooling demand for each household has been effectively reduced due to the improvement in thermal insulation of houses and energy efficiency of home appliances. The number of newly constructed houses meeting the 1999 standard increased by 20% between 2000 and 2004 (IBEC, 2006c), which contributes to the overall improvement of thermal insulation in the housing stock. The ratio of houses meeting standards has increased yearly to reach 32% in 2004. As of 2005, 30% of houses and 74% of buildings with a total floor area greater than 2 000 m^2 complied with the voluntary energy efficiency standards. The Japanese government set a policy target for 50% of houses to meet the standard in 2008. The improved energy conservation performance of houses newly entering the housing stock contributes to reducing overall household energy consumption.

Building standards have the disadvantage of not being very flexible; they have not been revised very often, and it is only with the last revision that the Energy Conservation Law covers the energy efficiency of large-scale existing residential buildings. They have also been useful in acting as standards for the provision of other programmes, such as labelling and subsidies. Making the energy efficiency components of building codes mandatory is also a way of increasing the overall EE of the building stock.

Appliance standards

Table 9 indicates the improvement in energy efficiency of home appliances by the Top Runner programme. The energy efficiency of air conditioners has improved by around 70%, which has contributed to the suppression of heating and cooling consumption in each household. The energy efficiency of refrigerators and freezers has also improved substantially in the past six years. The energy efficiency of these appliances has contributed to the decrease in energy consumption in kitchens of each household. Most energy-efficient appliances are beneficial in terms of life-cycle costs.

The advantage of the Top Runner programme is that it increases the energy efficiency of all appliances on the market through close collaboration with manufacturers. Thus far improved targets have been met much faster than predicted, and the programme appears successful (ECCJ, 2006). The programme is clear, since its requirements are established in concordance with an advisory committee that includes actors who are affected by the programme. It is however not very flexible, since targets and standards can take several years to develop, and target years established long in advance. These are difficult to modify in case of changing circumstances.

Table 9 • Target fiscal year and effects of the Top Runner programme

Appliances	Indicator for energy consumption	Improvement in energy consumption
TV	Annual electric power consumption (kWh/year)	25.7% (FY1997-FY2003)
Video cassette recorder (VCR)	Annual electric power consumption (kWh/year)	73.6% (FY1997-FY2003)
Air conditioner	COP	67.8% (FY1997-FY2004)
Refrigerator	Annual electric power consumption (kWh/year)	55.2% (FY1998-FY2004)
Electric freezer	Annual electric power consumption (kWh/year)	29.6% (FY1998-FY2004)

Source: Matsuo (2006), “The role of indicators in policy design and best practices in Japan”, presented at IEA Workshop Energy Efficiency in Buildings: Meeting the G8 Gleneagles Challenge, Paris, 27-28 November 2006.

Mandatory labelling for both manufacturers and retailers has made it easier for consumers to make a more energy-efficient choice. In theory, the replacement of household appliances with their highly energy-efficient counterparts would lead to a 40% reduction in CO_2 emissions per household (MOE, 2007).

Financial and incentive-based measures

Financial measures to improve household energy efficiency have been offered by various organisations in the form of preferential loans and subsidies. These measures address not only the construction of houses but also the renovation of existing houses. Observation of current loan and subsidy programmes makes it appear likely that financial instruments can contribute to the improvement of energy efficiency of houses. However, it is difficult to present the contribution in a quantitative manner, since these financial instruments cover not only energy efficiency but other features of houses, and thus are difficult to evaluate separately. Preferential loans offered by the GHLC covered 30% of construction in Japan, and this financial instrument was effective in raising the quality of houses. The NEDO subsidy programme suggests that financial incentives offered to homeowners can reduce energy consumption by about 10%, even though the project size was small compared to preferential loans. Currently, MLIT has requested that the government consider offering tax reductions when renovations to improve the energy efficiency of existing houses are undertaken; this will possibly be implemented starting in FY2008.

Offering financial assistance for consumers to purchase energy-efficient appliances, which tend to be more expensive, directly targets the upfront financial barrier to purchase. A study of such a programme in Iwate prefecture found it was a cost-effective measure and projected a positive impact on diffusion rates and a decrease in CO_2 emissions (Ashina and Nakata, 2007). However no national programme aimed at financing the investment in such appliances exists for the residential sector. Another option would be to set the minimum energy performance standards for appliances at a higher level, where least life-cycle cost is minimal. Should households spend more in upfront capital, from a societal point of view the cost is minimised through reduced energy consumption and reduced GHG emissions.

The various financial measures described in this study only marginally affect existing residential buildings; most efforts have been to finance purchasers of new homes or of very large residential buildings.

Voluntary agreements and partnerships

The number of houses undergoing evaluation and being issued a label has been rising since 2001, though the quantity of existing houses remains smaller than those undergoing evaluation during the design and construction phase. The labels do explicitly provide information on the building's energy efficiency, and thus can potentially incorporate this feature into the housing market if taken up by homeowners and real estate professionals. The training and certification of those performing the evaluation should also hopefully stimulate a higher level of awareness on EE issues among industry professionals.

Preferential loans offered through public-private partnerships with the GHLC and now the JHF directly tie loan conditions to building standards met, which offers incentives to those undertaking EE improvement measures. These loans have improved the EE standards in housing between 1996 and 2004, and the JHF continues to finance tens of thousands of individuals wishing to construct or renovate more energy-efficient houses. At present EE standards are only one of the criteria used to disburse loans; loans can be provided for other criteria which exclude EE. Thus there is potential to develop JHF-backed loans to be more geared towards improving EE.

Information and capacity-building measures

The revision of the Energy Conservation Law led enlargement and renovation of large-scale buildings to be managed by each municipal office. It is necessary to establish measures to motivate the owners of relatively small-scale buildings to voluntarily undertake energy conservation measures in their houses, considering the administrative costs needed for each building. The establishment and diffusion of tools to indicate the energy conservation of houses, such as the CASBEE and the expansion of financial assistance such as the MBS could be effective in making this happen. Such financing might be more effectively disbursed at the municipal level, with more detailed information regarding housing markets being available at this level of government (NEDO, 2007b). The expansion of CASBEE to smaller residential buildings, including detached houses, is a positive step; this will hopefully increase the financial assistance offered by municipal governments to these types of buildings as they dominate the existing housing stock.

It is also important to promote the energy conservation for small-scale detached houses accounting for the majority of the Japanese housing stock. In order to implement these measures, the establishment of markets for houses featuring energy conservation supported by the general public and enterprises is indispensable. In order to make this happen, it is necessary to establish an indicator of the energy conservation of detached houses and to diffuse it. The new voluntarily labelling system which applies to existing houses as well will hopefully stimulate this shift.

Conclusion

The longest running policies, those targeting building and appliance standards, have proven to be effective and have continuously expanded their applicability. They appear to be sustainable, having instigated a shift in building practices and appliance manufacturers. The financial measures described are relevant but their scope is too limited to allow for them to have impact in the existing residential building sector. Another weakness of these policies is that they target urban prefectures more than rural ones. While most households and people live in urban prefectures, those in rural prefectures emit more CO_2. The residential sector in rural prefectures emitted 52.5% of the total residential CO_2 emissions in Japan (Ashina and Nakata, 2007).

Most efforts at instigating market transformation, such as encouraging ESCOs and demand-side management programmes, largely focus on the commercial and industrial sectors. The MOE has recently adopted a proposal from Biwako Bank to use an ESCO scheme to introduce preferential interest rates for consumer loans to replace appliances with the most energy-saving models (MOE, 2007).The renewed emphasis on integrating energy and environmental policy into the economy may lead to increased inclusion of the existing residential building sector.

The Japanese government understands the importance of supporting energy efficiency improvements, recognising that it can contribute to both energy supply security and the prevention of global warming. It is also noted in the Energy White Paper 2006 that the progress of energy conservation may bring about a new investment field of energy-efficient technologies such as energy-efficient appliances. The 2007 White Paper and Cabinet Decision of June 2007 explicitly emphasise transforming the economy into one that integrates EE. While energy conservation measures in Japan have progressed since the oil crisis, those seeking to promote energy efficiency in the existing residential sector, mainly through addressing the financial barriers which prevent this, have been promoted more sluggishly as compared to other sectors. Statistics indicate that existing policies, including financial instruments, for improving energy efficiency in housing envelopes and home appliances, have contributed to suppress the growth of per household energy consumption. While per household consumption may have decreased, total energy consumption in the residential sector has increased by 12% in the past decade, making these policies even more relevant and necessary.

In Japan, energy efficiency in residential buildings is promoted through the cooperation of METI and the MLIT based on the Energy Conservation Law. The strength of this arrangement is that it seeks to promote a mix of policies, from mandatory to voluntary measures, while emphasising the potential of public-private partnerships. It has the potential to encourage sustainable policies which have an impact horizontally across the economy.

Chapter 4 • UNITED STATES OF AMERICA

Introduction

The United States of America (US) is an energy dependent nation. As such it is vulnerable to external events that could disrupt its energy supply. Increasing energy efficiency (EE) has long been part of the US's strategy to reduce dependence on foreign energy sources.

This chapter follows the plan exposed in the Introduction. The first section presents the national context of the US: its energy profile and main natural characteristics, as well as the institutional conditions and predominant actors of the energy market. In the second section, the chapter describes policies and measures which have been applied in recent years at the federal, regional, and state level. Finally, the last section evaluates policies' impact at each level of government — *i.e.* federal, regional, and state.

National context and policy framework

National context and energy profile

Energy profile

The US is a net importer of energy. In 2005 the US produced 73 million TJ and consumed 106 million TJ (EIA, 2007a, 2007b). As a net importer, the country is dependent on external energy sources and sensitive to external events, such as oil crises.

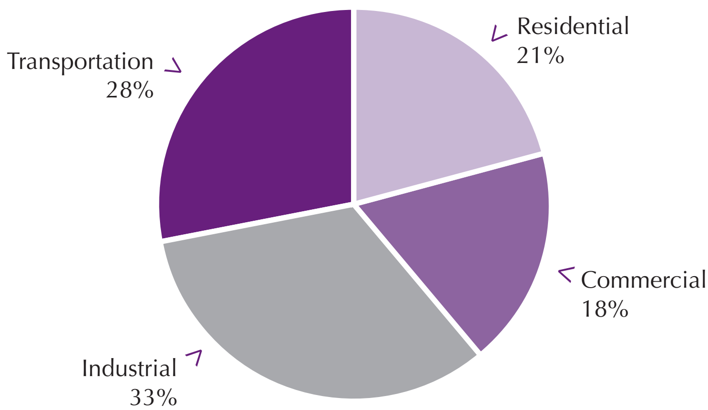
The US primary needs for energy are coal, petroleum and natural gas. In 2005, 84% of its energy consumed came from these three sources (EIA, 2007a, 2007c). Most coal is consumed in the electric utility sector and is used to generate electricity for building uses, as well as industrial sectors. Petroleum is mostly consumed in the transport sector, while relatively equal amounts of natural gas are consumed in the building and industrial sectors, and a smaller amount is consumed by electric utilities for end-use sectors.

Residential and commercial buildings use more than two-thirds of all electricity generated in the country. These sectors accounted for 39% of US energy use in 2006 (see Figure 24). Both economic and population growth are leading to a greater number of homes, as well as homes that are larger and better equipped. This in turn, further increases residential energy consumption.

During the 1970s and much of the 1980s, the residential sector saved proportionately more energy than any other sector. Per household energy use was cut by over a third within that time frame. Energy efficiency improvement measures were stimulated by the second oil price shock in 1979. Energy use per household declined rapidly immediately after the price shock, from

146 GJ in 1978 to 108.8 GJ in 1982. Energy use in this sector rebounded slightly in 1993 and declined again to106.7 GJ in 1997 and to 100.9 GJ in 2001(EIA, 2004; US Census Bureau, 2001). Continuing efficiency improvements have been offset by increases in the number of households, the amount of living space per capita, and the spread of more energy intensive equipment. A recent study shows that per capita energy use in 15 International Energy Agency (IEA) countries, including the US, has increased by 4% since 1990. This has mainly been driven by appliances energy demand, which grew by more than 70% in the US between 1990 and 2004 (IEA, 2007). The residential sector remains a relevant target for EE improvement policies, given its energy consumption and the factors offsetting EE improvements. An overview of the US housing market indicates the potential scope of energy efficiency improvement programmes in the residential sector.

Figure 24 • US energy use by end-use sector, 2006



Source: EIA (2007d), *Annual Energy Outlook.*

Housing sector

Housing market

The total US building stock covers approximately 300 billion square feet. During the period 1990-2000, housing growth in states in the Northeast of the country (6.6%) and in the Midwest (10.1%) was generally slower than the national pace (13.3%), while California led the country in terms of the total number of housing units in the US in 2000 (12.2 million). New homes are most common in the South and West (US Census Bureau, 2001). In the South, for example, 12.7% of the total housing inventory was built between 1995 and 2000 (Woodward and Damon, 2001).

On the whole, approximately 5 billion square feet are renovated and the same amount built every year. According to some organisations, for example Architect 2030, by the year 2035 approximately three-quarters of the built environment, both residential and non-residential, will be either new or renovated. This represents considerable potential for further energy efficiency improvements in existing residential buildings (Architect 2030, 2007).

Table 10 • ***Selected housing facts in the US***

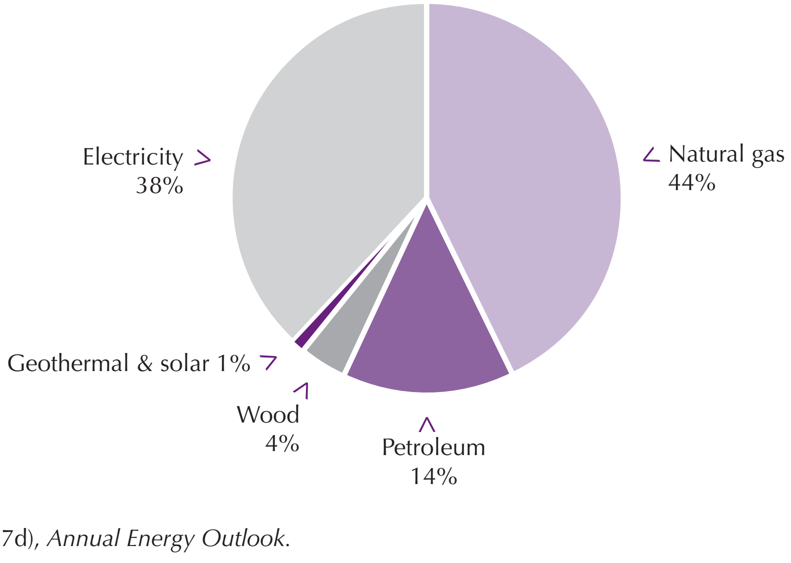
Housing facts US	
Housing units, 2005	124 521 886
Home ownership rate, 2000	66.2%
Housing units in multi-unit structures, 2000	26.4%
Median of owner-occupied housing units, 2000	USD 119 600
Households, 2000	105 480 101
Persons per household, 2000	2.59
Per capita money income, 1999	USD 21 587
Median household income, 2003	USD 43 318
Persons below poverty, percent, 2003	12.5%

Source: US Census Bureau.

Residential heating structure

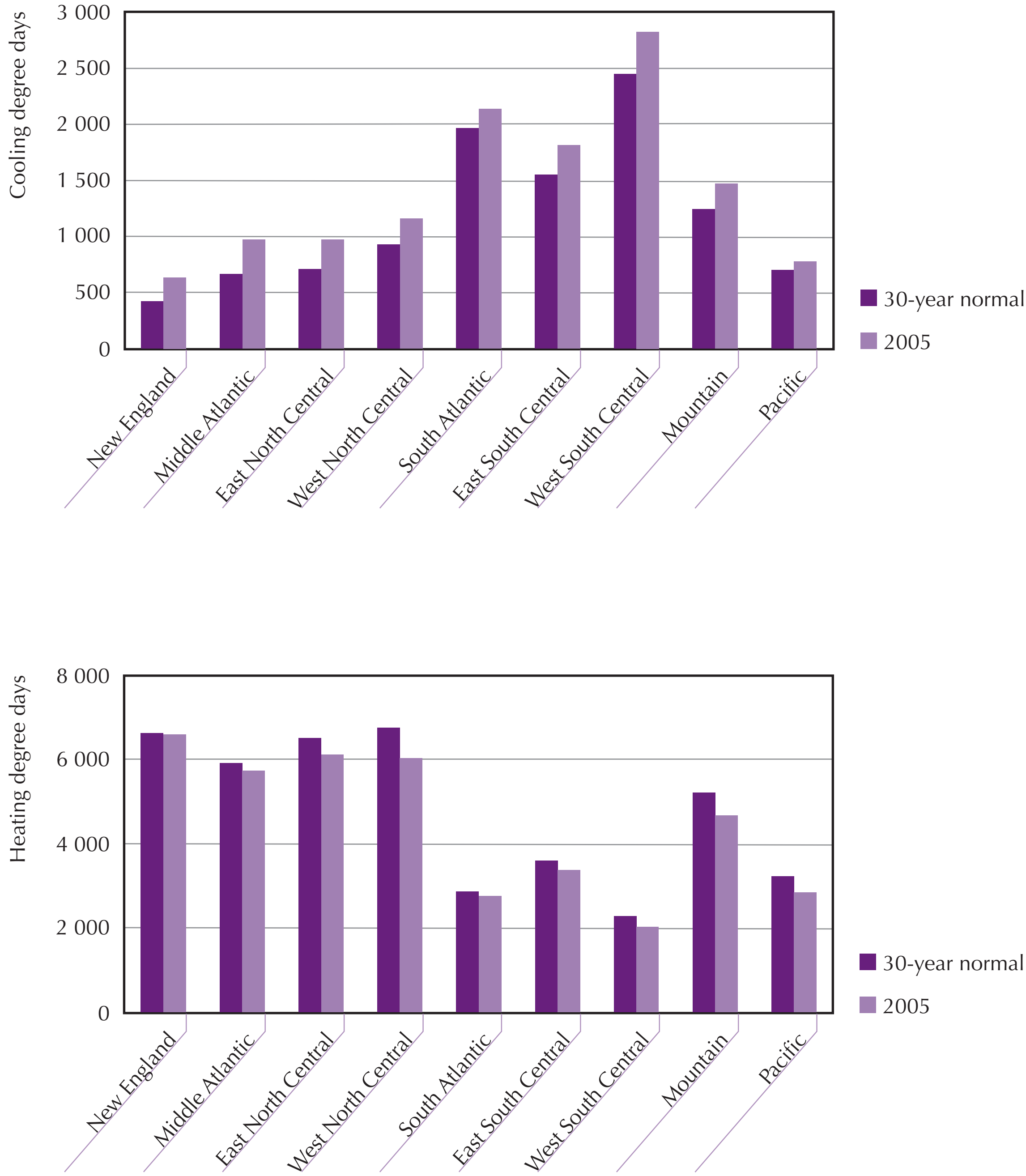
Heating accounts for about 34% of the energy use in residential buildings, making it the largest energy expense for most homes (US Department of Energy (DOE), 2005). Over 7.4 million TJ were used in 2005 to heat housing units; this makes heating systems a prime target for energy efficiency improvement measures. As seen in Figure 25, natural gas is by far the largest source of heat, followed by heating oil and propane. Over the past decades, the structure of the energy consumed in US housing units has changed. The percentage of energy provided by electricity increased whereas the energy provided by fuel oil/kerosene continuously decreased since 1978. The percentages of energy provided by natural gas (over 50%) and liquefied petroleum gases (LPG) are statistically unchanged from the 1978 levels. Heating needs also vary within the country given its variety of climate zones.

Figure 25 • ***US residential energy sources 2005***



Source: EIA (2007d), *Annual Energy Outlook.*

Figure 26 • ***Cooling degree days and heating degree days by census division 2005***



30-Year Normal: based on calculation based on data from 1971 through 2000.

Source: EIA (2005a), *Annual Energy Review*.

Climate indicators

The US has a wide range of climate zones. The climate is temperate in most areas, tropical in southern Florida, polar in Alaska, desertic in the Southwest, Mediterranean in coastal California, and arid in the Great Basin. As seen in Figure 26, the Northern part of the country is heating-dominated, whereas the southern part tends to be cooling-dominated (in each instance, the mean daily temperature is taken to be 65° F). These variations lead to differing energy needs and efficiency requirements, justifying the role of individual states in the implementation of EE improvement policies that are adapted to local conditions. While this dynamic will be examined further, an overview of the overarching goals and strategies guiding EE improvement policies at the federal government level is first required.

The next section turns to the institutional framework and main actors of each level of government. It will look in turn to the federal, regional, and state level.

Policy and institutional framework: federal level

Goals and strategies

Prior to 1973, the federal government's role in energy administration mostly concerned the monitoring of energy data, the facilitation of research and development, and the regulation of energy systems in cooperation with public, private, state and local institutions. In general, the government took a "benign approach" to energy administration, with the private sector largely overseeing production, distribution, marketing and pricing policies. The federal government would only occasionally intervene to address energy prices (DOE, 1994). As a result, many aspects of energy administration took place at the state, and even private sector, level.

The first oil crisis of 1973 highlighted the need for a more coherent national energy policy. Since then various measures have been implemented at the federal level, including the Energy Policy and Conservation Act of 1975, the Energy Policy and Production Act of 1976 and the Energy Policy Act (EPAct) of 1992. These measures have provided for action to be taken regarding energy efficiency, including building codes, labelling programmes, tax credits and weatherisation programmes.[26]

The National Energy Policy Development Group's 2001 report paved the way for the development of a new national energy policy. The report urged that action be taken to meet five national goals: i) modernising conservation efforts; ii) modernising the country's energy infrastructure; iii) increasing energy supplies; iv) accelerating protection and improvement of the environment, and; v) increasing the country's energy security (National Energy Policy Development Group, 2001). In 2005 a revised Energy Policy Act (EPAct) replaced that of 1992, setting out the key features of federal energy policy. In particular, the Act seeks to increase the country's energy security through:

26. For a brief summary of US federal level energy policy prior to 1977, see US DOE, November 1994, Part I.

- diversifying energy supply;
- reducing independence on foreign sources of energy;
- increasing energy efficiency and conservation in homes and businesses;
- improving the energy efficiency of vehicles;
- modernising energy infrastructure;
- promoting alternative and renewable energy sources;
- increasing domestic production; and
- encouraging the expansion of nuclear energy.

In relation to energy efficiency the EPAct includes extensive provisions which address the residential, private and government sectors. This includes energy efficiency standards for federal buildings, energy conservation standards for some consumer products, support for a model building energy code compliance programme, and the promotion of incentives for smart energy practices. In particular the Act provided tax credits for energy conservation improvements to homes. Tax credits were also provided for nuclear power and fossil fuel production, renewable energy, alternative motor vehicles and fuels and investments in clean coal facilities.

The goals and strategies define the trends of the policy measures implemented at the federal level, which will be exposed in detail in the next section. First, a description of the institutional framework and key actors of the energy market follows.

Institutional framework

The federal institutional and legal frameworks form a key component of energy efficiency policies in the US. Policy decisions, funding and programme management can take place at both federal and state levels, resulting in various interactions and mutual influences. In some situations federal legislation can restrain the independence of individual states to define their own policies. In others, states have flexibility in administering federal programmes or adhering to federal legislation. Sometimes states take the initiative and pave the way for progressive legislation at a federal level, while in other instances, states are required to implement regulations set at the federal level.

Since the first oil crisis of 1973 the federal government took the lead by providing federal funds, setting mandatory or optional standards (such as model building codes and appliance standards) and defining policy instruments which were implemented by the states (for example weatherisation programmes). Government and utility energy conservation programmes were an important element of the first period up to 1986 (Clinton *et al.*, 1986). Some progressive states, such as California, and regional alliances, such as the Northeast Energy Efficiency Partnership (NEEP), also initiated energy efficiency policies which in turn influenced federal action and encouraged other states (Clinton *et al.*, 1986). Initial state flexibility was restrained by federal regulations, particularly the detailed requirements of the Energy Policy and Conservation Act (EPCA) of 1975. At the same time the US Department of Energy (DOE) was criticised for not having implemented enough federal regulation, for instance in the case of appliance standards (Clinton *et al.*, 1986).

Federal policy was an important driver of state energy efficiency policy, especially in an earlier phase starting in the early 1970s. Federal policies that have directly or indirectly affected (through state implementation) the energy use of residential buildings include efficiency standards for appliances and equipment, appliance labelling, government purchasing and procurement, building codes and standards, and tax incentives (see Waide *et al.*, 2006). Several authors have nevertheless pointed out the role of states and their potential contributions to energy efficiency improvement (Clinton *et al.*, 1986; Kubo *et al.*, 2001; Brown *et al.*, 2002; Nadel *et al.*, 2006; Peterson and Rose, 2006; Gillingham *et al.*, 2004).

Though largely implemented at a state level, federal EE improvement policies are developed, administered and funded by a variety of actors. The principal bodies in the federal administration that determine and administer EE policies affecting existing residential buildings are described below.

Actors

Department of Energy (DOE)

The creation of the federal Department of Energy (DOE) in 1977 brought together scores of energy-related programmes that had been operating within various federal agencies. Prior to this, energy policies were largely considered as either ″nuclear″ or ″non-nuclear″, with the latter incorporating energy research, development, production and regulation (DOE, 1994).

Since its creation the DOE is the main body responsible for the administration of energy policy at the federal level. Its overarching mission has been conditioned by the circumstances of its establishment: the 1970s oil crisis and the Cold War, necessitating a focus on security, national defence, science and innovation. Its foremost mission is to advance the national, economic, and energy security of the US; to promote scientific and technological innovation in support of that mission; and to ensure environmental cleanup of the national nuclear weapons complex. In this regard, energy efficiency measures undertaken at the federal level are connected with the DOE's predominant policy mandate to ensure the country's energy security, as well as to strengthen scientific innovation, economic competitiveness and the quality of life (DOE, 2007a, 2007b).

Office of Energy Efficiency and Renewable Energy (EERE)

Within the DOE, energy efficiency matters are now chiefly dealt with by the Office of Energy Efficiency and Renewable Energy (EERE). This office focuses on strengthening the country's energy security, environmental quality, and economic vitality through public-private partnerships that: i) enhance energy efficiency and productivity; ii) bring clean, reliable and affordable energy technologies to the marketplace; and iii) make a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life. The EERE coordinates federal government efforts in relation to the research, development, and deployment of energy efficiency measures through investing in high-risk, high-value research and development that might not be otherwise carried out by the private sector alone. In so doing, the EERE works with state and local governments, the private sector, universities and government laboratories, among other actors (DOE, 2007c).

Building Technologies Program (BTP)

The EERE also administers the Department's Building Technologies Program (BTP). Through this programme, the Department works with states, the building industry and manufacturers to conduct research and development on technologies and practices for energy efficiency. It also works on improving building codes and appliance standards with state and local governments and seeks to promote energy – and money-saving opportunities for builders and consumers (DOE, 2007d). Through various programmes the BTP develops, implements, and coordinates research and development to improve energy efficiency of building components, working on both emerging technologies and integrating new technologies with innovative building practices. These components are integrated into building energy systems through system design and regulatory activities. The programme addresses both the building envelope (walls, windows, roofs) and equipment (heating, cooling equipment, lighting etc.) and their integration into optimal "whole building" designs. The BTP develops building design computer software and other tools to allow architects and others to apply this integrated design approach to individual buildings. The BTP's Building Energy Codes Program develops voluntary building codes, mandatory codes for federal buildings, and minimum appliance efficiency standards. The BTP also develops test procedures for documenting energy use for appliance labels, the appliance standards programme, the Energy Star programme and related deployment strategies. Within the BTP the DOE sponsors a public-private partnership, Building America, that conducts research on energy efficient solutions for new and existing housing that can be implemented on a production basis (EERE, 2007a; 2007b).

Environmental Protection Agency (EPA)

Much of the DOE's work, in the area of energy efficiency and renewable energy in particular, is assisted by the Environmental Protection Agency (EPA). Created in the 1970s to protect human health and the environment, the EPA's main activities are: i) directing the nation's environmental science, research, education and assessment efforts; ii) developing and enforcing regulations, often in cooperation with state, local and tribal governments, and; iii) providing financial assistance through state environmental programmes. The EPA develops and enforces regulations that implement environmental laws passed by Congress, some of which target energy saving and reductions in greenhouse gas emissions. In addition, the EPA conducts research and provides financial assistance to state governments and organisations wishing to implement projects or conduct research. It is also mandated to execute DOE requirements. Its largest programme affecting residential housing is the Energy Star programme administered jointly with the DOE, which will be discussed later in the chapter.

Department of Housing and Urban Development (HUD) & Department of Health and Human Services (HSS)

Two further actors of the federal administration are the US Department of Housing and Urban Development (HUD) and the Department of Health and Human Services (HSS). Among other activities, HUD is a partner of the public-private Partnership for Advancing Technology in Housing (PATH).[27]

27. *http://www.smartcommunities.ncat.org/buildings/usgovbe.shtml.*

Path seeks to expand the development and utilisation of new technologies to make American homes stronger, safer, and more durable. This also involves making homes more energy-efficient and environmentally-friendly, easier to maintain and less costly to operate, and more comfortable to live in. It provides information on best practices, a technology inventory, a Residential Structural Design Guide and other resources. Moreover, HUD participated in a national collaboration initiated by the DOE which prepared the floor for including Home Energy Rating Systems (HERS) and energy-efficient mortgages (EEMs) in the EPAct of 1992. The Department of Health and Human Services (HSS) operates the Low-Income Home Energy Assistance Program (LIHEAP), which will be discussed further in more detail.

Non-governmental organisations

Finally, non-governmental organisations have stimulated collaboration and exchange between the federal and the state level. These include the American Council for an Energy-Efficient Economy (ACEEE), the Alliance to Save Energy (ASE), and more recently the National Commission on Energy Policy.

The ACEEE is a non-profit organisation dedicated to advancing energy efficiency as a means of promoting economic prosperity and environmental protection. Its activities include conducting technical and policy assessments and advising policy makers. The ASE is a non-profit coalition of businesses, government, environmental and consumer leaders, which advocates for EE policies, undertakes research and seeks to build public-private partnerships in the energy efficiency arena. The National Commission on Energy Policy is a bipartisan group of 20 national energy experts from industry, government, academia, labour, consumer and environmental protection organisations. It seeks to consider energy policy reform in order to enhance US national security, strengthen the national economy and protect the global environment and public health (National Commission on Energy Policy, 2006). In addition the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has assisted with the development of codes, standards and labels for the industrial sector.

The above actors work alongside state level actors within the federal institutional structure to enact EE improvement measures in existing residential buildings. This sector is differentiated by state, regional and climatic zones. Given the particular federal structure of the US, these policies are developed at federal, regional and state levels. The following three sections of the chapter provide an overview of these policies, starting with the federal level.

Policy measures: federal level

At the federal level, energy efficiency measures are largely underpinned by a desire to balance sustainable energy use, competitiveness and security of supply. Energy efficiency is seen as one way to meet the country's significant energy needs in a cost-effective manner, while also contributing to energy security (DOE, 2007a). This connection between energy security and efficiency has been predominant since the 1970s and 1980s. Even within the last five years, conservation measures, including in the building sector, have been introduced in response to real or perceived energy crises.

Energy efficiency has also been linked with environmental aims, particularly in the minimisation of greenhouse gas emissions. In 2002, the federal government committed to reducing greenhouse gas intensity by 18% of the national economy by 2012.[28] The government hopes to lower emissions for every USD 1 million of the country's GDP from an estimated 183 tons in 2002 to 151 tons in 2012. Achieving these targets will involve a reduction of 100 million tons of emissions in 2012 alone, and more than 500 million tons in cumulative savings over the decade. Energy efficiency measures are one way to meet these emissions reduction goals, together with technology improvements and dissemination, the adoption of existing technologies, voluntary emissions reductions programmes with industry and a general shift toward "cleaner" fuels.

This section gives an overview of policies introduced at the federal level, following the policy classification developed in the introduction.

Regulatory measures

Building codes and standards

Before the introduction of federal building codes and standards in the late 1970s, states were, in principle, able to define their own standards. In many instances, this was done at the local government level, with states delegating power to them for that purpose (Gross and Pielert, 1977).

In 1976, amendments to the Energy Policy and Conservation Act 1975 paved the way for greater federal involvement in standard setting. The Act specified that states could set standards only in the absence of relevant federal legislation.[29] The 1976 amendments included Title III – the "Energy Conservation Standards for New Buildings Act", and Title IV, the "Energy Conservation in Existing Buildings Act", which provided a basis for developing performance standards. In 1979 the attempt to implement mandatory codes failed due to criticism that these were "too ambitious, too complex, too heavy to handle" and too reliant on a computer programme. Following this, federal codes became mandatory only for federal buildings. This left states with the freedom to undertake independent action in relation to non-federal residential and commercial buildings, excluding appliances and building equipment such as boilers and HVAC[30] which remained subject to federal regulations. Federal authorities have tried to coordinate the development of codes, however, by defining model energy codes (MEC), supporting voluntary action and providing funds for compliance software and state-specific implementation activities. The level of state action varies, with some states still not having adopted building codes even for new buildings and others exceeding the federal level model codes. To date 26 states have adopted residential energy codes meeting 2003 or 2006 IECC standards (BCAP, 2007).

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28. *Greehouse gas intensity refers to gas emissions per unit of economic activity. White House, 'Addressing Global Climate Change' <www.whitehouse.gov/ceq/global-change.html#2> (undated).*

29. *A good overview of the historical development of the Building Energy Standard Programme between the early 1970s and 1993 can be found in Shankle* et al.*, 1994. It summarises the time line of federal legislation impacting building energy standards as well as the evolution of voluntary codes and standards and the role of ASHRAE in this process.*

30. *HVAC (heating, ventilating, and air-conditioning) refers to the equipment, distribution network, and terminals that provide either collectively or individually the heating, ventilating, or air-conditioning processes to a building.*

Appliance and equipment standards

In the past, the absence of federal legislation allowed state governments a fair degree of freedom in establishing standards for appliances and equipment. This freedom was used by California to define standards in the 1970s and later, in the early- to mid-1980s, by other states such as Florida, New York and Kansas (see Nadel *et al.*, 2006).

Responding to concerns expressed by manufacturers, the US Congress adopted the National Appliance Energy Conservation Act (NAECA) establishing minimum energy performance standards (MEPS) in 1987. Since its coming into force states have had to seek special permission or a waiver from the DOE to establish their own, state-specific standards for appliances. Appliance standards were addressed by federal law to encourage energy savings and to replace a "patchwork of state standards". Following this legislation, in 1988 standards for furnaces and boilers, water heaters, central air conditioners, heat pumps and room air conditioners were addressed. A 1992 amendment addressed commercial furnaces and boilers among other appliances (see Nadel *et al.*, 2006 for a complete overview). Besides the building envelope, these appliances and equipment are key in determining the energy use of existing buildings. However, these federal standards appear outdated when compared with present technical possibilities. The minimal EE standard for furnaces and boilers took effect in 1992, 15 years ago, and much technical progress has been made since. For instance the minimum Annual Fuel Utilization Efficiency (AFUE)[31] value for new residential furnaces is only 78%, though it could be easily more than 90% using today's technology (see Lekov *et al.*, 2006).

In 2000, the DOE initiated a process of updating the existing standards for residential furnaces and boilers with the involvement of all stakeholders. The process included a dialogue consisting of state initiatives and federal responses, resulting in Congress enacting 16 new standards as part of the Energy Policy Act of 2005. After consultation, a Notice of Proposed Rulemaking (NOPR) was published in the Federal Register of 6 October 2006 (EERE, 2006a). The proposed standards would apply to all covered furnaces and boilers offered for sale in the US as of January 2015. The proposed standards are fairly moderate, as low as 80% to 84%,[32] whereas condensing furnaces could reach a much higher efficiency, an AFUE of 90% to 96% (Lekov *et al.*, 2006). Condensing technology is applied in several European countries[33] for gas furnaces and increasingly for fuel furnaces. It has further been demonstrated that condensing technology becomes cost-effective very quickly. The American Council for an Energy-Efficient Economy (ACEEE) recommends that states rather than the federal government implement certain specific near-term standards, citing the climatic differences between states as justification (see Nadel *et al.*, 2006).

31. Measures the amount of fuel converted to space heat in proportion to the amount of fuel entering the furnace. Commonly expressed as a percentage; a furnace with an AFUE of 90 could be said to be 90% efficient.

32. The proposed values are justified as follows: "The Energy Policy and Conservation Act …, as amended, specifies that any new or amended energy conservation standard the Department of Energy …prescribes for consumer products shall be designed to achieve the maximum improvement in energy efficiency…which the Secretary determines is technologically feasible and economically justified." (42 U.S.C. 6295[o][2][A]), see EERE (2006a).

33. For example the UK, the Netherlands, Germany, Switzerland, Austria and Belgium.

Financial and incentive-based measures

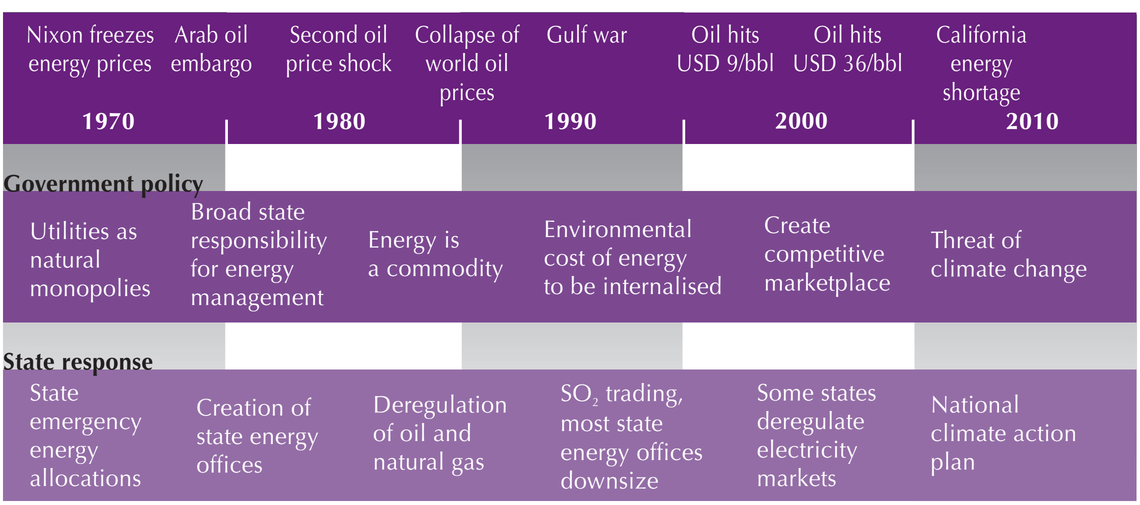
State Energy Conservation Programs (SECP), Institutional Conservation Program (ICP) and the State Energy Program (SEP)

Between 1974 and 1992, Congress established several complementary programmes, primarily within the DOE, to implement energy-saving measures in virtually every sector of activity (Sissine, 2006). These energy efficiency and energy conservation programmes were created originally in response to national oil import security and economic stability concerns.

In 2005 constant dollars, from FY1978 through FY2005, the DOE provided about USD 8.2 billion in grants for state and local energy conservation programmes. Funding was allocated to states and local organisations upon application rather than through a prescribed allocation mechanism. This allowed states to shape their own energy policies and programmes using federal funds.

Before State Energy Conservation Programs (SECP) were established in 1975, only a few states already performed energy planning (Clinton *et al.*, 1986). As of 1979, state activities were complemented by the Institutional Conservation Program (ICP), the Supplemental State Energy Conservation Program (SSECP) and by the Energy Extension Service (EES) which provided large (and variable) federal funding, especially during the early 1980s. The largest funding mechanism, the Institutional Conservation Program (ICP), provided federal funds administered by the states to allow schools, hospitals, local governments, and public-care facilities to assess energy saving potentials and to undertake energy-related capital improvements to their facilities (Clinton *et al.*, 1986). Hence, the ICP did not cover the residential sector, unlike other federally funded state energy programmes. State Energy Programs (SEP) have evolved along with state and federal policies to meet the demands of international events and national energy policy priorities (see Figure 27).

Figure 27 • Evolution of State Energy Programs



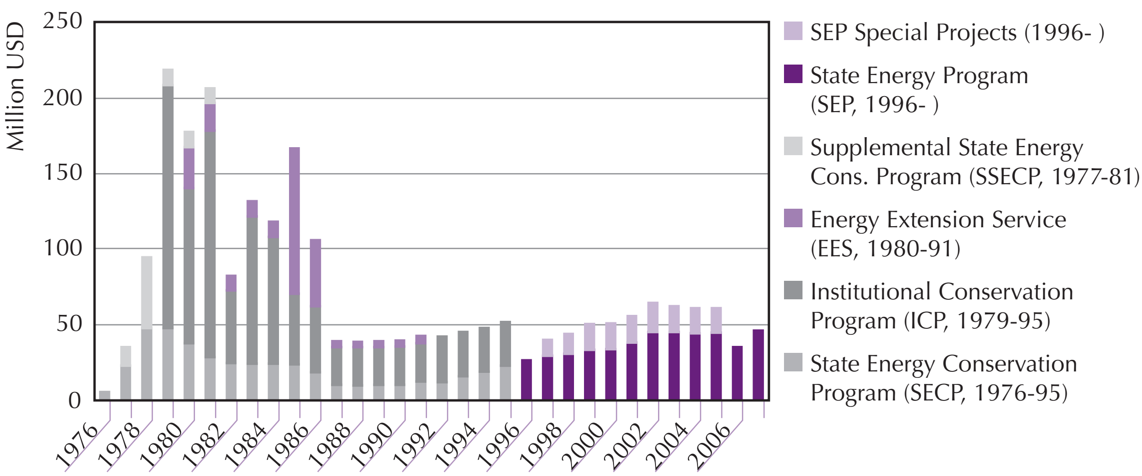
Source: EERE (2007b), "State Energy Program: History of the State Energy Program", (available at www.eere.energy.gov/state_energy_program/history.cfm).

The State Energy Program (SEP) was created in 1996, by consolidating the SECP and the ICP. The SEP supports the work of state energy offices (SEO) to increase the energy efficiency of residential buildings. State activities include demonstrating new energy efficiency technologies and construction techniques such as whole building design, and providing homeowners access to financing for energy efficiency projects. Some of the SEP-related projects are part of DOE's R&D programme Rebuild America. Many states combine their own money with funding from DOE's SEP and the private sector to support their energy projects. Technology programmes in DOE's Office of Energy Efficiency and Renewable Energy (EERE) work with the states via the State Energy Program's annual solicitation called Special Projects. With such special projects states may advance their EE policy, for example to define and to implement building codes as in the case of New York.

Historically, the intensity of funding from federal and other sources for state-specific energy programmes was highest between the late 1970s and 1986 when fossil energy prices collapsed (see Figure 28).

When the Petroleum Violation Escrow (PVE) funds became available (from court settlements with the large oil companies for alleged price violations) as of 1985, the US Congress started cutting funds to the ICP and the SECP, which affected all states. The PVE funds were used to finance the SEP and therefore state energy-related programmes (EERE, 2007c). However, most states have exhausted their PVE funds, and these represent a small percentage of total funding (EERE, 2007d). With limited PVE funds and direct federal funding for the State Energy Program, many states struggled to encourage energy efficiency measures in the mid 1990s. In August 2006 approximately USD 43 million in PVE funds, which had been tied up for an extended period in court, became available for distribution; these funds were the last that were being held in DOE's escrow accounts (EERE, 2006b).

***Figure 28* • Funding for state-specific energy programs from different federal sources (without weatherisation and without federal residential tax credits)**



Source: data from EERE (2007b), "State Energy Program: Funding to the States", (available at www.eere.energy.gov/state_energy_program/funding_states.cfm).

The range of activities covered by the SEP is quite broad; it includes buildings along with 18 other project areas. In 2002, 83% of the USD 44 million SEP funding as reported by states was used for various information measures, loans and grants, and codes and standards[34] (see Schweitzer and Tonn, 2005). Other project areas received much less SEP funding.[35] Interestingly, relative weights shift considerably if all funding (including non-SEP, but excluding system benefits charge, SBC) is considered: in this case retrofits have a relative weight of almost 40% and also the proportion of tax credits is much higher (10.7% instead of 0.8%) and closer to the proportion of loans and grants (15.3%), and financial incentives (6.4%). These three direct financial measures account for about one-third of the USD 542 million of all funding (SEP plus non-SEP, excluding SBC), providing considerable leverage to the SEP funding amount. Note that not all the states cover all the 18 project areas: 36 were active in the project area "Retrofits", 34 in "Loans and Grants", 28 in "Codes and Standards" and for instance only four in Home Energy Rating Systems (HERS) and energy efficient mortgages (EEMs) (see Schweitzer and Tonn, 2005 for details, also regarding the US wide impacts of each of the project areas).

While the federal State Energy Program plays an incontestably important role, the states ultimately decide on the direction and scope of their energy programmes.

Fiscal measures

Direct funding for energy efficiency measures through tax credits was first introduced at the federal level by way of the Energy Tax Act of 1978. Though both tax credits and tax deductions have been used, the former has traditionally been favoured in relation to energy efficiency .The federal government considers tax credits to be "more valuable" than equivalent tax deductions, in that credits reduce tax dollar-for-dollar while deductions only remove a percentage of the tax owed (DOE, 2007e).

In its May 2001 report, the National Energy Policy Development Group proposed extending the existing tax crediting system for energy efficiency and renewable energy so as to stimulate the commercialisation and sale of innovative energy efficient and renewable energy technologies. In response, the 2005 EPAct established new tax incentives for the purchase of a wide range of Energy Star products, and for businesses and manufacturers using energy efficient building products and practices (DOE, 2007a).

The current federal Energy Efficiency Tax Incentives for existing homes (see Table 11) offers cost-based incentives of 10% of the amount expended by the taxpayer for "Qualified Energy Efficiency Improvements" and up to USD 300 for "Qualified Energy Property", up to a maximum credit limit of USD 500.[36] The current system applies to relevant improvement or property installed

34. *Loans and grants: 16.2%, workshop/training: 15.5%, technical assistance: 12.1%, alternative energy: 11%, energy audits: 10.6%, mass media: 9.6% and codes and standards: 8.1%.*

35. e.g. *retrofits: 7.1%, financial incentives: 1.3%, tax credits: 0.8%, HERS: 0.1%.*

36. *"Qualified Energy Efficiency Improvements" are: any insulation material or system specifically designed to reduce heat loss or gain; exterior windows; exterior doors; and any metal roof having pigmented coatings specifically designed to reduce heat gain which meet Energy Star programme requirements."Qualified Energy Property" is defined as: electric heat pump water heaters with energy factor (EF) of 2.0 or greater; electric air source heat pumps with heating seasonal performance factor (HSPF) of 9.0 or greater; geothermal heat pumps; central air conditioners that receive the highest efficiency tier established by the Consortium of Energy Efficiency as of 1 January 2006; and natural gas, propane or oil water heaters with EF 0.8 or greater. There are however certain credit limitations in the order of: USD 50 for any advanced main air circulating*

between 1 January 2006 and 31 December 2007. Further, renovations must be carried out in accordance with standards outlined in the 2001 or 2004 International Energy Conservation Code (IECC). New tax credits came into effect in January 2006, and include a credit of 30%, or up to USD 2 000, for the purchase of solar water-heating equipment and photovoltaic systems (DOE, 2006). The existing tax incentives were to be updated in December 2007. However the provision to extend the incentives fell one vote short in the senate. The provision could possibly move forward in the course of 2008 (TIAP, 2007).

Table 11 • Possible tax credits for energy-efficient home improvements

(as of November 2005)

Product category	Product type	Tax credit specification	Tax credit
Windows	Exterior windows	Meet 2000 IECC & amendments	10% of cost not to exceed USD 200 total
	Skylights	Meet 2000 IECC & amendments	10% of cost not to exceed USD 200 total
	Exterior doors	Meet 2000 IECC & amendments	10% of cost not to exceed USD 500 total
Roofing	Metal roofs	Energy Star qualified	10% of cost not to exceed USD 500 total
Insulation	Insulation	Meet 2000 IECC & amendments	10% of cost not to exceed USD 500 total
HVAC	Central AC	EER 12.5/SEER 15 split Systems EER 12/SEER 14 package systems	USD 300
	Air source heat pumps	HSPF 9 EER 13 SEER 15	USD 300
	Geothermal heat pump	EER 14.1 COP 3.3 closed loop EER 16.2 COP 3.6 open loop EER 15 COP 3.5 direct expansion	USD 300
	Gas, oil, propane water heater	Energy factor 0.80	USD 300
	Electric heat pump water heater	Energy factor 2.0	USD 300
	Gas, oil, propane furnace or hot water boiler	AFUE 95	USD 150
	Advanced main air circulating fan	No more than 2% of furnace total energy use	USD 50

Source: Federal tax credits for energy efficiency, Energy Star.

fan, USD 150 for any qualified natural gas, propane, or oil furnace or hot water boiler, and USD 300 for any single item of Qualified Energy Property. The energy factor (EF) indicates a water heater's overall energy efficiency based on the amount of hot water produced per unit of fuel consumed over a typical day. Heating seasonal performance factor (HSPF) is the total heating output (in Btu) provided by the unit during its normal annual usage period for heating divided by the total energy input (in Wh) during the same period.

Between 1978 and 1983, 24 million households claimed tax credits. However, the maximum credit amount of USD 500 was considered too small to noticeably change behaviour and the programme apparently had a negligible impact on the rental and low-income sectors (Clinton *et al.*, 1986).

According to the Energy Information Administration's impacts of modelled provisions of the 2005 EPAct, the impact remains modest. The tax credits for purchases of renewable technologies included in the study have a measurable impact on the purchase of ground-source heat pumps, nearly doubling the stock of this little-used technology by 2025. Even still, ground-source heat pumps only account for 0.7% of the heating equipment stock in modelled 2025 case. Some 1.1 million households could claim the existing home tax credit in 2006 and 2007, which represents less than 1% of the housing stock in 2004 (EIA, 2005b).

Weatherization Assistance Program (WAP) and Low-Income Home Energy Assistance Program (LIHEAP)

Low-income households were particularly affected by the high energy prices during the mid- to late-1970s. In response, the federal government established the Weatherization Assistance Programme (WAP) and the Low-Income Housing Energy Assistance Programme (LIHEAP). These are implemented by states, together with complementary activities and funding initiated at the state and community levels.

Created in 1976 (see Table 12) and administered since 1977 by the DOE, the WAP seeks to enable low-income families to permanently reduce their energy bills through improving the energy efficiency of their homes. It is the US's longest running energy efficiency programme, and arguably one of its most successful, having provided weatherisation services to more than 5.6 million low-income families by 2005 and about 100 000 in 2006 (WAPTAC, 2006).

Weatherisation technologies applied have evolved over time and include a wide range of energy efficiency measures for retrofitting homes and apartment buildings. These include air sealing, furnace/boiler repair or replacement, wall or roof insulation, window replacement, and warm climate weatherisation. This involves inexpensive but effective upgrades – the average expenditure limit is USD 2 826 per home – and the subsequent energy savings normally pay for the upgrades within a few years.

Funding for the WAP is decided annually by the Senate and House Interior Appropriations Committees. The annual amount dedicated to the programme has varied considerably over time.[37] Based on the total annual amount, the DOE provides funding to states by applying a formula that considers the number of low-income homes, climate factors and the household energy expenditure of that state. The DOE provides core funding for the WAP, along with technical

37. The programme received from USD 160 to 200 million per year during the 1980s, with this amount decreasing during the 1990s to USD 100 million in 1996, before increasing to USD 240 Million by 2006. During the 1980s, the WAP and the LIHEAP were complemented by the Petroleum Violation Escrow (PVE) funds. These funds resulted from several successful lawsuits run by the federal government held against oil companies who had overcharged consumers during the gas shortage of the mid-1970s. The courts directed the oil companies to pay millions of dollars. As individual compensation was problematic, the states implemented programmes that would reduce consumers' energy costs.

guidance. The WAP funds are then administered by states, which are relatively autonomous in managing the weatherisation programmes, both in terms of eligibility criteria and in terms of programme type. States do not provide funding to households, but contract with local agencies (usually non-profits) to deliver weatherisation services to low-income households. As such, this programme is an excellent example of collaboration to enhance energy efficiency between federal, state and local-level actors.

Table 12 • *Weatherisation timeline*

1973	Oil crisis creates fuel shortages
1976	Congress creates the Weatherization Assistance Program focusing on emergency and temporary measures
1980	Emphasis on more cost-effective and permanent measures
1984	Space and water heating improvements authorised
1985	Furnace and boiler replacements approved
1990	Development and implementation of advanced audits
1994	Cooling measures for warm climates included
2000	Advanced energy audits in use nationwide
2001	Five million homes served

Source: DOE/EERE, websites.

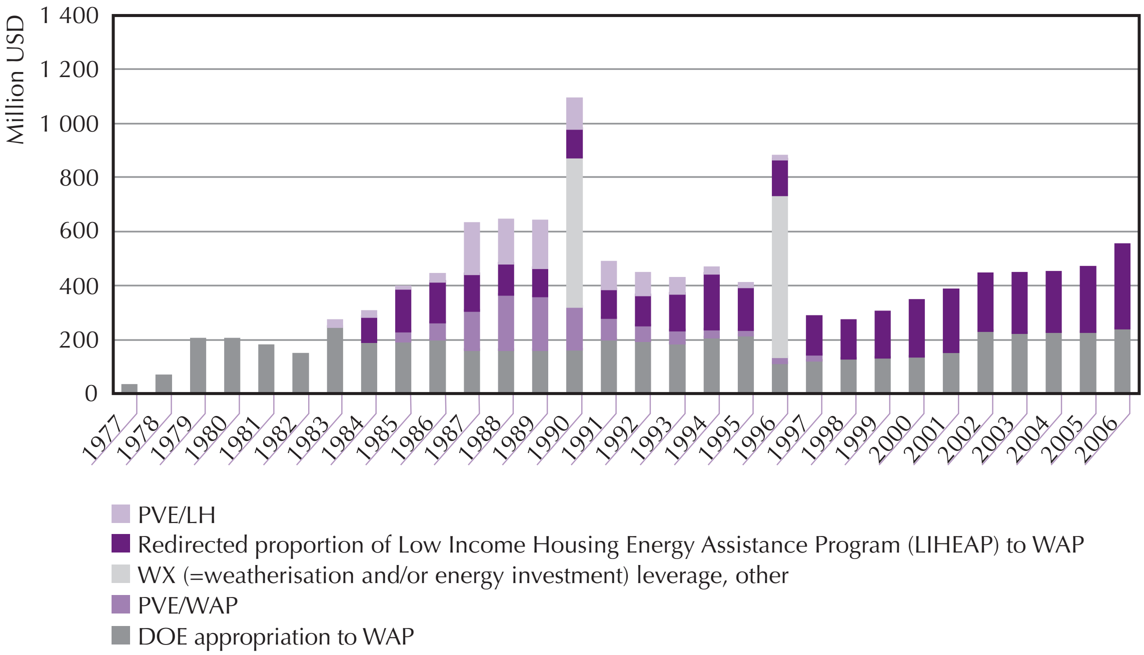
The Low-Income Housing Energy Assistance Programme (LIHEAP) was created by Congress in 1981 and is administered by the Department of Health and Human Services (HSS). The LIHEAP provides funding for states to assist low-income households in meeting their home energy costs. The funds are also used to intervene in times of energy crises, and to provide low-cost residential weatherisation and other cost-effective, energy-related home repair services. The main focus of the state programmes granted by LIHEAP is direct financial assistance to subsidise the energy bills of low-income households; EE improvements through residential weatherisation and other energy-related home repair are only secondary. Indeed the share for this type of assistance is limited to 15% of LIHEAP's grants (25% is allowable with a waiver from HHS). Beyond such requirements, states are free to allocate their funds on individual programme components. LIHEAP is therefore primarily designed for energy assistance and has a strong social character (Campaign for Home Energy Assistance, 2005).

Nevertheless, due to the large volume of the LIHEAP programme, about USD 1.9 billion plus up to USD 1 billion in emergency contingency funds (LIHEAP clearing house, 2007a), the LIHEAP funds allocated to energy efficiency measures fall between about USD 50 to USD 200 million, (LIHEAP clearing house 2007b; own estimations). Expressed in nominal dollars, the LIHEAP funding decreased after the mid-1980s due to reduced energy prices and by 1999 amounted to only about 50% of the mid-1980 level. The proportion of funding redirected to WAP has been increasing since 1994 to reach USD 240 million in 2006 (LIHEAP clearing house, 2007b).

These redirected funds are comparable with direct WAP funding amounts, which reached USD 228 million in 2006 (EERE, 2006c) (See Figure 29). Many states use DOE WAP funding to leverage money from additional sources (EERE, 2006d). In addition, LIHEAP provides a leverage incentive fund to reward grantees that add private or non-federal public resources beyond what could be provided with federal resources (HHS, 2007).

Figure 29 • Funding for weatherisation programmes between 1977 and 2006

(current million USD)



Source: LIHEAP Clearinghouse ; www.sustainable.doe.gov; www.waptac.org.

By reducing the energy bills of low-income families instead of offering financial aid, weatherisation lessens dependency and liberates these funds for spending on more pressing family issues. On average, weatherisation reduces heating bills by 32% and overall energy bills by USD 358 per year at current prices (EERE, 2006d). In terms of eligible households, the relevance and potential of the weatherisation programmes could be greater. In 1990 there were 27.9 million low-income households,[38] representing 30% of the 91.9 million US households registered. However, due to limited funding only a small share of potentially eligible households has been served – 5.6 millions households in 2006, comprising only about 16% of those eligible. Priority was given to families with one or more members who are disabled or elderly, to families with children and to households with high energy burden (Berry *et al.*, 1997).

These weatherisation programmes have helped spawn an energy efficiency industry for residential housing. This industry today employs 8 000 people in low-income weatherisation alone. Many

38. Incomes near or below the federal poverty guidelines for weatherisation eligibility in 1994, see Berry et al. *(1997).*

of the techniques that are today standard procedure in this industry were first developed and tested by the Weatherization Program. All in all, with non-energy benefits included, it appears that DOE's WAP has a benefit-to-cost ratio of about 1.34 from the programme perspective and 2.53 using the societal approach (Schweitzer, 2005). The per household energy savings, estimated at a meta-evaluation covering data from 1993 through 2005, equals 20 to 26% of pre-weatherisation consumption of natural gas for all end uses (Schweitzer, 2005). These savings are significantly higher than those reported by the national Weatherization Program evaluation (which focused on houses weatherised in 1989). This improvement is the result of advanced audits which became increasingly common starting in the early 1990s, as did the use of blower-door directed air sealing and high density wall insulation (Schweitzer, 2005). An evaluation of the 2006 programme year is not yet available.

Information and capacity-building programmes

Audits and information

Early examples of information measures launched by the federal government and administered by states include the Residential Conservation Service (RCS) and the Energy Extension Service (EES) (Clinton *et al.*, 1986). The RCS required local electric or gas utilities to provide on-site home energy audits on request. By the end of 1983, 40 states had implemented such programmes. However they experienced low participation rates, caused by ineffective utility marketing, limited local potential for cost-effective conservation, and the lack of a national priority regarding residential conservation activities (Clinton *et al.*, 1986). The impact of the Energy Extension Service (EES), whose aim was to provide information locally, was also rather qualified. Specific information measures such as on-site workshops, auditor training or targeted information campaigns were estimated to be more useful than general information (Clinton *et al.*, 1986).

A more recent policy measure of this kind is the Tax Incentive Assistance Project (TIAP), which is sponsored by a coalition of public interest non-profit groups, government agencies, and other energy efficiency-related organisations. The project is designed to provide information to consumers and businesses to assist them in accessing federal tax incentives available under the Energy Policy Act of 2005.[39]

The voluntary Home Energy Rating System (HERS) is a capacity-building tool initiated by the federal government and administered and implemented at the state level. HERS provides an evaluation of the energy efficiency of a home by comparing it with a computer-simulated reference house of identical size and shape that meets the minimum IECC requirements.[40] Widely accepted energy ratings increase market transparency since they allow developers and building purchasers to appraise a building's EE, a very important attribute. Such energy ratings are also a pre-requisite for energy efficient mortgages. These financial products provide the borrower with preferential loan rates and conditions when installing energy saving improvements or purchasing an energy efficient home. As an auditing tool HERS provides financing sectors with an established procedure and criteria needed to determine their mortgage products.

39. For more information about the TIAP, see www.energytaxincentives.org.

40. For more information about HERS, see www.usahers.com/.

Further examples of federal information and assistance activities, including the providing of tools, are:

- defining energy labels including their rating system (*e.g.* Energy Star, HERS);
- defining model building codes, to be further developed by states;
- provision of technical support documentation regarding codes and standards.[41]

Labelling and equipment

Federal labelling and other equipment-related programmes, though not always directly applicable to existing buildings, establish benchmarks for the future refurbishment of components of existing buildings, particularly boilers and windows. As will be seen later, they also establish standards used by utility companies in demand-side management programmes.

The Energy Star programme was first introduced by the EPA in 1992 as a voluntary labelling programme to facilitate the identification and promotion of energy efficient products. It is now run jointly by the EPA and the DOE and seeks to enhance energy efficient products and practices so as to reduce energy bills by up to one-third of what they might otherwise be.

Computers and monitors were the first products to be addressed under the scheme. Subsequently, other types of office equipment and residential heating and cooling equipment were included in the programme in 1994, and in 1996 the EPA partnered with the DOE to address other product categories. The Energy Star label now covers major appliances including boilers, office equipment, lighting, home electronics, windows, new homes and commercial and industrial buildings. By covering boilers and whole buildings, the Energy Star programme helps to increase energy efficiency in existing buildings through improved products (for example, Energy Star boilers use about 6% less energy than a standard boiler) and construction and installation practices. In the case of windows, the Energy Star label is also a pre-condition to obtain federal tax credits. Hence, this is an example of a combined policy approach used to overcome multiple and inter-related barriers to improving EE.

The Energy Star programme also provides auditing and technical services to encourage energy efficiency improvements, and distributes computer programmes to help simulate monetary savings through design improvements. Through partnerships with more than 8 000 private and public sector organisations, Energy Star delivers technical information and tools to organisations and consumers to assist them in choosing energy-efficient solutions and best management practices.

The programme has resulted in energy and cost savings across the country for businesses, organisations and consumers. These amounted to around USD 14 billion in 2006 alone, representing the greenhouse gas equivalent of what would ordinarily be emitted by 25 million cars. Providing labels for 50 different categories of products as well as auditing services helps overcome the information barrier preventing energy-efficient choices. In this way Energy Star offers a way to alleviate the effects of rising energy prices, which have become a major concern for consumers (Energy Star, 2007; EPA, 2007a).

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41. e.g. *water heaters, heat pumps, central and room air conditioners, residential furnaces and boilers etc., see www.eere.energy.gov/buildings/appliance_standards/information_resources.html for details.*

Research and development

The DOE activities in the area of energy efficiency include R&D grants to state and local governments, and voluntary guidelines for energy-efficient design in buildings. In particular, through the Building Technologies Program EERE works closely with the building industry and manufacturers to conduct research and development on technologies and practices for energy efficient houses and multi-family buildings, as well as research into standards for products.

However, overall, energy efficiency R&D funding makes up less than 15% of total R&D funding. From financial year 1978 through to financial year 2005, the DOE spent about USD 12.4 billion in 2005 constant dollars on energy efficiency R&D. A total of 17% was allocated to renewable energy, 26% to fossil fuel energy and 42% to nuclear energy R&D.

The EERE's Building Technologies Program includes a public-private partnership, Building America, which conducts energy efficiency R&D for new and existing housing. For existing buildings research is conducted to provide new product opportunities, implement energy-saving technologies and providing information to consumers. For new buildings, projects include system engineering research to produce energy and cost-efficient homes, from the design to the construction phase, implementing energy- and material-saving technologies (BTP, 2006). These research projects have resulted in 40 726 homes built in 36 states and across eight climate regions (BTP, 2004).

Demand-side management programmes

Demand-side management (DSM) or demand response (DR) programmes focus on decreasing the demand for energy by promoting efficiency, conservation, and load management. Some typical programme measures affecting residential buildings include energy audits, financial incentives for energy-efficient appliances and equipment, and rate structuring. Rate structuring encourages customers to use more energy during off-peak periods by lowering rates during those times.

After the energy crisis of the early 1970s, federal regulators and state public service commissions (PSC) began to implement policies that led to the creation of utility-based DSM programmes. While these programmes were developed on a state level by state utility commissions, they were backed by various federal measures, such as the Energy Policy and Conservation Act (1975), the Energy Conservation and Production Act (1976) and the national Energy Conservation Policy Act (1978) (Gillingham *et al.*, 2004; Clinton *et al.*, 1986). It was federal legislation, the Public Utility Regulatory Policies Act of 1978, which required states to include energy conservation considerations in their utility regulation. Some utility providers developed their own programmes; these became all the more important after electricity deregulation and restructuring began in the early 1990s (Clinton *et al.*, 1986).

DSM programmes have changed over time, initially emphasising information and loan programmes and later incorporating cash rebates to consumers for the purchase of designated energy-efficient equipment. Programmes became more comprehensive and often combined information with financial assistance and direct installation of energy-efficient equipment. From the 1990s onwards market transformation strategies were emphasised as these programmes became standard operating practice for many utilities, transforming their business activity from selling units of energy to also providing energy services (Gillingham *et al.*, 2004).

The functioning of DSM programmes, and its link to financing energy efficiency in existing residential buildings, at a state level will be examined further through the example of California.

This section will now describe policies initiated at a regional level.

Policy measures: regional level

Two kinds of regional level energy policy initiatives in the US will be examined. First, the federal government may pilot a federal programme in a particular region (Hutton and McNeill, 1981),[42] or may assist with the creation of a regional alliance to facilitate the implementation of federal level initiatives. Such alliances work closely with the federal authorities — including financially — to assist with implementing federal initiatives. Such is the case of the Northeast Energy Efficiency Partnership (NEEP).

Second, groups of states themselves may form regional level alliances to share experiences and resources and to define energy policy that is, to some extent, independent from federal activities. They may also seek to trigger federal policy reform. In most instances these kinds of regional initiatives have led to the development of energy efficiency requirements that have gone beyond those set at the federal level, for example requiring more stringent energy efficiency measures to be incorporated into existing state building codes. This is the case of the Western Governor's Association (WGA), which among other things supports the adoption of EE standards for various products not regulated by federal legislation.

In both instances, regional level initiatives are generally supported by and often work in close collaboration with a variety of organisations to advance energy efficiency measures. These include electric utilities, public benefit administrators, federal agencies, state governments, public interest groups, non-profit groups, universities and energy efficiency industry representatives. Moreover, in both instances, the success of the initiative ultimately remains at the will of the state governors. Examples of both types of regional level policy initiatives are provided below.

The Northeast Energy Efficiency Partnership (NEEP)

The Northeast Energy Efficiency Partnership (NEEP), which includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont, is an example of the first kind of regional level initiative. It has close connections with the federal level of government, in this case, the DOE and the EPA.[43] In fact, it was established by the EPA in 1996 in light of threats to demand-side management programmes arising from efforts to deregulate the electricity utility industry. It was thus created as a means to assist with the implementation of federal initiatives at the regional level.

42. *See, for example, the Low Cost / No Cost Energy Conservation Programme, which commenced in 1979 (see Hutten and McNeill, 1981), and the HERS pilot programme of the early 1990s.*

43. *NEEP's activities are now funded by sponsors: New York: Long Island Power Authority (LIPA) and NYSERDA; Maine: Efficiency Maine; Vermont: Efficiency Vermont, and others; the US EPA Energy Star Program, and the State Technologies Advancement Collaborative (STAC).*

One of its successful programmes is the Energy Star window initiative, established in 2002 with EPA funding. The programme aims to significantly enhance the market share of Energy Star windows in the Northeast region. Activities include free training programmes and the integration of Energy Star window specifications into state building energy codes. Since the initiative, the penetration of Energy Star windows has increased by about 40%, and the market share of Energy Star windows is appreciably higher in the Northeast region (55% to 60%) as compared not only to the US average (42%) but also to almost any other region, including those with similarly harsh climatic conditions (only the Mid-Atlantic region yielded similar market penetration over the same time period). Manufacturers and retailers have ascribed this growth to four factors: i) the increased presence of Energy Star branding; ii) higher fuel costs; iii) revised energy codes; and iv) the increased availability of utility rebates (NEEP, 2006). As the last two factors have also resulted from other policy measures; the need to combine several policy approaches to boost their impacts is underlined.

Western Governor's Association (WGA)

The second example of a regional level initiative, the Western Governor's Association (WGA) comprises 19 states, including Oregon, Washington and California, and three Pacific islands (American Samoa, Guam and the Northern Mariana Islands). Its main purposes are to develop regional policy, serve as a leadership forum, build regional capacity, conduct research and build public understanding (WGA, 2007a). Through the initiative, the members have issued a series of concrete recommendations and policies to combat global warming. Among these is a recommendation for the incorporation of aggressive energy efficiency measures into any updates of state building energy codes, with a view to achieving at least 20% electricity savings by 2020 in each state. The exchange of information, ideas and experiences through the association continues to assist states in managing their resources more efficiently. This includes the sharing of development costs for new programmes, and through advocating a shared agenda before Congress and the executive branch of the federal government. The association also provides a forum for the consideration of how to draw on federal level measures in pursuing regional aims (WGA, 2006).

Thus, regional level initiatives provide the opportunity to test federal level programmes, to share experiences and resources, to develop some policy measures independent of federal level activities and to provide a bridge between state and federal level activities. They may also be more effective in achieving policy aims through the sharing of resources and expertise, and through providing more standardised conditions for private sector entities operating in more than one state.

This section moves on to discuss policy measures enacted on the state level, ending with an overview of California as an example of how policy measures initiated at various levels can be implemented within states.

Policy measures: state level

Across the US, there is considerable variation in the degree and nature of "sub-federal" measures to address energy efficiency in the existing residential building sector. Such variations result from a range of factors, including a state's population size and growth, climate, energy resources and residential structure.

While the federal government has played a far greater role in directing energy policy since the mid-1970s, states nonetheless retain a fair degree of freedom in this area. Some states, most notably trail blazing California, have responded to this by developing their own energy efficiency initiatives and by encouraging the federal and other state governments to take further action. Other states have taken significantly less action to develop their own standards and other policy measures on energy efficiency. For instance, Alabama, Missouri, Mississippi, Wyoming and South Dakota do not have mandatory residential state energy codes (EPA, 2007b), while states such as Arkansas and South Carolina do not run subsidy programmes or provide tax incentives (DSIRE, 2007a).

The exhaustive survey of policies initiated in individual states falls beyond the scope of this study. Instead, a brief summary of the key features of activity in some Western states – California and Oregon, and four Eastern states – Florida, Maine, New York and Vermont, is provided. Instead the chapter focuses on the state of California as an illustration of state-federal-regional interaction. The State of California was chosen as a result of its predominant activity over and above any other states in the US. A summary table of individual state initiatives can be found in Annex I.

A brief overview of policy measures on the West and East Coasts

West Coast

While there are marked differences regarding action taken to tackle energy efficiency issues, most West Coast states have had energy efficiency-related policies and measures in place since the early 1970s. In most instances, the introduction and continued implementation of such measures relates to a due concern with protection of the environment and ensuring energy security. The region's focus on energy efficiency as a means of ensuring energy security was intensified further in 2001, after it experienced an energy crisis. As such, the case of the West Coast suggests that a combination of deeply rooted popular adherence to environmental protection and a sense of urgency can facilitate a focus on energy efficiency measures. All West Coast states are members of the Western Governors Association, and as such prioritise the issue of having clean and diversified energy sources, an initiative which includes achieving a 20% increase in energy efficiency by 2020 (WGA, 2007b).

As is the case across the US, variation exists among the states in terms of the degree of their focus on energy efficiency measures. The most active states have been Oregon, Washington and California, with the latter chief among them. California was among the first states to create a state agency responsible for energy efficiency, the California Energy Commission (CEC), and to implement EE standards for buildings. Stringent building code requirements, building and appliance efficiency standards as well as large-scale utility sponsored incentives are among the state's most effective policies. Its preoccupation with ensuring energy system security and alleviating environmental pressures has stimulated the state's continued prioritisation of energy efficiency issues. Oregon has also long promoted energy efficiency policies, stimulated largely by the vulnerability of its energy supply provision and concern with energy security; the state imports the totality of its petroleum and energy supply is thus dependent on other state's provision and stability (ODE, 2005). The Oregon Department of Energy encourages homeowner investment in cost-effective EE measures through a Residential Energy Tax Credit (RETC) and weatherisation promotion through various financial incentives (ECONorthwest, 2005). Meanwhile, Washington has enacted mandatory state-wide building codes that exceed 2006 IECC standards for most homes. Utility-sponsored DSM programmes are also strongly supported in Washington state, and have been running since the mid-1990s.

California stands out as being the most proactive in the area of energy efficiency and is discussed in a separate sub-section below.

East Coast

Throughout the 1980s and early 1990s, energy policy in Florida, Maine, New York and Vermont focused on demand-side management (DSM) by public utility authorities. These DSM programmes initially concentrated on load management, but increasingly shifted toward addressing energy efficiency. This was accompanied by a shift from focusing on fuels (oil and gas) to electricity use and appliances. DSM programmes decreased in significance with liberalisation of electricity markets in the 1990s. In some regions of the US, including in the Northeast, regional and state level initiatives sought to counterbalance this decline in DSM activities. Federal SEP and weatherisation funding also decreased in the late 1980s and early 1990s. Among the above four states, New York took early action and defined a comprehensive energy policy that was implemented by one single entity (NYSERDA), integrating state, local and utility activities (except weatherisation which was kept separately). The states of Vermont and Maine followed later, in 2000 and 2003 respectively.

In brief, energy conservation codes for new buildings are now mandatory in all four states. For existing buildings these are mandatory in certain cases, for building extensions or large remodelling projects where more than a certain percentage of the building is being renovated. There are also codes for component or appliance replacement, but compliance enforcement is usually quite low, at least for individual buildings. As the energy efficiency requirements for new buildings became more demanding, products such as windows and boilers, installation and operation practices of industry professionals improved. This was especially the case where code-related activities were combined with building energy performance ratings, such as in Vermont. These improvements in products and practices were applied also to existing buildings when renovated or if equipment was replaced at the end of its lifetime. Hence, in the above four states codes have through indirect impact improved energy efficiency in existing buildings.

Home Energy Rating Systems (HERS) have been implemented and used in several states and communities. As noted previously, accepted energy ratings increase market transparency by allowing building developers and buyers to appraise, the building's energy efficiency. They are also a pre-requisite for energy efficient mortgages.

Regarding the overall impacts of such measures, per capita energy use in the residential sector dropped dramatically between 1973 and 1983 in almost all large energy consumer states, as in the case of the US average, presumably due to the price and awareness effects of the 1973 oil crises. Since then, it has only slightly increased throughout the decades up to 2003, after which it stabilised in New York and Vermont, but not in Maine or Florida (EIA, 2003). This could be – to a certain extent – the result of different state-specific energy policies, but also of different economic and structural developments (For example a more elderly and wealthier population in Florida increasing the demand for energy services, and Maine's lower economic capability).

It would appear that the most effective policies have been building and appliance efficiency standards that involve utility-sponsored incentives. According to available evaluation studies about state level programmes in New York, Vermont, Maine and Florida, these programmes are also cost-effective. The New York Energy Smart programmes benefit-to-cost ratio ranges from 5.9 to 7.2 and 13.5 to 16.4 depending on assumptions (without the addition of non-energy benefits). Several studies indicate that in addition to direct benefits, there are several non-energy or ancillary benefits, such as reduced local air pollution, reduced greenhouse gas emissions and increased domestic economic activity (NYSERDA, 2007; Tonn and Peretz, 2007).

California

Context

California is the world's 8th largest economy (LAO, 2006; California Economic Strategy Panel, 2007). The state's energy system is dominated by petroleum to serve the transportation sector and natural gas to heat homes and generate electricity. California is the second largest emitter of greenhouse gases in the United States and about the 12th largest in the world; 22% of emissions derive from electricity generation and over 39% from transportation. As opposed to other energy sources, California produces most of its own electricity, importing only 22% to 32% of total electrical energy used. The state's blueprint to address increasing energy requirements, and in particular increasing electricity requirements, places energy efficiency as the cornerstone of California's energy strategy. While electricity consumption is dominated by the commercial sector, the residential sector follows closely. Therefore policies targeting energy efficiency in existing residential buildings play a role in increasing overall energy efficiency aims (CEC, 2007).

The state's relatively long history of addressing energy efficiency stems from a concern with energy system security, economic development and environmental protection. However, the 2001 electricity crisis marked a turning point in government and consumers' behaviour on the issue, placing energy efficiency even higher on the political agenda. This section focuses largely on post-2001 developments, so as to underline what can be done, within the American federal structure, to address energy efficiency in the existing residential building sector.

Policy aims and institutional framework

California was among the first states in the US to implement energy efficiency measures. In 1974 it created a state agency, now the California Energy Commission (CEC), with specific responsibility for energy efficiency. Its early work included the establishment of comprehensive energy efficiency standards for buildings, both residential and commercial.

California's current Energy Action Plan (EAP), released in 2005, endorsed by the Governor, California Public Utilities Commission (CPUC), and the CEC establishes energy efficiency as the state's top priority procurement resource. The EAP's overarching aim is for California's energy to be adequate, reliable, affordable and environmentally sound. Cost-effective energy efficiency is identified as the state's preferred mean of meeting energy needs. To implement this policy, the CPUC has laid the foundation over the past few years for an aggressive energy efficiency effort. This has been done by: i) removing utility disincentives for investments in energy efficiency by decoupling revenues from sales; ii) setting energy saving goals for utility companies; iii) requiring utilities companies to invest in energy efficiency whenever it is cheaper than procuring power; iv) adopting an administrative structure that integrates energy efficiency into utility procurement; v) delineating clear rules for energy efficiency programmes; and vi) encouraging all stakeholders to cooperate to develop the next generation of energy efficiency programmes.

The energy efficiency programmes included in the plan are implemented by different entities, including private companies, local governments, non-profit organisations, utilities, future community choice aggregators, and community-based organisations, through partnerships and competitive solicitations administered by the utilities and overseen by the CPUC.[44] The new administrative structure calls for utilities to invest in energy efficiency whenever it is cheaper than power plants; as a result, it is anticipated that California's largest utilities will more than double the level of energy savings achieved over the decade following from 2005. This is likely to bring considerable economic and environmental benefits to the state (CPUC, 2004).

California has managed to keep its electricity use relatively flat for the past 30 years primarily due to cost-effective building and appliance standards, and enhancements to efficiency programmes implemented by utilities (examples of these will be further developed). Electricity use has also been decreased by demand response programmes for customers. This involves implementing dynamic pricing tariffs, public education campaigns on energy use and new technologies. These result in both cost-effective savings and inducements for customers to achieve those savings (CPUC, 2005).

Regulatory measures

The California Energy Commission considers that cost-effective building and appliance efficiency standards are largely responsible for limiting electricity-related carbon emissions (CEC, 2007). It is therefore unsurprising that the current state code for residential buildings, as contained in the California Code of Regulations (Title 24, Part 6), exceeds 2003 IECC requirements and, unusually for the US, is mandatory state-wide. Local government agencies can only modify the code to be more stringent. The California building code is updated every three years, the current code being in effect as of 1 October 2005. Significant changes from the last code for residential buildings include energy-efficient lighting requirements, changes to duct and pipe insulation requirements, and the application of new federal air conditioner and water heater standards. For residential low-rise buildings the current code provision includes compliance credits for high performance ducts and building envelope features. The size of credit depends on the action taken. For example simply designing ducts to Air Conditioner Contractor's Association

44. The structure also calls for a range of measures that are not addressed here. For example, Executive Order S-20-04, issued on 14 December 2004, requires state agencies, departments and other entities under the direct authority of the Governor to take measures to reduce grid-based energy purchases for state-owned buildings by 20% by 2015.

guidelines or properly sealing duct joints provided lower levels of credit than having the HVAC system tested for duct leaks (DSIRE, 2007b).

The California Energy Commission has begun developing the 2008 update to the Building Energy Efficiency Standards. The new standards will cover both residential and non-residential buildings and include updates to lighting (indoor and outdoor), HVAC, domestic hot water, and building envelope measures. Among the new initiatives for the 2008 Standards are the New Solar Home Partnership (NSHP) which will include incentives for photovoltaic (PV) for homes, and the Programmable Communicating Thermostats (PCT), which will respond to demand response signals from the utilities during electricity shortages by reducing the HVAC load (BCAP, 2006).

Financial and incentive-based measures

California's energy efficiency financing programme offers 4.4% interest loans to public schools, public hospitals, cities, counties, special districts and public care institutions. The Programme has a USD 40 million endowment, with a maximum loan of USD 3 million per application. There is no minimum loan amount. The projects must be technically or economically feasible and must have a simple payback of 9.8 years or less, based on energy savings. Additionally, the Energy Commission provides technical assistance to help customers identify ways to save energy costs[45] and to encourage the most efficient use of energy in their facilities. The majority of these programmes are for public agencies.[46]

Further, in September 2005 the CPUC launched the most ambitious energy efficiency and conservation campaign in the history of the US utility industry. It authorised energy efficiency plans and USD 2 billion in funding for 2006-2008 for the state's utilities, reaffirming that cost-effective energy efficiency is the state's first line of defence against power shortages. The government provided USD 300 million to be invested in natural gas efficiency programmes (equivalent to approximately 1% of natural gas utility revenues), and USD 1.7 billion for electric efficiency programmes (equivalent to approximately 3% of electric utility revenues).

In September 1996, California created a four-year system benefits charge (SBC)[47] or public goods charge (PGC) funded through a nonbypassable wires charge. The fund supports cost-effective energy efficiency, renewable technologies, public interest research and low-income assistance programmes. In September 2000 the initial Assembly Bill (AB) which created the PGC became law through AB995, extending the electric PGC till 1 January 2012. A similar natural gas demand-side management (DSM) surcharge was created in February 1999 (CPUC, 2005). The PGC is largely used to fund utilities in support of demand-side management programmes. These programmes are managed by individual utilities, and include financial incentives such as loans, grants and rebates provided for improving energy efficiency. These measures are discussed in the next section.

45. *The Energy Commission pays a portion of the cost of the preparation of a report by a consultant. Often this cost is sufficient to analyse one or more facilities.*

46. *For more details, see www.ase.org/.*

47. *A system benefit charge is a small surcharge on all electricity sales for the purpose of funding energy efficiency programmes and other "public benefit" activities.*

Information and capacity-building programmes: demand-side management

In recognising that standards are the most cost-effective means to achieve energy efficiency, the California Energy Commission committed to pursuing high load management standards (CEC, 2007). In 2006, Assembly Bill 2021 required the CEC, in consultation with the CPUC and the publicly owned utilities, to produce a state-wide estimate for both investor- and publicly-owned utilities of "all potentially achievable cost-effective electricity and natural gas efficiency savings and establish state-wide annual targets for energy efficiency savings and demand reduction over 10 years"(CEC, 2007).

Utilities are therefore enlisted in a collaborative relationship to reduce energy demand and increase energy efficiency, using their local conditions and customer knowledge to develop programmes and offer incentives. The CPUC allocates 83% of its energy efficiency programmes funding to utility programmes. In 2004 utilities reported savings of 1.9 million MWh of electricity and 39 million Therms of natural gas in 2005, along with a 375 MWh demand reduction (CEC, 2007).

Independent energy utilities have established a range of programmes, which include rebates, loans and grants, to facilitate the financing of energy efficiency measures at the residential level and provided energy efficiency services to 156 000 low-income households in 2005 (Chang, 2006). By way of example, three such programmes are mentioned here.

The Residential Energy Efficiency Rebate Program, implemented by Roseville Electric, is a utility rebate programme for customers who make energy efficiency improvements to existing homes. Refurbishments eligible for the rebate include all types of insulation (*i.e.* attic, ceiling, roof, floor and wall), various appliances, heat pumps and central A/C units. The rebate amount ranges from USD 75 to USD 200 per house, and is conditional upon the insulation meeting a designated R-value[48] and the appliances meeting Energy Star requirements (DSIRE, 2007a).

The Weatherization Cash Grant Program, implemented by Alameda Power & Telecom, is open to company customers whose homes are at least 70% heated by electric power. The programme provides for the company to pay up to 80% of the cost of weatherisation activities in the customer's home, thereby directly funding an energy efficiency refurbishment need. The total maximum amount paid by the utility is USD 960 for a single-family unit and USD 480 for a multi-family dwelling (four or more units) (DSIRE, 2007b).

The Residential Energy Efficiency Loan Program, implemented by the Sacramento Municipal Utility District (SMUD), provides low-interest loans to help households finance energy efficient renovations for heat pumps, central A/C units, duct/air sealing, building insulation, windows, siding and roofs. However loans are not made to tenants renting or leasing property (DSIRE, 2007c). SMUD also offers a Residential Solar Loan Program, providing 100% loan financing over a ten-year period (current interest rate at 7.5%) for customers who install solar water heating or photovoltaic systems (DSIRE, 2007d).

48. See note 9 in Chapter 1.

This chapter has provided the framework for policies aiming to improve EE existing residential buildings, including the actors who operate within it. It has also underlined the balance between federal and state institutions. Energy policy goals and strategies have been exposed, and individual policies presented, with the example of California demonstrating how policies are enacted on a state level. The chapter will conclude with a brief impact analysis and evaluation of the policies described above.

Impact analysis and evaluation

Federal

A brief summary and analysis of the impacts of policy measures described above are presented below.

Regulatory measures

In the US building codes and standards are relevant, as in most states they address EE improvement measures in the case of renovation and upgrades. They are also clearly outlined for industry professionals. While the federal government has developed model energy codes and provided funds to encourage state implementation of more energy efficient codes, these measures can only be adopted at a state level. At state levels these measures appear to be effective, as the example of California shows, and flexible as they are usually updated every few years. Their effects are also long-term and can instigate long-term transformations in the construction industry. Mandatory federal appliance standards are inflexible; they have not been updated regularly and are therefore not very high. Their advantage lies in limiting customers' choices to a more efficient technology, ensuring its adoption and the associated reductions in energy demand. In its modelled assessment of energy efficiency policies, the Energy Information Administration identified the implementation of high appliance efficiency standards and building code policies in the residential sector as effective energy saving measures (EIA, 2005). Regulatory measures in the US have been upheld for a sufficiently long period of time and have proven sustainable.

Financial and incentive-based measures

Providing direct funding to states through the State Energy Program (SEP) remains an essential measure, since it is states who determine how to use these funds depending on their particular needs. Without federal funding states would be much more limited in implementing EE improvement measures. This measure is flexible, clear, and effective, though variations in yearly funding amounts introduce a measure of uncertainty. For example federal funding to energy programmes decreased between 1992 and 1999, and stemmed from the reduction in oil prices over that period (EIA, 2000).

Federal tax incentives have a small impact on EE improvement measures being implemented. Tax credits tend to be small relative to the cost of adopting the technology and thus do not noticeably change behaviour. They also tend to be enacted for relatively short periods and affect only a small percentage of households (Clinton *et al.*, 1986; EIA, 2005b, 2005c).

Weatherisation programmes are shown to result in concrete energy consumption savings. Their current constraint is that they affect only a small share of potentially eligible households. They are administered by the states and are therefore flexible, with each state determining specific eligibility criteria. In addition, the policy has proved sustainable as it has helped spawn an EE industry for residential housing, and these benefits have become ingrained as many techniques developed for weatherisation programmes are today standard practice (Berry *et al.*, 1997; Schweitzer, 2005).

Information and capacity-building programmes

Earlier home energy audit and information programmes had limited impact on homeowners; low participation rates, limited potential for cost-effective conservation and ineffective marketing were some of the causes. More specific information measures such as on-site workshops, auditor training and targeted information campaigns were deemed more useful (Clinton *et al.*, 1986). The Home Energy Rating System (HERS) programmes are in large part financed through federal funds but are administered by the states. The standards used for the rating system are developed by states, and would need to be subject to regular updates to be flexible and remain effective. If upheld for long enough periods their advantage lies in making EE a standard feature of the housing market, since HERS are used to obtain energy efficient mortgages and can be used to finance upgrades of existing homes. They directly address the financial barriers to residential EE improvements and have led to an evolution of the housing market. States also use HERS to verify compliance with building energy codes (Residential Energy Services Network (RESNET), 2007).

The Energy Star programme has effectively resulted in energy and cost savings for consumers, businesses and organisations. In 2006 these amounted to savings of USD 14 billion on energy bills and 170 billion kWh of energy (EPA, 2007a). The programme is more sustainable and has greater impact when its ratings are used as criteria for financial and incentive-based measures such as utility loans, grants and rebates, as well as energy efficient mortgages.

Research and development funding for EE programmes remain modest, and their impacts on the existing residential sector are limited. Most R&D activity has focussed on new product opportunities and whole-building projects (BTP, 2004).

Demand-side measures appear to have an impact when implemented by states: utility-sponsored incentives are considered one of the most effective EE improvement policies in California. In the EIA's assessment of energy efficiency policies, national level energy performance standards for electricity and natural gas suppliers to reduce growth in their customers' energy use was modelled. It was identified as being one of two individual policies (the other not affecting the residential sector) with the greatest cumulative impact on energy consumption (EIA, 2005c).

Concluding remarks

While the impacts of various policy measures have been summarised, in terms of particular measures, the post-evaluation data needed to provide a more quantitative analysis was lacking. Such an evaluation would need to discriminate between the various effects that impact energy efficiency, such as autonomous technical progress and renovation activity, price effects and others. Further, there may be a range of indirect benefits that arise from energy efficiency measures, such as reduced air pollution and greenhouse gas emissions, or increased domestic economic activity, that are harder to quantify (Tonn and Peretz, 2007; NYSERDA, 2007). As mentioned, these can include the various economic activities surrounding weatherisation of homes or of certification programmes for industry professionals. Finally, the impacts of energy efficiency programmes are all the more difficult to estimate given that the residential building stock and the average floor area have risen, and that the effects of higher and extended internal temperatures in buildings are difficult to assess. In particular, the latter might suggest that gains at the federal and state level have been offset by increases in the number of households, the amount of living space per capita and the market penetration of high energy-using equipment.

The analysis of Californian activities given below provides an example of what can be achieved within the confines of the US's federalist structure, showing impacts of certain federally initiated measures which are visible at the state level.

Regional

A regional initiative such as the Western Governor's Association (WGA) impacts EE improvement policies primarily by sharing information and development costs for new programmes. These reduce financial and informational barriers and help states manage their EE programmes more efficiently. The WGA also establishes EE aims, such as more efficient building energy codes and a goal of achieving a 20% increase in energy efficiency by 2020, which are in turn adopted by individual states (WGA, 2007a).

The Northeast Energy Efficiency Partnership (NEEP) has established the Energy Star window initiative which has increased the penetration of energy efficient windows by about 40% since 2002. The initiative has led to higher than average market share of Energy Star windows in the Northeast region (NEEP, 2006).

The advantage of regional policy initiatives is that they group together states with similar energy profiles and needs, allowing them to identify issues that are most relevant in addressing EE refurbishments in existing buildings as well as ways of implementing them, through sharing information and costs. Policies enacted are therefore more relevant and clear. Their larger size allows them to have greater impact when lobbying federal institutions or when undertaking market transformation projects such the Energy Star window initiative. Since members are most often represented by elected representatives, the sustainability of policies is also prioritised (WGA, 2007b).

California

Over the past 30 years California has held per capita electricity use at an almost constant rate, while the rest of the US has seen its per capita electricity use increase by nearly 50%. This has been possible through investments in energy efficiency programmes and improvements in building and appliance efficiency standards (Chang, 2006). The state has also been able to save more than 12 000 MW of peak demand, and about 40 000 GWh each year, while increasing its inflation-adjusted economic output per unit of electricity consumed by over 40%. This compares with a national average of 8%. Over the last decade alone, the net benefits of energy efficiency programmes to the Californian economy have provided more than USD 5.3 billion. And the most recent standards for buildings and appliances are intended to save 2 800 MW over the next ten years (Chang, 2006; CEC, 2007; CPUC, 2005).

According to the California Energy Commission and Public Utilities Commission Action Plan II, the most influential policies in bringing about increased energy efficiency in Californian homes have been: efficiency standards for buildings and appliances, utility-sponsored incentives, and code requirements, which may not be evaluated as "energy savings", but which regulate electric resistance for space and water heating. California building codes and appliance standards are relatively flexible, as they are updated every few years to account for changes in technology, though the process is time-consuming and must be started in advance. In addition, standards have been upheld since the 1970s and have proved sustainable, ensuring lasting impact on the market. In relation to the second category, utility-sponsored incentives have allowed consumers to overcome the initial cost barrier that may hinder investment in energy efficiency refurbishments. They benefit from clarity and flexibility, as individual utility providers can modify and update programmes which are clearly explained to their customers. As they are largely funded by a systems benefit charge, these programmes have been and can be upheld for long periods of time as they do not depend on grants. They are also sustainable in instilling habits among customers and stimulating economic activities surrounding residential EE refurbishments. Realising the serious threat of a new energy crisis, many Californian utilities have seen the economic advantage of enhancing energy efficiency, rather than building new power plants to face peak demand.

Changes to Californian laws have also played a key role in ensuring efficient utilities programmes. In particular, tariff adjustments have meant that the financial position of utilities is no longer linked exclusively to the amount of electricity and natural gas sold. The direct involvement of utilities has allowed a more rapid market creation, and a genuine rise in consumer awareness of these issues (CEC, 2007; CPUC, 2005).

The interaction between federal and state policies can be seen in the Energy Star programme. Initiated at the federal level, it has become a basis for local public utility companies providing rebates, grants and loans to consumers seeking to improve their household energy efficiency. Further, in updating the Building Energy Efficiency Standards, federal standards are incorporated with state-developed measures.

In California, strong political will triggered appropriate funding and regulatory change, allowing the resources of different actors, including utilities themselves, to be engaged in the energy chain. As such, the experiences of California suggest that a combination of popular adherence to environmental matters, coupled with a prioritisation of supply security can provide a sound basis for a fundamental shift in terms of how energy efficiency is addressed.

As the example of California demonstrates, the programmes and policies with the most impact are those which benefit from clarity (codes, standards, utility programmes directed at customers), flexibility (utility run programmes, regular updates of codes and standards) and are sustained for long enough periods to be sustainable by instilling behavioural changes and enabling market transformation. They are also relevant, since the former measures limit choice to the most energy efficient options. The latter measure addresses financial barriers to EE refurbishments and provides incentives for more energy-efficient behaviour.

Conclusion

In the United States, the most successful programmes and policies in increasing the energy efficiency of existing buildings have been policy packages grouping federal, regional and state levels. The impact of individual policies also increases when used in combination (EIA, 2005). For example the effectiveness of the federal Energy Star label is increased when local state utility companies use it as a condition for their rebate, loan and grant programmes, or when a regional partnership like the NEEP uses it as the basis for large market transformation initiatives. Similarly, revised energy codes for buildings lead to increased usage of energy efficient appliances and building components. Code and appliance efficiency standards can be developed at both the federal (with model building codes and minimum appliance standards) and state levels (as California did). In addition regional organisations such as the WGA aim to increase EE standards beyond those established by federal and state codes at local levels (WGA, 2007c). This is particularly useful for WGA member states that do not have mandatory state building codes, such as Arizona. This confluence of policies at various levels pushes EE improvements in the residential sector even further. Certain programmes also increase policy sustainability by stimulating economic activity surrounding EE improvements in existing buildings, such as the federally funded and state implemented HERS and weatherisation programmes.

Federal and state actors often act in collaboration with industry professional and non-governmental organisations, both for developing policies as well as implementing them. This lattice of arrangements has both advantages and disadvantages. States have the ability to develop and implement measures adapted to local conditions, which can result in policies that are clearer as well as more flexible and sustainable. On the other hand, the absence of a comprehensive, mandatory national level approach to energy efficiency has allowed some states to fall behind in terms of taking appropriate measures to encourage EE improvements in existing residential buildings; this is particularly the case regarding building codes, as several states either do not have mandatory residential building codes or have rather lax codes.

While establishing policies at the national level, such as minimum building energy codes, might increase policy impacts by increasing EE improvements nation-wide, allowing states the freedom to enact their policies is necessary given the country's federal structure. Policy measures at the state level have the advantage of being more relevant, addressing particular state needs in terms of financing EE improvements. They are potentially more sustainable, since state-level actors are committed to the economic development of their states and will therefore seek policies that have a positive impact on economic activity, thereby increasing chances the policy will result in market transformation. The states also play a role in increasing the clarity of federal policies, by enabling local actors to access federal funding. Allowing states to implement policies also improves their flexibility, since changing circumstances and differing local conditions can be accounted for. The federal government plays an important role in capacity-building by providing the financial means for states to enact policies. It also provides guiding strategies and tools to reduce the costs of enacting policies to individual states, such as technical assistance and model building codes.

In addition, the analysis does not suggest that specific mandatory policies established at the national level would have the most impact in enabling EE improvements in existing buildings, given the size and political organisation of the country. The federal government currently provides funding and assistance to the states for certain general policies (such as weatherisation or developing energy codes for buildings) and special projects, while also establishing general policy guidelines in the form of the 2005 Energy Policy Act. Leaving states to determine and implement specific programmes according to their needs and circumstances increases the likelihood of relevant, clear, flexible and sustainable measures being adopted.

Chapter 5 • THE EUROPEAN UNION

Introduction

Energy policies have always been part of the European Union's common goals. The 1955 Messina Declaration expressed the objective of a common market for Europe. It also declared that: "Putting more abundant energy at a cheaper price at the disposal of the European economies constitutes a fundamental element of economic progress". Energy has also been central to the European Union's (EU) economic project. The 1990s saw the growth of EU legislation targeted at increasing energy efficiency (EE), spurred primarily by energy conservation and climate change concerns. This took the form of directives on labelling of domestic energy-using appliances, and standards for these appliances as well as construction materials.

Ensuring the EU's security of supply has become an increasing challenge. Dependence on external sources of energy is constantly increasing; the EU imports 50% of its energy, and estimates that this figure could rise to 60% within the next 25 years (EU Commission, 2006a). Reducing energy consumption without compromising economic growth is the overarching aim of the EU's energy policy. This chapter provides an overview of recent EU energy policy objectives, particularly the policies targeting energy efficiency improvements in existing residential buildings. While these are implemented by individual countries, the EU plays an essential role in creating a framework enabling countries to overcome barriers impeding energy efficiency improvement measures in this sector.

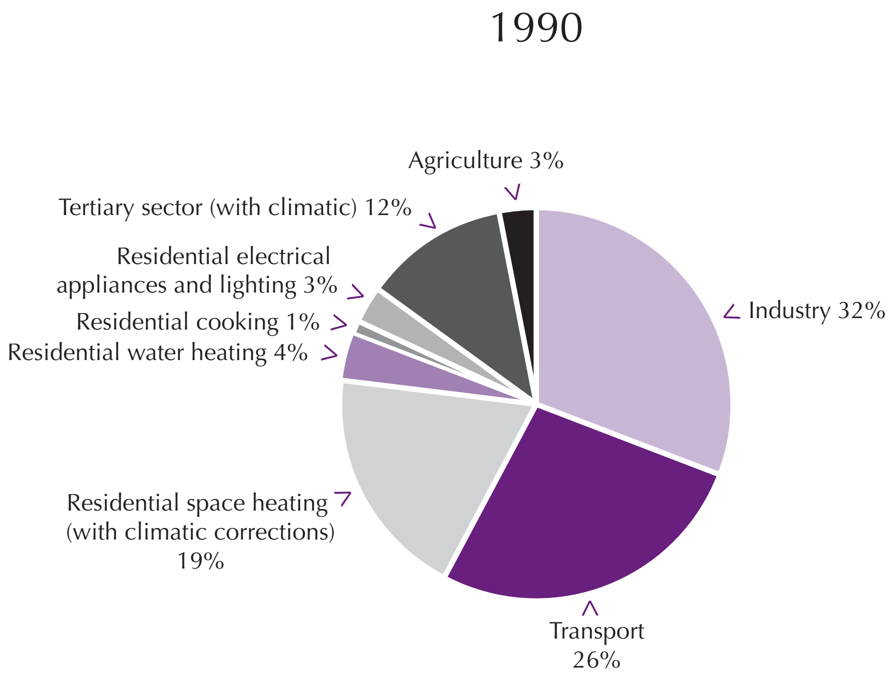
The chapter begins by providing the framework that contains these policies, including the legal and administrative structure of the EU, and the actors who operate within it and impact these policies. Energy policy goals and strategies are exposed before individual policies are presented. The chapter concludes with an impact analysis, evaluation and recommendations.

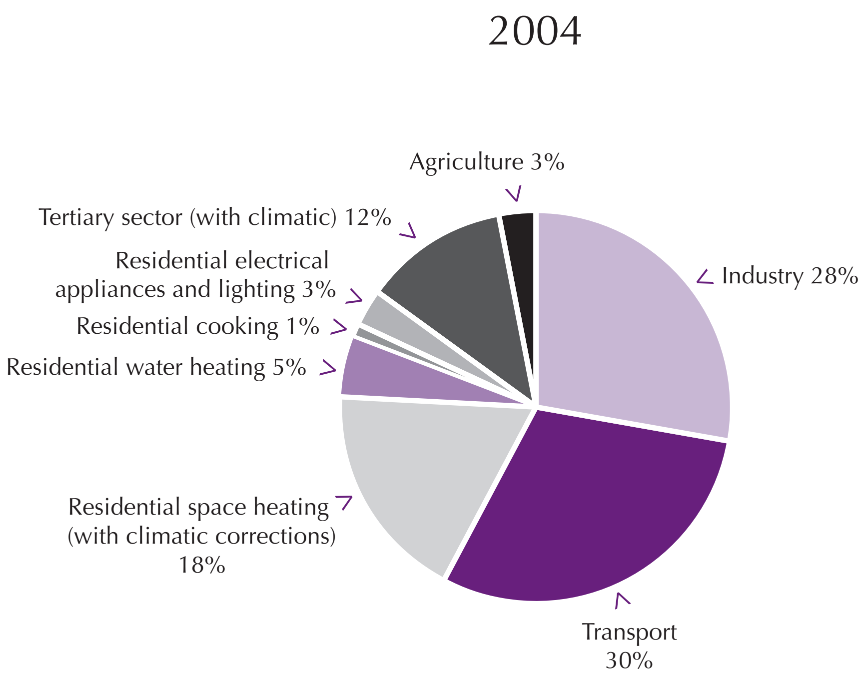
General context and policy framework

General context and energy profile

Energy efficiency in buildings has long been the domain of national energy efficiency strategies. The first driving force for thermal buildings regulations in EU member states from 1970 to the late 90s was triggered mainly by external events such as the first and second oil price shock. Progressively, energy efficiency improvements in the sector of existing buildings were dealt with both in energy conservation and climate mitigation terms. In recent years the European Union has had an impact on the activities for building regulation at the national level. The implementation of the European Energy Performance of Buildings Directive (EPBD) has led to a further harmonisation of efforts; informal meetings between countries began as early as 2002, with

Figure 30 • ***Final energy demand per sector in the EU25 (corrected for yearly climate variations)***





Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

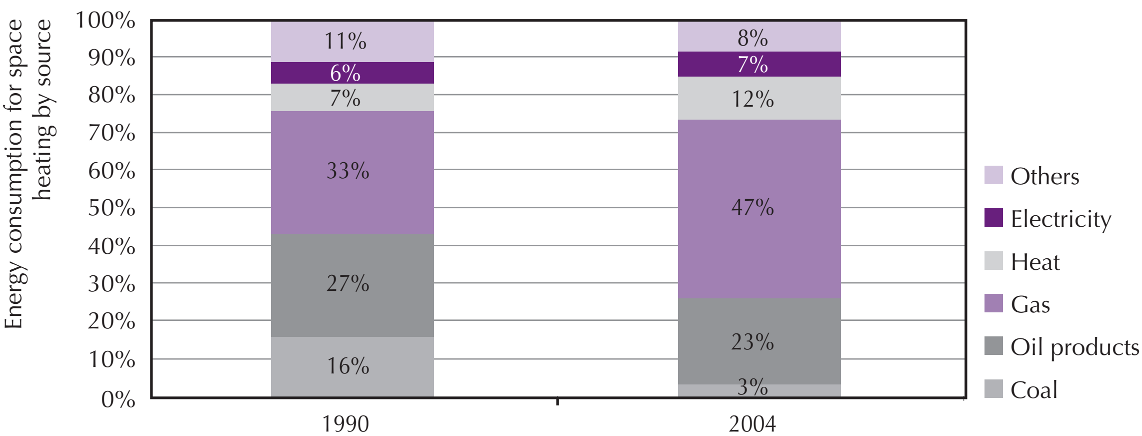
officialised harmonisation talks started in 2004 with EPBD Concerted Action. This harmonisation will continue in the future as it requires a regular update of existing regulations.

The following section provides a brief overview of the conditions framing the European building sector such as climate indicators, the macro-economic and energy economic background as well as the housing market in the EU27.

The building sector (including residential, service sector and industrial buildings as well as residential water heating) accounted in 2004 for 40% of the EU's energy requirements. This share has remained essentially constant since 1990 despite strong thermal regulation in the different member states of the EU (Figure 30). The building sector offers the largest single potential for energy efficiency. Research shows that more than one-fifth of the present energy consumption and up to 30-45 million tonnes of CO_2 per year could be saved within a five to ten year period by applying more ambitious standards to new buildings and to the refurbishment of buildings (Ecofys, 2005). Since the majority of buildings that will be standing in 2050 have already been built, improving the EE of existing buildings is essential for long-term energy policy goals.

Coal and oil market shares for residential space heating decreased from 43% in 1990 to 26% in 2004. Meanwhile natural gas and district heat rose from 40% to 59% (Figure 31). This shift in energy carrier use had a double impact on efficiency; on the one hand higher heating efficiency could be reached in heating systems due to the move from solid and liquid fuels to gas and district heating. On the other hand the wider-spread use of natural gas and district heat has led to a further spread of central heating systems with higher system losses.

Figure 31• Final energy consumption for space heating in the EU25 1990-2004 (by fuel)



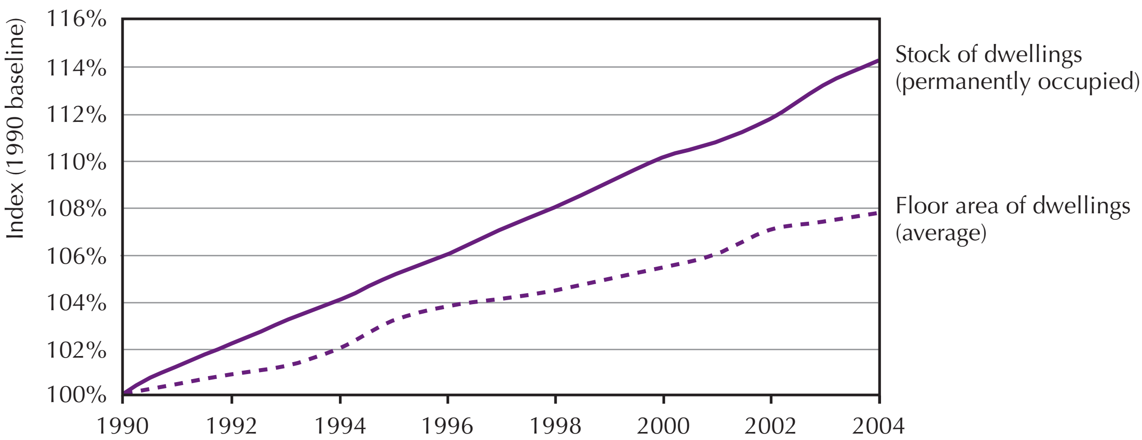
Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

Driving forces

As will be seen in the impact analysis section, between 1990 and 2004, energy efficiency policies resulted in a 13% improvement in residential sector energy efficiency in the EU. While energy consumption would have been that much higher without implementation of these policies, certain driving forces are still on the rise and can work against the gains made (Figure 32). Some of the major driving forces are as follows:

- The stock of dwellings rose by 14% in the 1990 to 2004 period.
- During the same period of time the average floor area per person rose by 8%.
- Internal temperatures in buildings are higher today, heating periods more extended and a larger share of rooms in buildings are heated. However the effects of these changes are difficult to quantify, and they are not uniform across member states. Larger dwelling area and fewer occupants per dwelling stimulated an upward pressure on demand (IEA, 2004). In certain countries this has been offset by efficiency gains from lower conversion losses and a reduction in the useful energy intensity for space heating, such as in Sweden, Norway and Denmark (IEA, 2007).

Figure 32 • Major driving forces for energy consumption in the building sector of the EU25

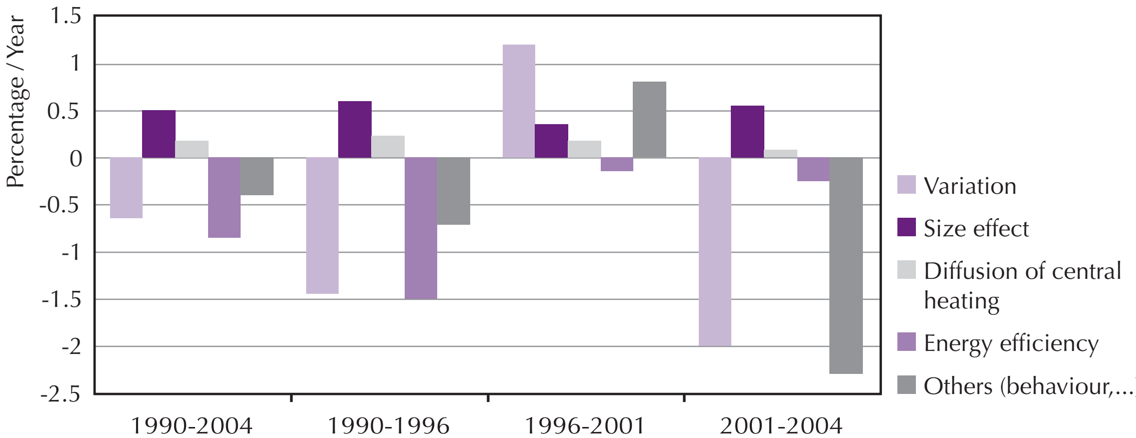


Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

The overall impact of these different driving forces as compared to the achieved improvement in energy efficiency was negative but varying across the past 15 years (Figure 33). From 1996 to 2001, low energy efficiency gains and negative behavioural effects have increased energy consumption. The impact on behaviour of high residential energy prices for heating becomes visible after 2001.

Larger dwellings (size effect; +0.45 m^2/year on average for the EU15) and the diffusion of central heating in the South of Europe have offset more than half of the reduction in consumption per square metre for space heating (1990-2004); it can be expected that such effects have also a strong impact on energy consumption in the new EU member states.

Figure 33 • ***Net impact of driving forces, energy efficiency and behaviour on the variation of space heating energy consumption per dwelling in the EU15 (% change per year)***



Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

Housing sector

The renovation market for the European Union is described in the following Table 13. New constructions represent over 2 million buildings per year in the EU15. However about 64% of all residential surfaces (single-family houses and apartments) were built before 1975, when the energy requirements for buildings were relatively poor (see Table 14). This indicates the large potential for energy efficiency improvement in existing residential buildings.

Table 13 • ***Overview of the park of residential buildings in the EU***

	Existing stock		**New dwellings constructed in 2004**
	Park (million dwellings)	Energy consumption (PJ)	
EU15	156.4	7 648	2.1
EU25	182.2	8 657	n/a

Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

Table 14 • Characterisation of the building stock in the EU15 by climatic zone, by building age and by type of building (in million m²)

	Building age	Total	Single-family house	Apartment house <1 000m²	Apartment house >1 000m²	Small non-residen-tial buildings <1 000m²	Non-residen-tial buildings >1 000m²
	Year						
Cold climatic zone	< 1975	534	220	109	59	55	92
	1975-1990	154	63	31	17	16	27
	1991-2002	120	31	26	14	18	30
Moderate climatic zone	< 1975	9 145	4 607	1 242	669	780	1 848
	1975-1990	2 551	1 290	348	187	216	511
	1991-2002	1 708	670	181	97	226	535
Warm climatic zone	< 1975	3 116	1 197	769	414	319	416
	1975-1990	1 945	748	480	259	199	259
	1991-2002	1 175	399	256	138	166	216

Source: Ecofys (2005), *Cost-Effective Climate Protection in the EU Building Stock,* Report for EURIMA.

Climate indicators

Buildings in the European Union are exposed to large variations in climatic conditions. Measured in heating degree days,[49] these vary from a low in Malta of 564 (average long-term) degree days to a high of close to 5 000 degree days in Finland. The average at EU25 level is 3 386 degree days (Figure 34). The cold climate in Northern and Eastern European countries provides a strong incentive to improve the thermal performance of buildings for comfort reasons alone.

Against this background, the next section will present the intricate institutional framework within which EU policies are developed and implemented.

Legal, administrative and institutional framework

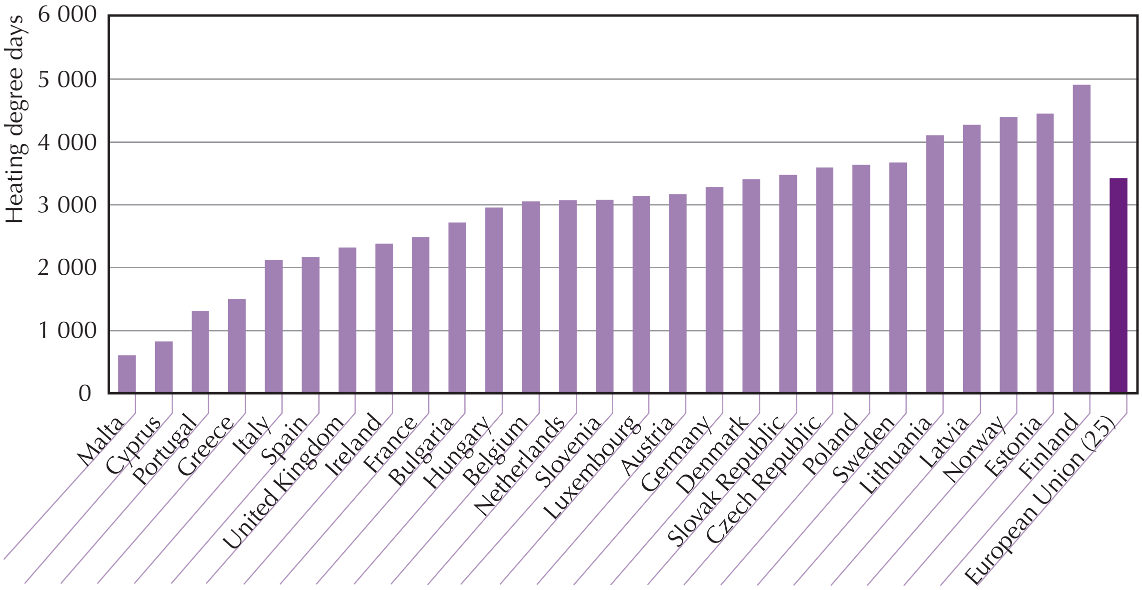
Legal framework

The legal framework at the EU level is based on three levels of jurisdiction forming the a*cquis communautaire:*

- Primary legislation: the treaties.
- Secondary legislation: regulations, directives, decisions, recommendations and opinions made by the Union's institutions in accordance with the treaties.
- Decisions of the European Court of Justice and the Court of First Instance.

49. See note 5 in Chapter 1.

Figure 34 • *Long-term average heating degree days in the EU25*



Source: Odyssee (2006), Odyssee database, Energy indicators in Europe.

Legislation affecting energy efficiency in buildings generally takes the form of directives. Directives are directly applied to states and bind all EU members. However they require implementation by national legislation in order to take effect. In practice this can lead to incomplete implementation of the directive, or insufficient enforcement of the national laws modified or created by the directive. Directives can include both minimum and maximum harmonisation clauses. Some do not allow for any modifications, while others allow member states to develop their own requirements based on framework rules, for example in the case of energy performance certificates. However, states that fail or refuse to implement directives as part of national law can be fined by the European Court of Justice. The European Commission is taking implementation of the EPBD very seriously; as of December 2007, 20 infringement procedures had been launched against countries failing to notify their national implementing measures. All EU legislation must be based on a specific treaty article, which is referred to as the legal basis of the legislation. For example regulatory measures aiming at improving energy efficiency are based on Articles 95 (internal market) and 75 (environment) of the European Community Treaty.

Administrative framework

The EU's decision-making process involves three main institutions:

- the European Parliament (EP), which represents the EU's citizens and is directly elected by them;
- the Council of the European Union, which represents the individual member states;
- the European Commission, which seeks to uphold the interests of the Union as a whole.

This 'institutional triangle' produces the policies and laws applied throughout the EU. In principle, the Commission proposes new laws, while the Parliament and Council adopt them.

There are three main legislative procedures in the European Union, with the main difference between them being how the European Parliament interacts with the Council: Co-decision procedure, Assent procedure (Council must obtain the EP's assent before a decision can be made), and Consultation procedure (Council holds non-binding consultations with the EP and other bodies before adopting a proposal by the Commission).

The Co-decision is the procedure used for most EU law-making (for example in the case of the EU Directive for Energy performance in Buildings or the Energy Services Directive). In the co-decision procedure, Parliament does not merely give its opinion: it shares legislative power equally with the Council. Both Council and Parliament have to adopt the legislation through an interactive process.

EU regulation and national implementation

Directives must be adopted in national legislation to come into force. The interaction between EU regulation and national implementation is a complex process which for individual member states depends on many factors, such as:

- priority of the envisaged legislation in the national context and the national strategy;
- speed of the national legislative process;
- existence of previous national legislation;
- accompanying measures (*e.g.* national promotion campaigns for building certificates);
- lack of national competencies to implement the measures (*e.g.* lack of experts to establish building certificates).

These factors lead to very different contexts among EU member states with respect to the speed of national implementation (which often takes several years) as well as to the resulting national impact of the policy. This can be seen by the variety in the implementation status of the European Energy Performance of Buildings Directive. The Directive is meant to have been implemented by 1 January 2006 but allows for a transition period of up to three years for selected provisions. Approaches to implementation vary depending on particular national priorities and environment, also seen in the different implementation plans for the EPBD among member countries. Some plan national procedures, others regional; some have not yet finished their drafts while others have all documents ready (see EPBD Buildings Platform Country Reports, 2007).

The policy impact can also vary considerably from country to country. Given that EU legislation is not necessarily more ambitious than the most ambitious national policies, impact might vary from zero to very large. For example the EU Directive for Boilers of 1992 had little influence in Germany since its national requirements were already at the Directive's level. Countries with building energy efficiency measures already in place, such as Denmark, Germany or the Netherlands, have found it easier to integrate them into EPBD requirements than others, particularly new member states.

Actors

Certain important actors in the EU affecting energy efficiency policies in existing residential buildings are described below.

Comité Européen de Normalisation (CEN)/ European Committee for Standardisation

The European Committee for Standardisation (CEN) is a non-profit technical organisation set up under Belgian law in 1961. It was founded by the national standards bodies in the European Economic Community and the European Free Trade Area (EFTA) countries. The European Commission or EFTA Secretariat request CEN to develop standards that support their policies by issuing formal mandates. The 30 national representatives to the CEN vote for and implement European Standards (EN).

Directorate-General for Energy and Transport (DG TREN)

The European Commission's Directorate-General for Energy and Transport (DG TREN) is responsible for creating a genuine internal market for electricity and gas, promoting new energy sources and managing a more coordinated approach to security of supply. The Intelligent Energy Europe Executive Agency, which implements financial aid programmes in the energy sector, also reports to the Directorate-General.

European Association of Insulation Manufacturers (EURIMA)

EURIMA represents the interests of all major mineral wool producers throughout Europe. Its members manufacture a wide range of mineral wool products for the thermal and acoustic insulation and fire protection of domestic and commercial buildings and industrial facilities. EURIMA was established in 1959 to promote improved standards and regulations for the use of insulation materials. EURIMA is a regular participant in consultation periods opened by the Commission while developing proposals. It publishes opinion papers and seeks to exert influence on regulations in support of its members.

International Network for Information on Ventilation and Energy Performance (INIVE)

INIVE is a registered European Economic Interest Group (EEIG). An EEIG allows companies, firms and other legal bodies (for example universities or individuals) to combine together and register as a grouping with a separate legal personality able to operate across national borders. An EEIG is meant to represent the interests of its members. The INIVE comprises research institutes, universities and companies from France, Belgium, the Netherlands, Greece and Norway. INIVE combines the expertise of its members, conducts research, forecasts trends and provides consultation and systems in the areas of building sector energy efficiency, indoor climate and ventilation. INIVE is responsible for coordinating the work of the Energy Performance of Buildings Directive information platform for DG TREN.

Policy and institutional framework

Past and present goals

In Europe, aggregate primary energy consumption rose by about 40% between 1970 and 2000. In 2005, energy consumption in the EU27 stood at 48 926 PJ (Eurostat, 2007). Further, the EU is becoming increasingly dependent on imported energy. Accordingly, European energy efficiency policies are embedded in the following general policy framework that aims to balance the goals of sustainable energy use, competitiveness and security of supply:

- Under the UN Climate Change Convention (1992),[50] the European Union has engaged to stabilise global temperatures at a level that is compatible with sustainable development. In quantitative terms, according to most experts, this implies a maximum temperature increase of 2 degrees above pre-industrial levels.
- Under the Kyoto Protocol (1997),[51] the European Union has engaged to reduce greenhouse gas emissions by 8% in the year 2012. This general target is spread among the individual EU member states in the "EU Burden Sharing" approach. This allows individual member states to set different quantitative targets according to their level of economic development.
- The recent European Energy Efficiency and Services Directive sets a target for an energy efficiency improvement of 9% in nine years (2008-2016).
- On 19 October 2006 the Commission adopted the Energy Efficiency Action Plan, containing measures that would put the EU on the path to achieving a key goal of reducing its global primary energy use by 20% by 2020.
- The 2007 Energy and Climate Change Package *Energy for a Changing World* (see below) specifies a unilateral minimum commitment by the EU to reduce its greenhouse gas (GHG) emissions by 20% in 2020 (compared with 1990 levels). However, for international negotiations the EU envisages a more ambitious objective of 30% reduction in greenhouse gas emissions for all developed countries by 2020 compared to 1990 levels. In addition, 2050 global GHG emissions must be reduced by up to 50% compared to 1990 levels, implying emissions reductions in industrialised countries of 60%-80% by 2050.

Strategies

An Action Plan to Improve Energy Efficiency was adopted in 2000. The Plan led to the amendment of Directive 93/76/EEC on the energy certification of buildings, which seeks to limit CO_2 emissions and includes insulation measures and heating requirements. It also led to the development of the Directive on the Energy Performance of Buildings. The Directives on boilers (92/42/EEC) and on construction products (89/106/EEC) also figure among the main actions taken in the building sector, and in September 2000 a Directive on energy efficiency for lighting was adopted.

In its 2005 Green Paper on Energy Efficiency, the Commission showed that up to 20% of EU energy use could be saved by 2020: equivalent to spending as much as EUR 60 billion less on energy, as well as making a major contribution to energy security and creating up to a million new jobs in the sectors directly concerned. The Green Paper calls for rigorous implementation of all energy efficiency measures taken by the EU, combined with new measures, in order to meet this goal.

The Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC) was adopted by the Council in April 2006. The Directive seeks to increase energy efficiency all along the supply chain right up to the retail stage when energy is sold to the end-user. It requires member states to achieve 1% yearly energy savings in the retail, supply and distribution of electricity,

50. It entered into force on 21 March 1994.

51. The agreement came into force on 16 February 2005.

natural gas, urban heating, and other energy products, including transport fuels. Member states are required to draw up national action plans to achieve these yearly savings over nine years, starting in January 2008. The action plans must be reviewed every three years and be submitted to Commission for approval. The first set of national plans were approved in July 2007. The Directive also requires suppliers and retailers to provide energy efficiency measures to their customers. It sets up a harmonised measurement system for energy savings and a harmonised framework aimed at creating a single EU market for energy efficiency, which includes common definitions, information, financial and legal instruments.

The 2006 Green Paper *A European Strategy for Sustainable, Competitive and Secure Energy* proposes six priority areas for discussion, with the aim of achieving the three policy objectives of energy that is sustainable, competitive and secure. Energy efficiency is upheld as a cost-effective means of both increasing living standards and saving money, while helping create a sustainable and competitive energy market. The EU proposes to treat the strategic issues identified in the Green Paper in a Strategic EU Energy Review to be presented to the Council and Parliament on a regular basis, monitoring progress and identifying new challenges and responses on all aspects of energy policy. The October 2006 Action Plan on Energy Efficiency builds upon the policies developed by its predecessor. The Action Plan includes measures which are expected to save Europe some 20% in energy consumption by 2020 and decrease its energy bill by more than EUR 100 billion every year if the programme's measures are implemented and deliver. It would also be able to prevent 780 million tonnes of CO_2 emissions - twice the EU target under the Kyoto Protocol. The plan identifies 75 specific actions in ten priority areas to be implemented over a six-year period. It also identifies the residential buildings sector as holding the largest cost-effective savings potential, due to its substantial share of total energy consumption. The full energy saving potential in this sector is estimated to be 27% by 2020.

Making buildings more energy efficient is a priority action area. Suggested measures include establishing minimum performance requirements for renovated buildings and providing financing for cost-effective measures. Minimum standards for appliances and labelling programmes, using taxation to promote the purchase of energy-efficient appliances and materials, as well as raising energy efficiency awareness are also central action areas with consequences on the residential building sector.

With respect to buildings, the Action Plan states as priority actions "rapidly improving the energy performance of the EU's existing buildings and taking the lead to make very low energy houses the norm for new buildings" as well as "coherent use of taxation to achieve more efficient use of energy". Particularly relevant are:

- New energy standards for buildings and promoting low-energy buildings ("passive houses") (2008-9).
- Facilitate bank financing for investments in energy efficiency by small- and medium-sized enterprises and energy service companies (2007-8).
- Boosting efficiency in new member states.
- Coherent use of taxation with the preparation of a Green Paper on indirect taxation in 2007.
- Awareness and education campaigns.

- Improving energy efficiency in urban areas through a "Covenant of Mayors" (to be created in 2007) which will exchange best practices.
- International agreements to foster energy efficiency worldwide.
- New energy performance standards for product groups such as boilers, copiers, TVs and lighting (from 2007).

The 2006 Action Plan forms part of the latest EU policy instrument in the field of energy, the 2007 Energy Policy for Europe. The new Energy Policy has a deep vision; one of transforming Europe into a highly energy-efficient and low-carbon energy economy, catalysing a new industrial revolution. The Policy combines measures aimed at creating an internal market for gas and electricity, establishing sustainable power generation through renewables, and investing in strategic technologies. The targets of reducing the EU's greenhouse gas emissions and global primary energy use by 20% by 2020 are also reiterated. Energy efficiency remains a major pillar of the policy, since it provides a way to achieve these targets while limiting potential costs and maximising potential competitiveness gains.

In January 2008, the EU Commission released *20 20 by 2020: Europe's Climate Change Opportunity*. While focussing on renewable energy source targets and carbon capture and storage, it included a communication on energy efficiency, "Moving Forward Together on Energy Efficiency", which reiterates the target of obtaining a 20% saving of EU energy consumption by 2020. It underlines the role of National Energy Efficiency Action Plans (NEEAPs) in ensuring that directives are implemented and this target achieved. The communication emphasises that EE's role in the EU's integrated climate and energy policy cannot be underestimated, which explains the infringement procedures ongoing against the ten member states that haven't as yet submitted NEEAPs. The EU plans to use NEEAPs to monitor implementation of directives and highlight best practices. This will allow for the Commission to better assess which new measures to introduce and how to facilitate implementation.

Complementary policies and strategies

The European Union is active in several complementary policy fields that generally support its energy efficiency policies and those on energy-efficient buildings in particular:

- In 1997, the EU started working towards a target 12% share of renewable energy in gross inland consumption by 2010. It now appears this target will not be met. In response the Commission proposed, as part of the Energy Policy for Europe, a Renewable Energy Road Map. It sets a target of 20% for renewable energy's share of energy consumption in the EU by 2020. Such a target could eventually stimulate the development of renewable energy sources for use in residential buildings and individual households, and the Plan describes measures that would facilitate this development in the future.
- The 2004 Directive on cogeneration urges EU member states to exploit their potential for combined production of heat and electricity (cogeneration). A key element for the further expansion of cogeneration is the development of decentralised cogeneration systems in smaller facilities as well as small applications (households, commerce, and public facilities). The Directive aims to establish a common framework for supporting the installation of cogeneration plants, and has established harmonised efficiency reference values. The EPBD requires that the installation of alternative power systems, such as cogeneration, be examined

during the construction of buildings over 1 000 m^2. However for the time being such requirements are not mandatory in cases of refurbishments.

- The EU cohesion policy[52] identifies supporting energy efficiency and the development of renewable energy sources as important objectives. The EU member states and regions are called, when preparing their National Strategic Reference Frameworks and operational programmes for 2007-2013, to make effective use of the possibilities provided for by cohesion policy in support of the energy efficiency and renewable strategies.
- The EU's Seventh Framework Programme for Research and Technological Development (FP7) includes an important research line on energy efficiency in general and on buildings in particular.

The aim of improved energy efficiency has been set out in the earlier existing legal instruments previously mentioned. The EPBD effective since January 2006 builds on those measures, with the aim of providing an ambitious step forward to increase the energy performance of public, commercial and private buildings in all member states. The Commission has already begun a process to revise the current EPBD. Among the issues discussed is the size limit of buildings falling under the current EPBD (over 1 000 m^2). Extending the EPBD's scope to smaller buildings would increase its impact on the existing buildings.

Policy measures

An overview of relevant European policy measures that impact directly on buildings are seen in Table 15. Legislation on electric appliances in the residential sector (except for the labelling directive for air conditioners), which constitutes another important policy area for the European Union in the residential building sector, is however not included in the table. Most of the impact of legislation in this sector is still to come. Older directives such as the minimum efficiency requirement for boilers had limited impact in a number of countries where the national legislation was already more advanced (*e.g.* in Germany) or the Directive was not effectively implemented. The initial attempts to introduce energy audits and energy certificates in the frame of the SAVE Directive of 1993 also had a very limited impact. Only the Energy Performance of Buildings Directive of 2002 shows so far a larger impact at the national level. However implementation in the member states is still ongoing though it was meant to be complete by the beginning of 2006.

This section will provide an overview of policy measures enacted in the residential sector by the European Union, using the classification outlined in the introductory chapter.

52. Cohesion policy refers to the redistribution of wealth between regions to balance out the effects of economic integration. Since 2004 these funds are concentrated on Lisbon (innovation, growth, jobs) and Gothenburg (sustainable development) goals. 82% of the funds allocated for the 2007-13 period are directed towards the least developed members and regions.

Table 15 • Overview on recent energy policy measures regarding the case of the European Union from the MURE database

Short description	Starting year	Relevance for residential buildings
Minimum efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels (92/42/EEC)	1992	Weak to strong impact depending on EU member state
Energy Certification of Buildings (93/76/EEC - SAVE)	1993	Weak impact
Public awareness campaign for an energy sustainable europe	2000	Weak impact
Energy labelling of household air-conditioners (2002/31/EC)	2002	Potentially high impact
Promotion of electricity produced from renewable energy sources in the internal electricity market (2001/77/EC). Relevant for the integration of PV into buildings	2001	Weak to strong impact depending on EU member state
Energy Performance of Buildings (2002/91/EC)	2002	Strong impact but implementation still ongoing
Community framework for the taxation of energy products and electricity (2003/96/EC)	2003	Weak impact
Ecodesign requirements for energy-using products (2005/32/EC). Is concerned among others with heating and water heating equipment, lighting in the residential and tertiary sectors, HVAC (heating, ventilation and air conditioning) systems	2005	Strong impact expected on some technologies
Energy End-Use Efficiency and Energy Services Directive (2006/32/EC)	2006	Strong impact expected

Source: MURE-Database (2006), http://www.isis-it.com/mure/ as of 16/10/2006.

Regulatory measures

Energy Performance of Buildings Directive (EPBD)

The European Union's most important instrument to improve energy efficiency in buildings is the Energy Performance of Buildings Directive (EPBD) (Directive 2002/91/EC), which seeks to create a common framework to improve the energy performance of buildings. The Directive forms part of the framework of Community initiatives on climate change and security of supply, since increased energy efficiency both reduces GHG emissions and dependency on imported energy. The Directive concerns the residential and tertiary sectors (offices, public buildings, etc.). It covers all aspects of energy efficiency in buildings in an attempt to establish a truly integrated approach. Complementing the EPBD is the Eco-design Directive, which deals with regulation of household appliances. Measures on labelling and mandatory minimum efficiency requirements are part of another policy line which is not described in this document. The Directive does cover the electric building infrastructure in larger buildings, particularly in the service sector.

The four main aspects of the proposed general EPBD framework are as follows:

- It introduces a common methodology for calculating the integrated energy performance of buildings.
- It establishes minimum standards on the energy performance of new buildings and existing buildings that are subject to major renovation.
- It introduces systems for the energy certification of new and existing buildings during construction, sale and rental of buildings or units, and for regular certification of public buildings, with prominent display of this certification.
- It requires regular inspection of boilers and central air-conditioning systems in buildings in addition to an assessment of heating installations in which the boilers are more than 15 years old.

The common calculation methodology should include all the aspects that determine energy efficiency and not just the quality of the building's insulation. This integrated approach should take account of aspects such as heating and cooling installations, lighting installations, the position and orientation of the building, heat recovery, etc. The minimum standards for buildings are calculated on the basis of the above methodology. The member states are responsible for setting the minimum standards. Energy performance certificates should be made available when buildings are constructed, sold or rented out. The Directive specifically mentions rented buildings, which experience principal-agent problems, with the aim of ensuring that the owner take the necessary EE improvement measures.

The member states will ensure that the certification and inspection of buildings are carried out by qualified and independent personnel. The Commission, with the assistance of a committee, is responsible for adapting the annex to technical progress. The annex contains the framework for the calculation of energy performances of buildings and the requirements for the inspection of boilers and central air conditioning systems.

The 4th of January 2006 was the official deadline by which the member states had to transpose the Directive into national law. States may, because of lack of qualified and/or accredited experts, have an additional period of three years to fully apply the certification procedures.

Several activities targeted at the different actors have been set up by the Directorate-General for Energy and Transport of the European Commission to facilitate the implementation of the EPBD, including a mandate given to CEN and the Commission's ManagEnergy initiative to support the work of local actors. Other activities supporting implementation include various projects funded by the Intelligent Energy-Europe programme (IEE) and its predecessor funding programme, SAVE, such as the EPBD Concerted Action. An important tool supporting implementation is the EPBD Buildings Platform, established to facilitate communication and information flow amongst all stakeholders and to assist with the early evaluation of the impact of the Directive. The EPBD Buildings Platform is being managed by INIVE on behalf of the European Commission's DG TREN. Target groups for the Platform include all those who are actively involved with the built environment, including policy makers, energy agencies, architects, planners, developers, building services engineers, and the construction industry. It works in close collaboration with other related activities, enhancing the communication between relevant European Commission funded projects in the frame of the Intelligent Energy-Europe programme, the EPBD Concerted Action, CEN standardisation work and the Energy Demand Management Committee, thus amplifying their effect.

The European Commission decided after consultation with member states' experts, interest groups and the CEN, that there was an urgent need for standards to support the EPBD. A mandate was given to CEN (Mandate 343) to develop a set of standards. The set is based on a list of 31 topics covering calculation, measurement and inspection procedures, including methods on the level of building components and systems. The aim was to offer within a short period (2004-2006) a clear set of well-harmonised standards for the basis of national procedures in the member states. In particular member states with a very limited experience in the field of the EPBD could benefit from this in the short term. In addition, these increase the accessibility, transparency and objectivity of the energy performance assessment in the member states in general. An overview of the CEN related activities is given by Hogeling (2006).

The EPBD has already had an important impact at the national level:

- Recent revisions of building regulations in ten countries: Austria, Greece (2001), Germany, Netherlands, Ireland (2002), Finland (2003), Italy (2005), UK, France, Denmark (2006). The revisions are connected to the EPBD, including its introductory phase before 2002.
- The EPBD gives an additional push to the previous national activities: on average, four revisions have been carried out at the national level since 1973 in most countries with an energy saving of 60% for dwellings built now compared to 1973. EPBD intends to continue in that direction with an updated building regulation every five years.

In the short term there will be a limited impact on the average unit consumption given the emphasis on new buildings; in 2005, dwellings built since 1990 represented only 18% of total stock. However, the EPBD also aims at existing buildings. Extending the EPBD to smaller existing buildings appears likely, though once the Directive in its current state has been successfully implemented (EU Commission, 2006c). The requirements for new buildings will only have a limited impact in the short term since new building activity is only approximately 1% per year, and since new buildings are already relatively efficient. However efficiency requirements for new buildings entail a large reduction in the long term, since the savings are cumulative.

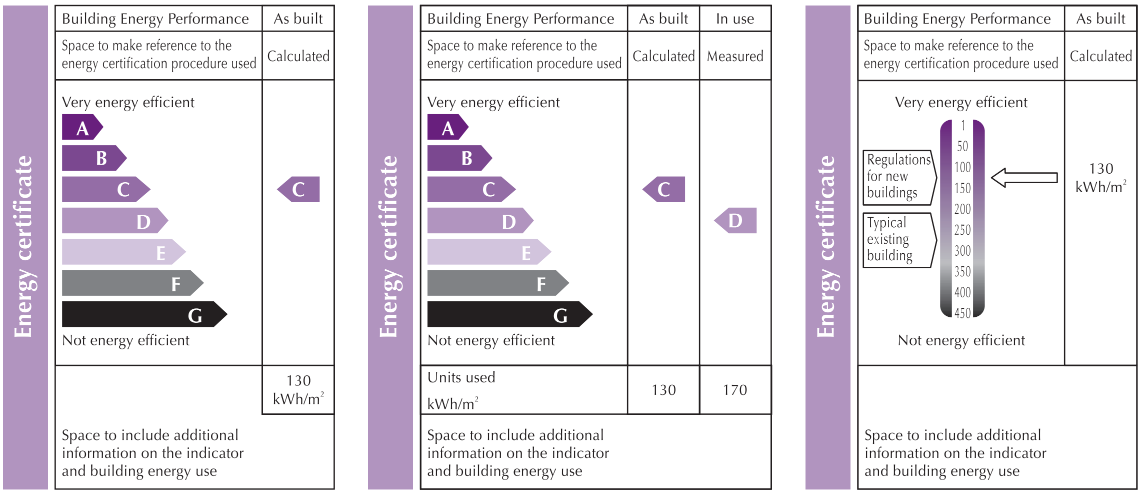
Efficiency requirements for existing buildings will be able to unlock their EE potentials over 30 – 40 years, since this is a typical renovation cycle. Certification schemes for buildings and inspection of HVAC's can realise these potentials faster since these will take place more often.

Thus far the EPBD remains the instrument with most potential impact on energy efficiency in existing residential buildings in the short term (a five to ten year period) or even in the medium term up to 2020.

Energy performance certificates

Article 7 of the EPBD introduces a system for rating and certifying the energy performance of new and existing buildings. The methodology for calculating energy performance is provided in the annex and in Article 2.2 (the definition of energy performance). The methodology is complemented by 31 voluntary European Standards (ENs). Energy performance certificates (EPCs) are required when buildings are sold or rented. The scope of the provisions on certification allows national legislation to exempt certain types of buildings, such as historic monuments and places of worship. For public buildings, the directive requires prominent display of this certification and other relevant information. Certificates must be less than ten years old. EPCs are currently being implemented in several EU member states, such as France, the UK, Ireland and Portugal. Infringement procedures have started for those countries substantially delaying implementation. All EPCs contain the same basic information and can be understood by everybody (see examples of national examples of energy certificates below). Methodologies for certification and inspections are also converging into only a few major procedures among all countries.

Figure 35 • Examples of national energy performance certificates



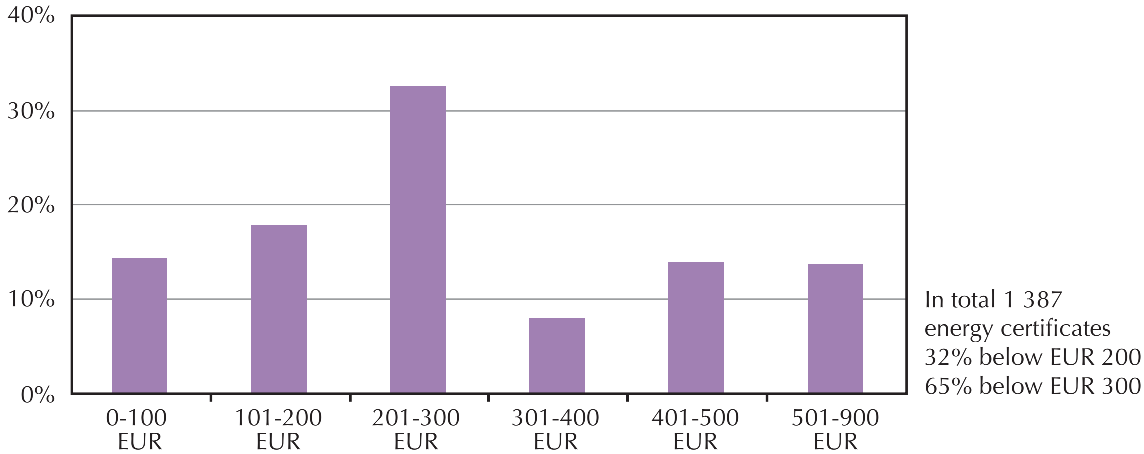
Source: Visier (2006), "Energy performance certification procedures, present status," EPBD Buildings Platform Working Paper P03, available at www.buildingsplatform.eu.

Certification for apartments or units designed for separate use in blocks may be based on a common certification of the whole building for blocks with a common heating system, or on the assessment of another representative apartment in the same block.

The energy performance certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of the building. The certificate shall be accompanied by recommendations for the cost-effective improvement of the energy performance. The objective of the certificates is the provision of information. An important debate has been carried out with respect to using certificates with an asset or calculated rating, based on calculated energy use under standardised occupancy conditions, or on an operational or measured rating based on metered energy use. In the case of a change in building occupancy or energy use within the building, the metered rating would no longer be valid. The certificates can be based on calculated energy consumption (asset rating) or on metered energy consumption (operational rating). They have different advantages and both rating systems can be indicated on the certificate as well, as seen in the second example of energy certificates above.

The costs for certificates in residential buildings have been evaluated in the case of Germany (Figure 36). Based on an investigation on 4 000 residential buildings the overview shows that 65% of all certificates have costs below EUR 300.

Figure 36 • Costs for energy performance certificates in Germany



Source: Fraunhofer-ISI (2005), Okoinstitut, Fraunhofer IBP, Karlsruhe.

Should energy performance certificates be used for buildings in the same way as labels rating the energy efficiency of household appliances, they could definitely have a substantial impact on consumer choices. It is too early to asses the overall impact of certification, as this measure has only been recently put in place. During the establishment of labels for refrigerators, as well as previous building certification activities, it was observed that the level of impact depended on complementary activities such as information provision, financial support, various incentives and legislation (Laustsen, 2007). This type of interaction may be seen in the case of EPCs. Determining energy performance certificates for buildings is considerably more complex than labels for electric appliances and requires substantial skills from the organisations which establish the certificates.

Eco-design Directive

The 2005 Directive on the Eco-design of Energy-using Products (Directive 2005/32/EC) provides coherent EU-wide rules on the ecological design of products such as electrical devices and heating equipment. Eco-design means integrating life-cycle environmental impact considerations into the production design phase. It includes accounting for energy efficiency. By establishing EU-wide rules the Directive also seeks to eliminate disparities in national legislation that can hinder internal trade. While the Directive aims to have a wide scope and include all energy-using products (other than vehicles and transportation), it will target certain products. For example products with high environmental impact, a high level of trade in the internal market, or products with a clear potential for improvement, due to failure of market forces or a lack of legal requirements.

The Eco-design Directive is a framework directive: it does not directly introduce binding requirements for specific products. Rather, it provides conditions and criteria for subsequent sets of requirements, likely in the form of future directives on specific products. This allows for directives to be developed more quickly, since they will all be issued a common set of conditions, for example reporting obligations. Member states will know that these are the same for all products affected by the framework directive, thereby also streamlining the implementation process. Existing product directives are now considered to be implementing the Eco-design Directive.

At present studies establishing a methodology and calculation tool have been completed. Preparatory studies are being conducted on certain product groups seen as targets for implementation. Currently these include laundry dryers, vacuum cleaners, complicated set top boxes, domestic lighting and solid fuel small combustion installations (particularly for heating).

Financial and incentive-based measures

Fiscal measures: energy taxation

Directive 2003/96/EC of 27 October 2003 *(Restructuring the Community framework for the taxation of energy products and electricity)* sets minimum taxation rates for motor fuel, fuel for industrial or commercial use, heating fuel and electricity. The levels of taxation[53] applied by the member states may not be lower than the minimum rates set in the Directive.

The minimum levels of taxation applicable to heating fuels and electricity are shown in Table 16.

Table 16 • Minimum levels of taxation applicable to heating fuels and electricity for non-business use

	Current minimum excise rates	Minimum excise rates from 1.1.2004 (non-business use)
Diesel (EUR/1 000 L)	18	21
Heavy fuel oil (EUR/1 000 kg)	13	15
Kerosene (EUR/1 000 L)	0	0
LPG (EUR/1 000 kg)	0	0
Natural gas (EUR/GJ)	-	0.3
Coal and coke (EUR/GJ)	-	0.3
Electricity (EUR/MWh)	-	1

Source: Scadplus (2007), "Community framework for the taxation of energy products and electriciy," http://europa.eu/scadplus/leg/en/lvb/l27019.htm.

53. Total charge levied in respect of all indirect taxes except VAT calculated directly or indirectly on the quantity of energy products and electricity at the time of release for consumption.

For some member states the Directive defines transitional periods during which they are required to gradually reduce the gap between their rates and the new minimum rates of taxation. Apart from the transitional periods, member states were authorised to continue applying their various derogations until 31 December 2006, subject to prior review by the Council. Following requests from the member states entering the EU on 1 May 2004, the Commission has proposed transitional arrangements for these countries.

The overall impact of the minimum excise rates in the residential sector appears low, given overall price levels and the excise rates already applied in most EU member states. In the new EU member states, which so far have not applied excise taxes, the Directive could have some impact. The taxation level needs to be raised substantially before considerable impact can be seen. The Commission, in its March 2007 Green Paper on market-based instruments for environment and related policy purposes, examines the possibility of reviewing the Directive to make it more relevant for meeting these policy objectives. The Paper also proposes a reform that would tax environmentally damaging behaviour, and encourages member states to reform environmentally harmful subsidies. This could apply to subsidised energy prices, and in turn influence energy consumption. Measures specifically affecting the residential housing sector have not as yet been addressed.

Structural and Cohesion Funds (SCF)

The Structural and Cohesion Funds (SCF) were established by the EU member states to facilitate the economic and social development of disadvantaged regions. This goal is based on the concept of economic and social cohesion, which has gradually led to the definition of the European regional policy.

The current Structural Funds package for 2007-13 amounts to EUR 308 billion, making up 35.7% of the total EU budget. Structural Funds which could potentially be used to finance energy efficiency improvements in the residential sector are the European Regional Development Fund (ERDF) and the European Social Fund (ESF). The principal objective of ERDF is to promote economic and social cohesion within the European Union. The reduction of imbalances between regions or social groups is achieved through the development and structural adjustment of regional economies. The ESF focuses on supporting programmes targeting the labour market, work conditions and social exclusion. It should also support programmes that anticipate and promote economic change. Cohesion Funds do not co-finance programmes but clearly identified projects or stages of projects. These projects are submitted to the Commission by the member states, managed by the national authorities and supervised by a monitoring committee. The total amount available for 2007-13 is EUR 61 billion.[54] Eligible member countries present a national strategic reference framework and operational programmes, which must be in line with and contribute to European policy guidelines.

In July 2006 the Council lay down provisions to harmonise the objectives of these three funds: convergence, regional competitiveness and employment, and European territorial cooperation. Convergence fund allocations are earmarked for improving economic growth

54. http://ec.europa.eu/regional_policy/funds/prosee/see_en.htm.

and employment in least-developed member states and regions. Regional competitiveness is for encouraging competitiveness and attractiveness in regions other than the most disadvantaged. European territorial cooperation is aimed at improving cross-border and inter-regional cooperation.

Table 17 • Budget and objectives of the Structural Funds

Total budget = EUR 307.9 billion		
Objective	Proportion of total budget (%)	Budget (billion EUR)
"Convergence" objective	81.9	252.2
"Regional competitiveness and employment" objective	15.7	48.3
"European territorial cooperation" objective	2.4	7.4

Source: Cicmanova (2006), "Sustainable Use of Energy in the European Regions – a Tool to Achieve the European Cohesion Policy Goals", Energie-Cités.

Overall the SCF are now more focussed on the Lisbon (growth, competitiveness and employment) and Gothenburg (environment and sustainable development) objectives, and place sustainable economic growth at the forefront. The funds can therefore be used to help finance national programmes and projects aimed at improving energy efficiency in residential buildings. This is a welcome development as thus far not much funding has been devoted to sustainable energy projects.[55] Few projects are devoted to sustainable development and even fewer to energy efficiency. Nevertheless, this depends primarily on the initiative of the individual country. For example in Hungary in 2004-06, ERDF contributed EUR 327 million of a total EUR 440 million budget for the "Environmentally Friendly Development of Energy Management" programme. Of this, EUR 7.7 million was set for supporting energy conservation (EUR 4.7 million, 2 800 projects) and renewable energy (EUR 3 million, 500 projects) projects for individual households ("private people") (INFORSE-Europe, 2006).

Approximately half of the SCF will go to the EU10 central and eastern European countries.[56] There is much potential for initiating energy efficiency improvements in residential buildings, given the often older buildings and equipment in these countries. Energy intensity (energy use per unit of GDP produced) is also on average 30% higher in the EU-10 countries than the EU average (Lapillonne and Poilier, 2007).

This instrument can have an important impact depending on the individual member states' willingness to introduce projects related to energy efficiency in existing buildings. Requiring member states to develop national energy efficiency action plans, developing Europe-wide energy efficiency policies and the EPBD will hopefully encourage these types of projects in member countries. A new IEE funded capacity-building project, PromoSCene, aims to assist

55. See http://www.inforse.dk/europe/index.htm.

56. Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovenia and Slovakia.

managing authorities to enhance the use of SCF-financed investments in energy efficiency and renewable energy. PromoSCene will help these authorities in managing the energy-related priorities of their operational programmes. PromoSCene expects energy-related projects to represent 15% of the total 2007-13 SCF budget, and aims to help complete one-third of this share by 2009 (PromoSCene, 2007).

Intelligent Energy-Europe (IEE)

In 2003 the Council and Parliament adopted a new multiannual programme aimed at providing financial support for local, regional and national initiatives in the field of renewable energy, energy efficiency, the energy aspects of transport, and international promotion. IEE replaced previous framework programmes for financing energy efficiency measures (SAVE, 1996 to 2002), and renewable energy (ALTENER, 1993-2002).

The first IEE programme had a budget of EUR 200 million until 2006, of which EUR 69 million was channelled into the SAVE stream for improving energy efficiency and the rational use of energy. The majority of funding was devoted to new and renewable energy promotion (EUR 80 million). The programme is open to any legal, public or private person established in the territory of the EU, the candidate countries and the countries of the European Free Trade Association (EFTA) and the European Economic Area (EEA). Projects selected for funding are done so on a competitive basis, with EU contribution limited to a percentage of the total cost.

The second IEE programme began in early 2007 and runs till 2013. It is integrated into the European Competitiveness and Innovation Framework Programme (CIP). IEE is one of CIP's three sub-programmes along with the Entrepreneurship and Innovation Programme, and the Information and Communication Technologies Policy Support Programme. This reflects the EU's strategy of integrating energy efficiency and renewable energy into the larger policy goal of transforming the EU's economy into one that is knowledge-based, competitive and low-carbon. The 2007 Energy Policy promotes this vision, emphasising that European companies can become leaders in the energy efficiency and renewable energy sectors.

The framework programme has been allocated a budged of EUR 3.6 billion. According to an indicative breakdown, 60% of the overall budget (2.1 billion) is allocated to the Entrepreneurship and Innovation Programme. One-fifth of this (430 million) is earmarked for promoting eco-innovation, aimed at small- and medium-sized enterprises (SMEs). The Intelligent Energy - Europe Programme receives 20% (EUR 730 million) of the overall budget (EUROPA, 2006).

The IEE projects are the most relevant within the CIP to improving energy efficiency in existing buildings. It does not support technical research and development projects, or "hardware" projects such as installation and infrastructure development. Rather it supports information and capacity-building projects, seeking to support implementation of policies already established by the EU. The 2008 call for project proposals is currently ongoing, with EUR 50 million available to fund projects, supporting up to 75% of eligible costs as opposed to the 50% provided in previous years. Projects should be designed to contribute to enabling policies, market transformation, behavioural change, access to capital, and training. The IEE thus enables local actors to develop their own projects, which therefore have a greater chance of being relevant, and supports projects which are sustainable. Projects are divided into five subjects: Renewable energy, energy efficiency, transport, developing countries, and horizontal, cross-cutting projects (financing, monitoring, education, and sustainable communities).

There are currently 30 projects devoted entirely to energy efficiency in buildings, many of which contribute to the implementation of the EPBD. For example, the "E-tool" project is developing a simple toolset based on operational ratings to evaluate the energy saving potential of existing buildings, across various building categories and climate zones. In the renewable energy field, there are currently 23 projects on small-scale applications of renewable energy, the kind that could be used in existing residential buildings and individual households. One example is the "PERCH" project, which aims to support the installation of micro-combined heat and power (CHP) and renewable energy systems (RES) for use by individual households or small buildings. It seeks to provide the information necessary to those wising to install these systems, particularly regarding the connection of such electricity generating units to a national grid.

Information and capacity-building programmes

Energy service companies (ESCOs)

Energy services include a variety of activities, such as: energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property management, and energy and equipment supply (Bertoldi *et al.,* 2006). Energy services are of primary importance for the refurbishment of existing buildings. This has been shown by the uptake of building refurbishment measures through instruments such as the UK Energy Efficiency Commitment (EEC), which sets energy-saving targets for electrical and gas utility companies to reach by enacting programmes that reduce customer energy use.

The framework for energy service companies (ESCOs) is fixed in the 2006 EU Directive for End-use Efficiency and Energy Services. The Directive seeks to establish targets or incentives and the improvement of the institutional, financial and legal frameworks. It also seeks to eliminate market barriers and imperfections which prevent efficient end-use of energy. An important target of this directive is to develop a market for energy services and for providing energy-saving measures. The main provisions to spur energy services are:

- A public sector obligation to take energy efficiency into account in public procurements related to the purchase of vehicles, buildings and other equipment.
- A supply-side obligation for energy distributors and retailers to offer efficiency improvement measures to their customers.
- A requirement for member states to remove barriers to ESCOs and Third Party Financing (TPF).

Another important policy framework for ESCOs in the EU is set with the restructuring of the electricity and gas markets. In 1996 a European Directive (96/92/EC) established the rules for an internal electricity market. To accelerate electricity market restructuring, in June 2003 the new Directive on market liberalisation was adopted (2003/54/EC). The timetable for market opening was revised: the electricity and gas markets would be fully liberalised by July 2004 for non-household customers, while all customers (including households) are now able to choose their supplier (since 1 July 2007). The effect of market liberalisation on energy efficiency is still under discussion and is dependent upon many factors. Falling and volatile prices have a negative impact on ESCO projects, and short-term oriented suppliers maximising turnover and margins may be hostile to action beyond simply providing energy. At the same time improved efficiency on the demand-side may be fostered by distribution companies trying to retain customers and attract new ones. This may involve offering energy services as "added value" to an otherwise homogenous commodity such as electricity.

Before showing substantial impact, provisions for the emergence of an energy services market must be implemented by the different member states. Without these changes the market will not develop. Service obligations for energy suppliers, such as the Energy Efficiency Commitment in the UK, have shown that they might play an important role in spurring energy efficiency improvements in existing buildings.

White certificates (WhC)

White certificates (WhC) are documents certifying that a certain reduction of energy consumption has been attained. Under such a system authorities impose energy efficiency obligations on power and/or gas suppliers, which can undertake the energy efficiency measures or buy WhC. Energy savings that are realised and certified generate WhC. The system is discussed and tested as an option to promote energy efficiency in the residential and commercial sectors, unlike emissions trading which focuses on power and energy intensive sectors. Suppliers who do not meet their obligations must pay a penalty, and those who surpass their obligations can sell these to other parties in the form of WhC. It should be noted that a white certificate scheme does not necessarily imply introducing the possibility of trading. This is the case in the UK; suppliers can only trade their energy saving obligations, and in practice this rarely takes place. The tradability aspect enables suppliers to meet the savings objective in a cost-effective and flexible way, and allows parties who are not under obligations to participate in the scheme, such as energy service companies. In Europe, the possibility of white certificate trading is envisaged in the Energy Services Directive and practiced in Italy and France, while Denmark and the Netherlands are seriously considering its introduction in the near future. The manner in which these schemes are set up and managed differ from country to country.

A SAVE funded programme studying market mechanisms for improving energy efficiency ("White & Green") used a market allocation modelling tool to study the impact of white certificates in Western Europe. A medium-sized target, one of a 1% reduction in energy use from 2004-10 and a 2% reduction from 2010-20, was cost-effective and resulted in significant energy savings. These occurred mostly in the natural gas sector, and as a result of reduced consumption and higher penetration of energy-efficient technologies. The model showed a decrease in residential sector energy consumption of 0.8 EJ in 2010, 1.8 EJ in 2015 and 3.4 EJ in 2020 (Mundaca and Santi, 2004).

The potential for an EU-wide WhC scheme is therefore strong; while the system is market-based, it requires strong regulation to function. The EU is well placed to provide the standardised measurement and certification systems needed to establish a homogenous certificate and guide member countries in setting targets. For WhC schemes to function, the energy market also needs to be separated. This entails the presence of several generation and distribution companies, and that the transmission grid is freely accessible by independent actors. These conditions do not exist perfectly in all member states, and the EU is providing the framework to push countries into "unbundling" their energy markets. A unified energy market, with all households being able to choose their energy suppliers throughout the EU and all kinds of energy efficiency measures being offered, would lead to the most cost-effective ways of achieving energy efficiency improvements (Oikonomou and Patel, 2004). An ongoing IIE funded project continues to study the development of WhC schemes in the EU. The EuroWhiteCert programme recommends caution regarding setting EU-wide targets, as its research shows performance of WhC schemes is country- and case-specific. It also cautions that distributional effects of an EU-wide scheme would need to be considered. The harmonisation of national institutions required for an EU-wide scheme would be a long and complicated procedure requiring strong political will (EuroWhiteCert, 2007).

Bertoldi *et al.* (2005, 2006) compare this system with other mechanisms that may improve the efficiency of energy consumption (command-and-control and economic instruments). The authors debate the integration of white certificate schemes, with other existing domestic and international permit and certificate schemes, such as the Emission Trading Scheme (ETS) for CO_2 emissions. They see integration with the EU ETS as beneficial due to "the streamlining and simplification of the already overcrowded energy policy space and therefore increased market transparency; improved static and dynamic efficiency; increased market liquidity; and enhanced environmental integrity of the emission trading scheme". The EuroWhiteCert project recommends keeping the two schemes separate for some time to come, since their interaction would currently be rather complex (EuroWhiteCert, 2007).

Energy audits

Energy audits and voluntary agreements were already envisaged in the now repealed SAVE Directive (93/76/EEC), and they are an integral part of the recent EU Directives that impact energy efficiency in existing buildings.

Producing energy performance certificates as required by the EPBD normally includes energy audits. The Directive has provided impetus for the training and certification of energy performance raters. The Energy Services Directive refers to the use of audits and voluntary agreements on several occasions. Energy audits are listed as a possible method to provide data for measuring and calculating energy savings in Article 4.1 (measurement and verification of savings target). Article 6 of the Directive requires member states to ensure that their energy distributors and/or retail energy sales companies offer their customers energy services or energy efficiency improvement measures. One option is to offer competitively priced and independent energy audits. Voluntary agreements that fulfil these objectives must also include monitoring and reporting requirements similar to those found in audit programmes.

Article 12 further requires member states to ensure the availability of efficient, high-quality energy audit schemes to all final consumers of energy. These may be available in simplified form for customer segments with non-complex facilities (for example by internet or by mail). Audits completed for the Buildings Directive or from voluntary agreement schemes meeting certain conditions are considered to fulfil this requirement.

The EU Action Plan for Energy Efficiency adopted in October 2006 includes energy audits. Pending agreement by the Commission, proposals may be made to improve the quality and criteria of different types of energy audits and of voluntary agreements, to ensure their wide acceptance and continuous use.

Information programme: Sustainable Energy Europe campaign

In order to ensure that member states and the relevant actors within them are aware of the various policies and programmes designed to encourage EE improvements in the residential sector, the EU has launched various information programmes. The Sustainable Energy Europe campaign is an ambitious information programme which seeks to target all European citizens and stakeholders.

The Sustainable Energy Europe campaign was established within the framework of the Intelligent Energy–Europe programme by the European Commission. The campaign aims to raise public awareness and promote sustainable energy production and use. It supports and promotes activities across nine campaign areas, of which four target communities and one buildings.

Through its Sustainable Energy Partnership, it seeks to showcase and publicly recognise the pioneers that model effective sustainable energy development, to encourage large-scale replication at local, regional, national and European levels. The campaign is based on strong, efficient and coherent communication channels that can increase the visibility of these actions and create a "network of excellence" at the European level. Every public or private institution, company or organisation implementing or planning to implement sustainable energy actions and programmes can become a Sustainable Energy Partner. They are given rights to use the campaign logo, receive a promotional toolbox, are included in the campaign's annual catalogue, newsletters and Europe-wide networking and promotional activities. Partners are also eligible to participate in an annual award competition.

The campaign also has associates, who are major and well-established umbrella organisations involving sustainable energy actors. Their powerful network of contacts significantly increases the visibility of the campaign and its activities. Individual citizens are also encouraged to participate in the campaign. They are provided with information regarding sustainable energy use, updates on European initiatives concerning sustainable energy, as well as the opportunity to participate in local Energy Days or Energy Weeks organised by the campaign. These events bring together a variety of public and private sustainable energy stakeholders and showcase initiatives. The campaign also has a media desk to ensure communication on sustainable energy issues, a media service for journalists, and provides assistance to members with media campaigns.

The campaign is a response to the strong need for sensitisation and information identified during the debate of the Green Paper on Energy Efficiency. Demonstrating and validating the potential of current energy efficiency measures and technology were deemed particularly useful initiatives (EU Commission, 2006c).

Impact analysis and evaluation

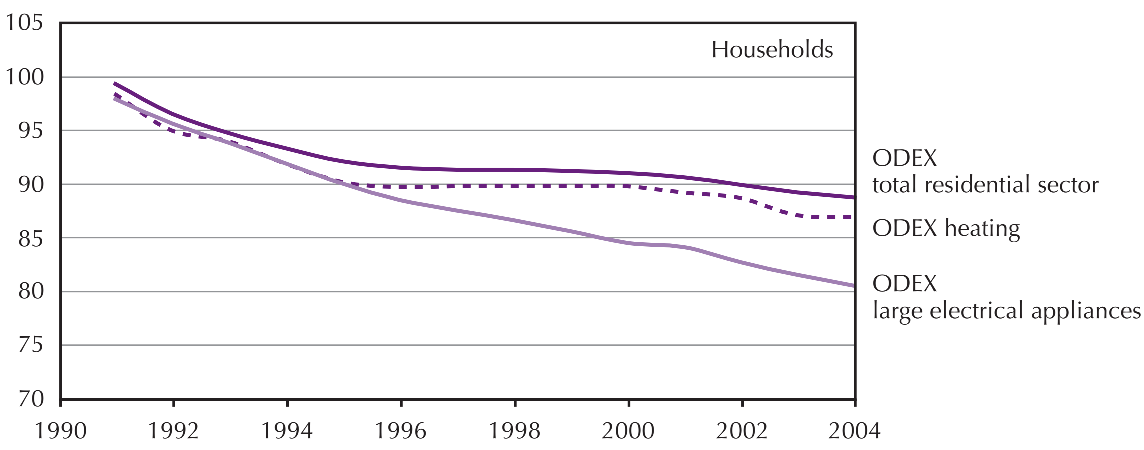
The impact of energy efficiency policies in buildings is essentially evaluated through three types of methodologies. The first is through energy efficiency indicators, which measure unit consumption and show EE changes by sector and a detailed energy-end use level; a decrease in the indicator shows an increase in energy efficiency. Second, *ex-post* modelling shows the overall affect of policies after they have been in place, while *ex-ante* modelling attempts to project expected impacts of policies. Finally, diffusion indicators look at the market penetration of energy-efficient technologies or the percentage of actors taking up certain energy-efficient practices. This section presents the results of findings from the above three methodologies as applied to the EU.

Impact analysis

Energy efficiency indicators

The ODYSSEE project that monitors the performance of the European building stock on a regular basis does so through the bottom-up "ODEX" energy indicator (Figure 37). For the heating of buildings this indicator shows essentially the technical improvements in terms of energy consumption per square metre. For electric appliances it is based on the individual performance of each electric appliance. However, even this index still does not fully reflect the impacts of regulation for new and existing buildings given the combined effect of compensating social drivers (such as increased internal temperatures and longer heating periods), and of the slow penetration of the building stock with new energy-efficient buildings. This is also the reason why the indicator shows a stabilisation or even a slight increase over the second half of the nineties after a strong decrease in the early nineties. Only in 2004 does this indicator start to decrease as an effect of energy prices.

Figure 37 • Impact evaluation of residential sector energy efficiency policies with the ODEX (heating and electric appliances)

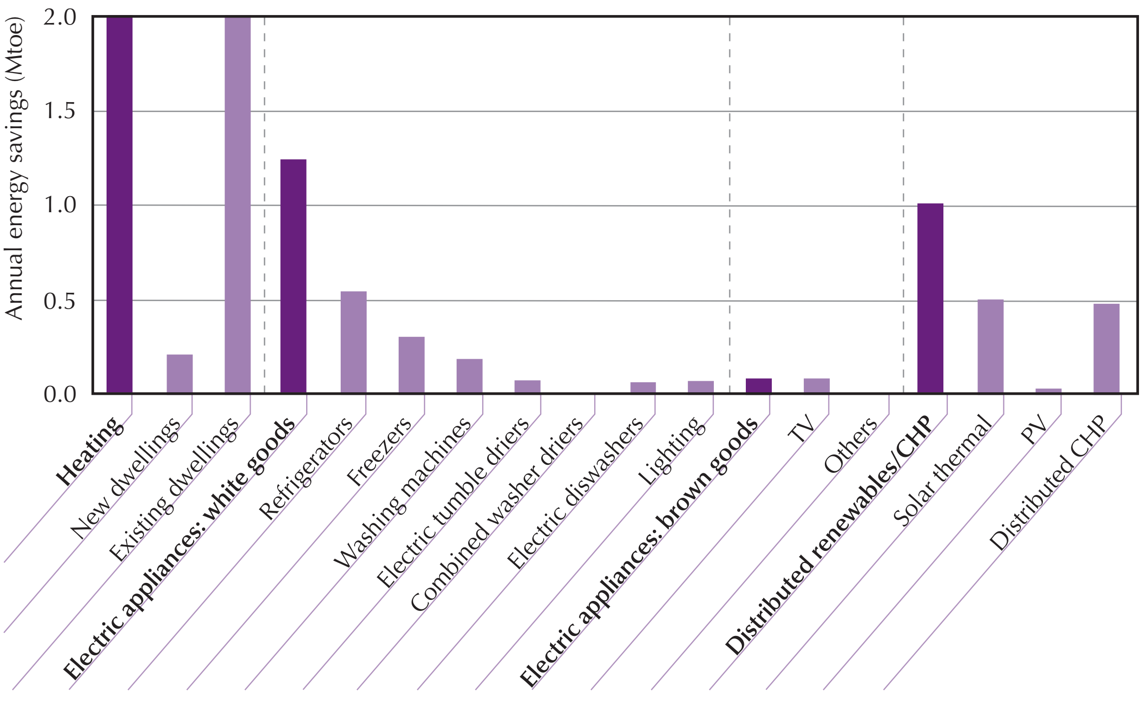


Source: Odyssee (2006), Odyssee database, Energy indicators: Country Profile EU.

Modelling ex-post or ex-ante the impacts of energy efficiency policies in Europe

Below are the results from the Odyssee-MURE project in terms of an *ex-post* evaluation of combined EU and national policies for the residential sector (Figure 38), as well as from an *ex-ante* analysis of economic potentials for energy efficiency in the same project (Figure 39). This impact evaluation shows that policy measures aiming at heating, and in particular those aiming at existing buildings, had by far the largest impact in the period 1990-2000 (savings of 364.2 PJ). Regulation for buildings played by far the largest role in this. The *ex-ante* evaluation shows that through a combination of measures relating to boilers, harmonised and improved building regulation, programmes for the insulation of existing buildings and renewable energy sources in buildings, annual energy consumption might be curbed by 3 349 PJ up to 2025 in the EU15.

Figure 38 • Ex-post evaluation of energy efficiency measures in the EU15 in the period 1990-2000

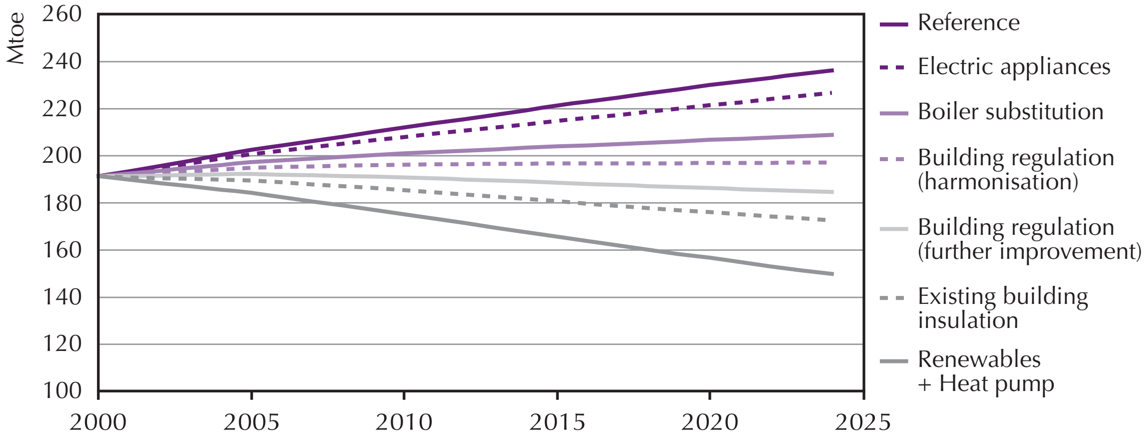


Source: ADEME (2005), *Energy-efficiency Monitoring in the EU-15,* Editions ADEME, Paris.

Diffusion indicators of energy-efficient technologies in buildings

Regular information on diffusion is currently lacking. Figure 40 shows the development of low emission glazing and condensing boilers and Figure 41 of insulation thicknesses in different EU member states. Regardless of climate correlation, political support has a crucial influence. Condensing boilers for example have reached very high levels in the Netherlands. Recently, the UK has largely increased the level of condensing boilers through regulation and the Energy

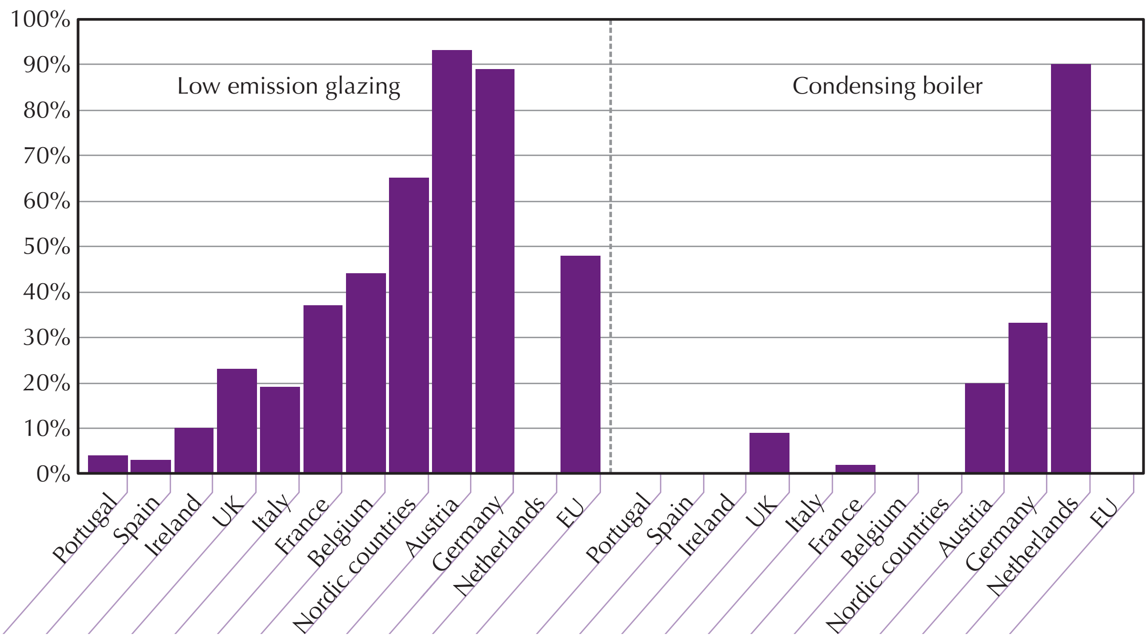
Figure 39 • *Ex-ante evaluations of economic energy efficiency measures in the EU15 2000-2025*



Source: ADEME (2005), *Energy-efficiency Monitoring in the EU-15,* Editions ADEME, Paris.

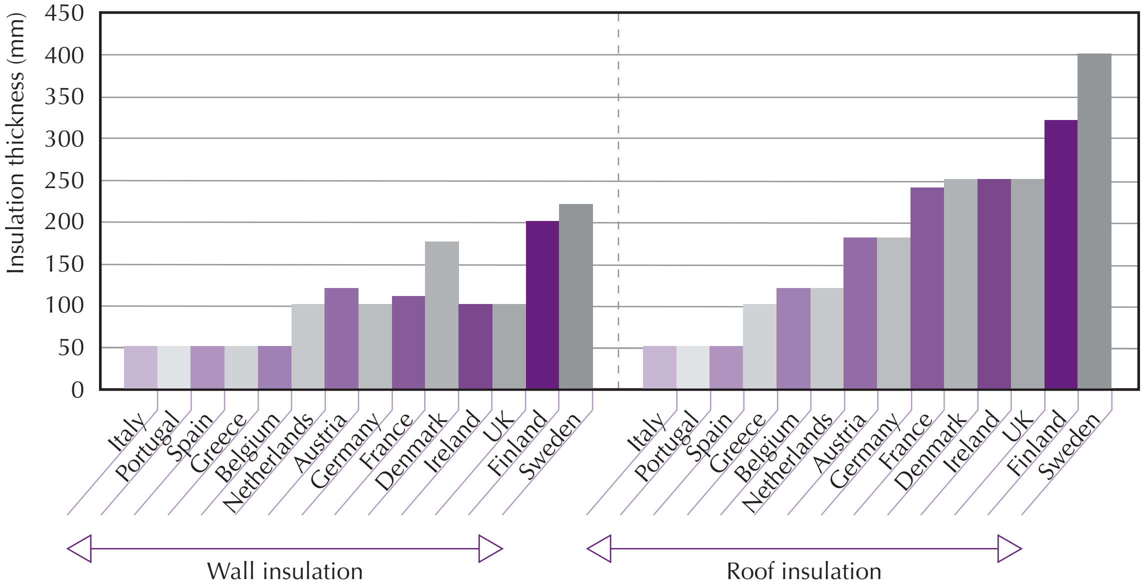
Efficiency Commitment (EEC) schemes: wall hung condensing boilers experienced a dramatic increase in 2005 when they more than doubled in units sold in this market segment, reaching a share of more than 65%. The reason for this shift is that building regulations have been introduced in England and Wales requiring the installation of condensing boilers in all new buildings and as a replacement for gas-fired boilers during renovations.

Figure 40 • *Diffusion of low emission glazing and condensing boilers in EU countries (2004)*



Source: Calculations based on data from Saint Gobain and the European Heating Association.

Figure 41 • ***Diffusion of insulation thickness (2004)***



Source: Calculations based on data from Eurima.

Evaluation

An evaluation of the various policy measures described in reference to the criteria outlined in the introductory chapter are presented below.

Regulatory measures: EPBD and EPCs

Impact and effectiveness

The EPBD is widely expected to have a strong impact on the energy efficiency of the existing residential sector; particularly should it be extended to include smaller buildings. The Directive will require all buildings to eventually meet minimum energy efficiency standards, as older buildings are renovated and new ones constructed. It is relevant as it addresses key elements of energy efficiency in buildings, namely insulation and energy sources. The major strength of the EPBD being an EU-wide regulation is the establishment of standardised measurements and verifications protocol. The information and administrative costs that establishing quantification methods for cost-benefits analysis and certification represent can be overcome in this way.

The EPBD has already instigated building code revisions in various countries. Thus far consumers receiving EPCs and energy audits have been very satisfied, stating that the certificates and the accompanying energy efficiency improvement recommendations are easy to understand (Shorrock and Coward, 2007).

Clarity and flexibility

The EPBD is supported by various initiatives that seek to ensure its clarity. The Building Platforms initiative and other IIE funded programmes are aimed at ensuring all stakeholders are provided with the resources required to understand and implement the Directive. The provision of revising the Directive every five years should enable it to be flexible, though it will also require continuing efforts to ensure clarity.

Sustainability and relevance

Finally, the EPBD aims to be sustainable through initiating market transformation. It consolidates EU efforts seeking to improve energy efficiency in buildings with a long-term view of transforming the construction and housing industries. The EPBD creates the need and demand for more energy-efficient technologies, for new training and certification across the entire construction industry, and can stimulate shifts in the real estate market through its integration of energy efficiency. The Directive therefore meets the EU's objective that energy efficiency improvement policies also enhance and transform the economy.

Financial and incentive-based measures: taxation, SCF and the IEE

Energy Taxation Directive

The Energy Taxation Directive has had limited impact on the residential sector. Fiscal measures are not easily enacted at the EU level, taxation being an area of strong state control. The EU could more easily use reductions in VAT for more energy-efficient products as a means of stimulating their use in households. The Commission has launched discussion on the taxation issue and the input of various stakeholders might be helpful in elucidating possible solutions.

Structural and Cohesion Funds (SCF)

The potential of the SCF to encourage energy efficiency measures in existing residential buildings, particularly in the least-developed states and regions, is only now being tapped. It is important that the EU has developed broad policy objectives which explicitly encourage energy efficiency, as state programmes and projects should be in line with these. Making sustainable energy consumption part of funding priorities is a further step in this direction. The new provisions have the advantage of being clear, and this new harmonisation of objectives is likely to remain in place long enough to affect the manner in which funds are disbursed. That this change has occurred only very recently shows the policy's inherent lack of flexibility in terms of financing energy efficiency improvements; rebalancing policy aims and their institutional framework is time consuming.

Intelligent Energy-Europe (IEE)

The IEE has the advantage of having a long history through its predecessor programmes. The total funding disbursed is rather small, even compared to funds available in individual member states, and the overall impact of the projects funded is unknown. The IEE does however explicitly disburse funding to programmes meeting the sustainability criteria and those which are more relevant for improving energy efficiency in existing residential buildings. Its integration within the CIP also weighs funding disbursements towards market transformation and projects that may have positive long-term economic effects. This shows the EU's capacity to re-prioritise funding policies, as it has done with the IEE and the SCF.

Information and capacity-building programmes

These types of policies are imbedded within the EU's legislative activities. These are supported by various framework agreements, and even included as clauses within certain directives. For example the EPBD imposes an obligation for information measures, supported by the Commission, to be put in place. The EU supports its legislative activity with the development of technical tools, like in the case of EPCs. Further, it contributes to funding various energy agencies across Europe.

A need for clearer information and sensitisation of public opinion to instil behavioural changes was expressed during the Green Paper on Energy Efficiency debate. Action to synchronise, assess and re-prioritise existing policies has been requested. The EU is well positioned to deliver these needs.

In the field of energy efficiency, the EU is providing templates for reporting, evaluating, comparing and benchmarking energy efficiency measures and savings. This significantly reduces the costs individual states would face when attempting to develop these tools, and allows for the harmonised action required.

Most importantly it can work to transform market conditions that act as barriers to improved energy efficiency measures in existing residential buildings. Initiatives on ESCOs, audits and white certificates reflect this push for change. These policies are relevant in improving energy efficiency in existing residential buildings and they have had impact in individual countries. The latest Energy Policy for Europe reiterates the need to "unbundle" energy provision. The EU aims to promote such market-based measures due to their flexibility, an essential condition given the variety of member states. What the EU can provide is the regulatory framework and standardised quantitative tools required for such measures to be successful.

Policy lessons

Ecofys (2005) has identified a portfolio of cost-effective energy conservation measures and retrofit packages to show how the potentials for EE in buildings may be realised. This might be applied to the European building stock.

One of the main barriers for the implementation of energy-saving measures, especially in rented apartments, is the divergence in interests of the tenant and the owner/investor, or the principal-agent problem. Whereas owners invest in energy-saving measures, tenants benefit from the reduction of energy costs and the increase in comfort. Often the opportunities to increase the rent are legally limited or the return on investment is extended over a long period of time.

Another common impediment for private homeowners is a lack of funds available for necessary maintenance or retrofit measures. This may shift the measures taken towards smaller investments and less energy-efficient solutions.

In order to overcome these obstacles, Ecofys (2005) recommend that the EU, national governments, and banks play an active role in providing a supportive framework for the implementation of the EPBD. These organisations may facilitate the access to direct and indirect financial support and could provide incentives for investors in refurbishment projects in EU member states. The following options are proposed by Ecofys (2005) for further discussion at a policy level.

Establishing revolving funds for refurbishment projects at a regional level

Revolving funds can be developed and administered by public institutions as a financing mechanism to support the investment in energy efficiency measures in the building sector. A reserve of money could be made accessible to registered organisations or individuals. Over a given period of time the debtor is expected to repay the original sum, which will replenish the fund and allow others to benefit from loans. The financial savings achieved by energy efficiency projects, easily determinable, are funnelled back into the capital fund thus creating an ongoing revolving capital fund. Each year these savings are reinvested into the fund until the capital investment is paid off. Revolving funds were implemented and tested in various countries such as the UK and turned out to be a suitable means for pursuing longer-term targets.

Providing incentives through subsidies and reduced interest rates on loans

A targeted subsidy policy could be introduced to help finance the improvement of energy efficiency measures in the building sector. Reduced interest rates on loans issued by banks would be another option. These policies have to be consistent in order to achieve a good result, which means that the earmarked subsidy amount for certain measures, such as improved insulation, must match the demand for them. However, tying up these types of subsidies with loan arrangements could make the subsidies hard to acquire if the customers wanted to install technology on their own. There should be a clear indication of which measures are subsidised, but the receipt of subsidies should not be dependent upon the specific equipment supplier from which an investor purchases the technology. Special attention should be given to the area of subsidy schemes: subsidies for mature and thus "commercially available"[57] technologies are not encouraged, since this may result in increasing prices and may degrade the quality of services.

Lowering the value added tax

As another option the value added tax (VAT) could be lowered in EU member states for any product type that contributes to decreasing energy consumption in buildings. Typically, this would apply for insulation material, improved windows or state-of-the-art heating technology to be installed during refurbishment measures. Lowering VAT would accelerate and support sales mechanisms of these products and could lead to stimulating the construction supply markets in general.

The right legal framework for retrofitting

In some EU countries, investors are allowed to increase rental fees after a refurbishment measure to a maximum of twice the monthly energy cost savings[58] (averaged annualised energy cost

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57. This recommendation may be qualified: it could be more relevant to avoid providing subsidies for "economically available" technologies and to give funds to "commercially available" ones as far as they are not financially viable.

58. Ecofys (2005) did not specify how energy cost savings are calculated in the respective countries.

savings), provided that the measures improve the energy efficiency of a building. With or without involvement of the EU, a similar legal framework could be expanded to other EU member states. Note that such a cost-pass-through scheme is primarily designed to create incentives for owners; tenants would not necessarily be better of, depending on the assumptions made to calculate the energy cost savings (energy prices, interest rates and their respective future dynamics).

Conclusion

The European Union itself has no legal means to directly provide subsidies for energy efficiency in buildings. However, structural funds could be used for this purpose as they increasingly integrate criteria for sustainable development and energy efficiency. Economic incentives such as energy taxation have been used very cautiously in the form of minimum taxation levels due to the strong prerogative of the member states in this domain.

All in all, regulation remains the main instrument for the improvement of energy efficiency in existing buildings but is complemented with elements such as building certification, inspection and auditing schemes and the creation of a market for energy services. In the future, white certificates, which are now implemented in several EU member states, might play an increasing role at the EU level.

The challenge for policies developed at the EU level is ensuring a balance between clarity and flexibility. The bureaucratic process involved with issuing Directives is heavy. On the other hand too many policies become burdensome for member states to keep track of and implement. This has led to an increased focus on synchronising and assessing existing policies. The EU has introduced mandatory national energy efficiency action plans, updated every three years, to do so. The Commission has also proposed to establish an Office of the Energy Observatory within the Directorate-General for Energy and Transport. This is intended to streamline existing energy-related information and reporting obligations (EU Commission, 2007).

The main strength of EU policies is their sustainability; they aim for the energy efficiency of all buildings, including existing residential ones, to become an integral part of economic activity. They uphold a long-term vision of energy efficiency and its role in ensuring energy that is reliable, secure and competitive. This expanded vision also allows the development of efficient policy packages, such as the EPBD and creating the environment for white certificates, or awareness-raising campaigns combined with stimulating market transformation (EU Commission, 2007d). The impact of these policies will likely be measured within member states. The EU's role is one of providing long-term energy efficiency objectives for member states to follow, and of providing templates that allow for harmonised action and ease of implementation within member states. It is concerned with removing the barriers to improved energy efficiency in existing residential buildings through market transformation. The EU is proving to effectively take on the role of leading and facilitating this transformation, due to the variety of policy tools available to it at different levels of government and society. It is through this combination of policies that the EU aims to create what the Action Plan for Energy Efficiency deems most necessary: "A paradigm shift … to change the behavioural patterns of our societies, so that we use less energy while enjoying the same quality of life".

Chapter 6 • FRANCE

Introduction

The energy dependence of France has made its energy conservation awareness acute. Effective energy use and energy security considerations have been important. Following the second oil price shock of 1979 France became increasingly conscious of energy efficiency, and initiated measures targeting the residential and building sectors. These efforts took off once again in the mid-1990s, when France became concerned with mitigating climate change and prioritised renewable energy policies and EE in its national action plans.

This chapter will follow the development of policies targeting EE improvements in existing residential buildings, culminating in the government's most recent policy statements which recognise EE as a major pillar to reach its goals of mitigating climate change, achieving security of supply and competitiveness. An overview of the past and present policy frameworks is presented, with an explanation of the major actors involved in developing and implementing these policies. This chapter will present a review of various policies, followed by an analysis and evaluation of the policies and their impacts.

National context and policy framework

National context and energy profile

Historical background

Historically, France's dependence on energy imports being a strong cause for concern, energy policy has been focused on the supply side (nuclear and oil) in order to meet the increasing demand for fuels and electricity. Up to the first oil price shock in 1973, energy efficiency policy was not an explicit goal. Following this, the rational use of energy became an important policy second to diversification (nuclear energy, hydro, natural gas), in a bid to secure energy provision, reduce price risks and foreign dependency. During the first half of the 1980s, with the second oil price shock and the objective to reduce energy costs, energy conservation policy was brought to the fore, particularly in the sectors of buildings and industry. The goal was to reduce the future energy demand of new buildings and to moderate the energy consumption of existing ones. No quantitative efficiency goals were formulated at that time. Up to the mid-1980s, activity in the residential and the tertiary sectors included four main policy lines (Martin *et al.*, 1998):

- Inducing habits of economic energy use, particularly by room temperature management.
- Establishing a thermal regulation for new residential (as from 1974) and tertiary buildings (as from 1976).

- Creating incentives for energy conservation retrofits in existing buildings through financial aid or fiscal incentives for investments and energy audits.
- Instilling specific energy management measures in public buildings.

With decreasing oil prices starting in 1986, energy efficiency activities were strongly reduced in all sectors. The policies mentioned above persisted but with much lower intensity.

Energy efficiency policies re-emerged only during the 1990s with the climate change debate. Renewable energies were also given more consideration, in order to comply with the European Union community strategy and action plan on renewable sources of energy.

Since the mid-1980s most policies targeting energy efficiency in existing buildings are derived from both energy and environmental policy goals.

Housing sector

Background information

Background information regarding the housing market is useful to discern the potential development of EE. Total building energy demand may vary according to renovation, retrofit and structural changes, on the level of both building envelope and technologies. Structural changes include changes in the structure of heating and hot water systems and changes in the age distribution of buildings, including the replacement of existing buildings with new ones.

A majority of dwellings are single-family houses and their share is still growing. They accounted for 56% of the housing stock in 2003, which accounts for 68% of the floor area (see Annex II). Almost four in every five or 78% of buildings in the French building stock were constructed before 1981, either before building codes for new buildings were first introduced (in 1974) or reinforced (1982). Further, an important portion of buildings constructed after 1975 do not perform much better than those of the previous period in terms of energy efficiency (Table 42, Annex II). On the whole, approximately the same building space area is either new or renovated every year, and the building renewal rate is at less than 1% per year (DGEMP, 2007). The turnover of existing building acquisitions exceeds by far the expenditures for new buildings.

The tenure status varies according to building type. In 2002, 56% of building residents were owner-occupiers. The large majority (about 80% in 2001) of those in detached houses own their homes; the rest being occupied by tenants of the private (11%) or the social sector (5%), or by another occupier type. Conversely ownership rate is in a clear minority in apartment buildings (25% in 2001). Also a considerable number of dwellings (6.2 million, representing about 20%) are in co-property. This is particularly challenging for EE improvements, since a large number of stakeholders are involved. A significant proportion of apartment units, representing 4.1 million dwellings, are in the social sector (DGUHC, 2003). This represents 37% of the 11 million dwellings in apartment buildings. In 2002, tenant households in the social sector account for 17% of all dwellings.

The total housing expenditures in France amounted to about 19% of GDP in 1984, 20% in 2002 and increased to 21.3% in 2004 (CCL, 2006). Energy expenditures represent an increasing portion of current household expenditures (see Table 43, Annex II).

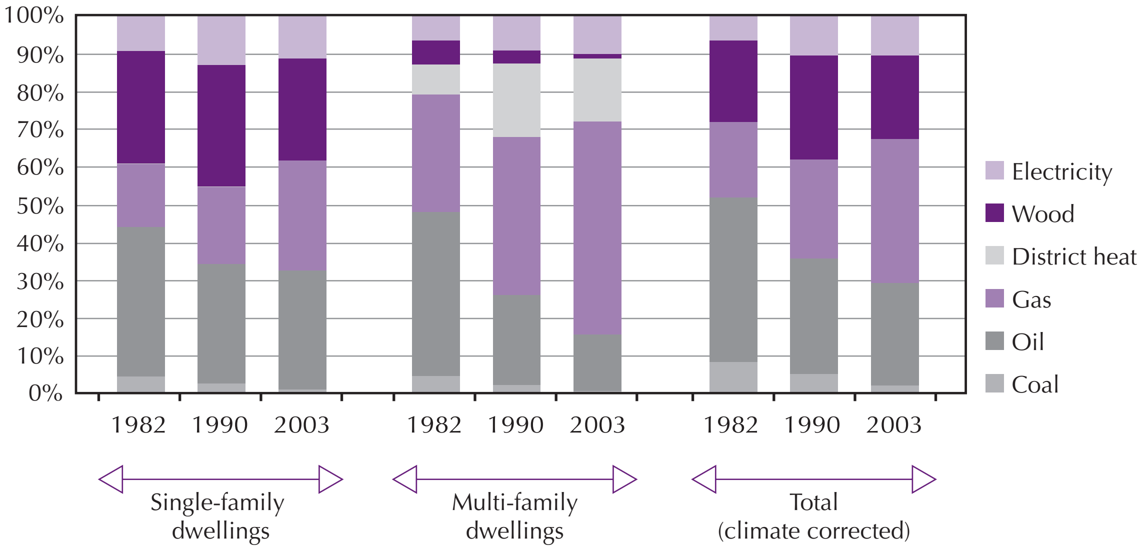
By and large, at least 70% of the building stock holds considerable potential for energy efficiency improvement either by renovation/retrofitting or by demolition and new construction.

Energy use in the residential sector

The residential sector accounts for almost 30% of the total final energy demand in France (DGEMP/OE, 2006). Final energy demand increased by 22% (about 360 PJ) to 1 972 PJ between 1982 and 2003;[59] electricity accounts for 230 PJ of this increase.

Energy demand of the building sector is dominated by space heating, especially in buildings constructed before the mid-1970s. Space heating represented 75% of household energy consumption in 2002. Since the early 1980s structural change in energy use for space heating resulted in a substantial reduction in the shares of coal and oil, while natural gas increased both its share and its absolute value.

Figure 42* • *Final energy demand (numbers in Mtoe and graphical representation in %) for space heating in the French residential sector



The values of the two buildings types are not climate corrected and (district) heat is missing for the (climate corrected) total of the whole residential sector (heating degree days 1982: 2 285; 1990: 2 082; 2003: 2 279).

Source: Mure (2006), MURE-Odyssee Database (Version 4.1).

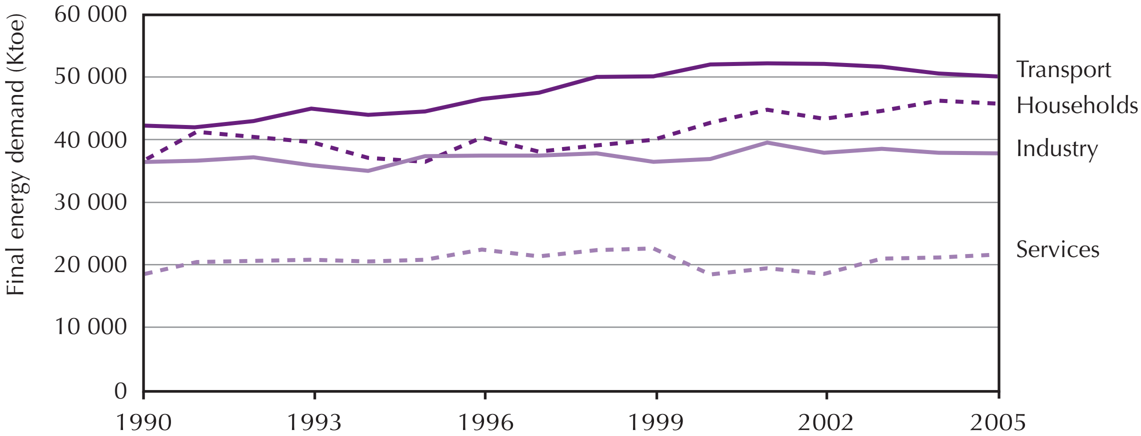
Main drivers in the residential sector

Energy demand is determined by physical and economic drivers and may be counterbalanced by structural changes and techno-economic progress. These driving forces have led to a constant growth of final energy demand in all sectors (Figure 43). The only exceptions have been the two energy price shocks, which reduced energy demand in the industrial, residential and service

59. Climate corrected version of the ODYSSEE Database, Version 4.1.

sectors. The transport sector, after sustained growth, has recently shown stagnation in its final energy demand.

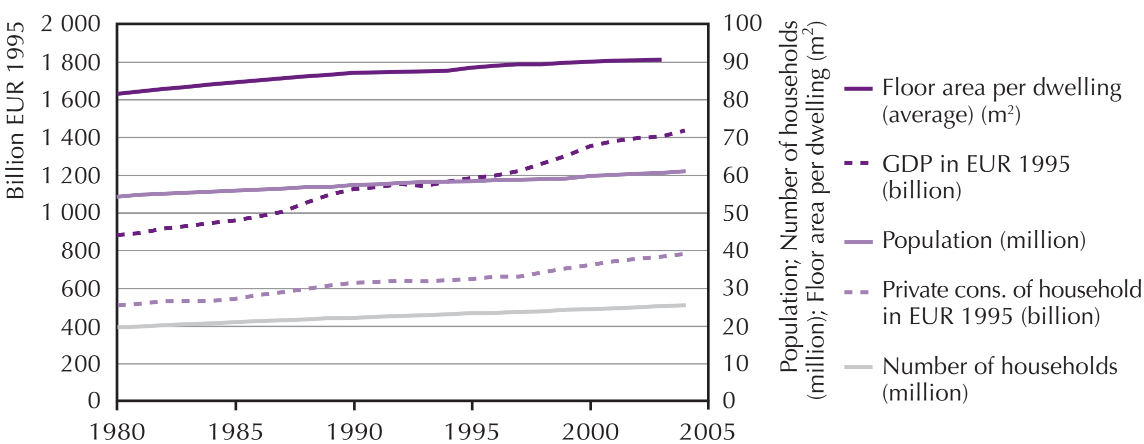
Figure 43 • *Final energy demand (ktoe) per sector in France between 1990 and 2005*



Source: Eurostat (2007), Energy database, Environment and Energy: Suppy, transformation, consumption, http://epp.eurostat.ec.europa.eu.

The growth of physical and economic factors was particularly strong during the 1960s and 1970s and is still growing (Figure 44). Particularly relevant for the building sector are the population growth (+12% between 1980 and 2004), the increase of building stock[60] (+31%), and the growing appliance and equipment use rate, led by economic growth and increased wealth. During the same period the average floor area per dwelling – especially in single-family houses - increased by 11%, concurrently extending the surface area to be heated.

Figure 44 • *Selected drivers of household energy demand in France*



Source: Mure (2006), MURE Odyssee Database (Version 4.1)

60. Note that the number of households is almost equivalent to the number of dwellings.

The increase in final energy demand would have been more pronounced had energy efficiency levels and energy services remained constant, and without any structural change such as more efficient dwellings and end-use appliances. While the main drivers of the residential building sector such as the number of dwellings and the average area per dwelling rose 45% between 1980 and 2004, the final energy demand of these sectors increased by 26%.

Climate indicator

The average household in France is located in a moderate climate zone. There are quite large climatic variations within the country. In the North East of France the climate is similar to that of Switzerland, Austria and large parts of Germany, with typical values between 3 000 and 3 500 heating degree days (HDD). In the South of France the heating degree days are only half these values. Heating requirements vary accordingly and the current building code distinguishes three main climate zones. On average taking the 1980 to 2003 time period, the long term HDD in France is slightly lower than the EU15 countries' average (2 540).[61]

Policy and institutional framework

Since the mid-1980s, policies regarding EE in the building sector have been a means to comply with wider goals and strategies, such as climate change, rather than an end in itself. This section will look at France's goals in which EE in existing buildings plays a part, as well as the broad strategies to achieve these goals and the primary actors who shape and implement EE policies.

Past and present policy goals

It was only in the 1990s, and with the strengthening of the climate change debate, that quantitative energy efficiency policy goals were formulated. Under the Kyoto Protocol and following the EU burden sharing negotiations, France committed to stabilise its global greenhouse gas emissions compared to the 1990 baseline in the first commitment period (2008-2012). Other EU countries either engage in reducing their emissions or are allowed a limited increase. The National Programme against Climate Change (PNLCC), elaborated by an inter-departmental working group between 1998 and 2000, was adopted by the government in January 2000. Its objective was to avoid CO_2 emissions of 16 Mtce[62] between 2008 and 2012 so as to offset the expected increase which is – in the dynamic view – equivalent to a reduction of about 10% (MIES, 2000; WEC and ADEME, 2004). The reduction goal in the building sector is estimated to be less than proportional, namely 2.7 Mtce. According to the PNLCC, the insulation of existing buildings would contribute to a mitigation of 0.2 Mtce; complementary efficiency measures regarding existing buildings include efficient boilers or measures targeting public buildings (MIES, 2000).

The PNLCC has been complemented by a National Programme on Energy Efficiency Enhancement (PNAEE), presented by the government in December 2000 and adopted by the national assembly

61. ODYSSEE-database Version 4.1.

62. Metric Tons Carbon Equivalent.

(parliament). The goal was to minimise the consequences of oil crises that regularly affect the world economy and to complement the French programme on climate change mitigation. Accordingly the PNAEE's aims include improving the EE both in the residential and the public sectors (MATE/MEFI, 2000). It also promotes the development of renewable energies to comply with the corresponding EU directive. Both the PNLCC and the PNAEE explicitly put EE back on the agenda.

It became increasingly apparent that the PNLCC and the PNAEE were insufficient to meet the climate change mitigation goals.[63] A national energy debate launched by the Ministry of Industry in 2003 culminated in the November 2003 White Book on energy, and the *Plan Climat* (Climate Plan) programme of 2004. This finally engendered a guiding law on energy policy[64] which reinforces the PNLCC. In 2003 the government's *Facteur 4* (Factor 4) goal was announced, aiming at a fourfold reduction of 1990-level carbon emissions by 2050. In the short term (up to 2010) the buildings sector is expected to contribute to 16% of the 72 $MtCO_2$ emission reductions proposed by the plan. It prescribes four long-term policy goals: i) to contribute to energy independence and security of supply; ii) to ensure competitive energy prices; iii) to preserve human health and the environment, primarily through mitigating climate change; and iv) to guarantee social and territorial coherence by ensuring that all have access to energy.[65] These goals are reiterated in the most recent National Programme on Energy Efficiency Enhancement (DGEMP, 2007). They are translated into operational quantitative goals and include a fourfold reduction of CO_2 emissions by 2050,[66] a decrease of final energy intensity by 2% per year up to 2015 and by 2.5% up to 2030, and a strong increase of renewable energies up to 2010. In the long term, EE in the building sector should be improved significantly to reach a specific demand lower than 50 kWh/m^2 a on average for the entire building stock by 2050.

The environmental conference (*Grenelle de l'environnement*) launched by the presidency in the summer of 2007 produced a report in October which reiterated the Factor 4 goal, and emphasised the need to reduce the energy consumption of existing buildings to reach this goal. It announced the aim of reducing their energy consumption to a range of 50 and 80 kWh/m^2, equivalent to a fourfold reduction, within the next ten years. Finally, the move towards a low-carbon economy and sustainable economic growth was emphasised (Tuot, 2007).

Strategies

France's strategy regarding EE in the building sector includes regulations, economic incentives (both fiscal measures and subsidies), and information measures. These have been complemented by measures in the public sector, for the state to set itself as a model for private actors. At the turn of the century, new policy instruments were introduced: guarantee and investment funds

63. *Indeed these goals contrast strongly with the perspectives of the "*Scénario énergétique tendanciel à 2030 pour la France*" (DGEMP/OE 2004) where the above mentioned goals were not part of the baseline assumptions. The final energy demand of the residential and tertiary sector is expected to increase up to 2 407 + 1 147 = 3 354 PJ (starting from 1 896 + 892 = 2 788 PJ in 2000), where electricity contributes with about 544, 2 PJ (71%) to this increase. Note that the underlying assumptions regarding policy measures in the building sectors are the full implementation of RT 2000 and RT 2005.*

64. Loi N° 2005-781 du 13 juillet 2005 de programme fixant les orientations de la politique énergétique.

65. *See Le Déaut* et al., Rapport fait au nom de la mission d'information sur l'effet de serre *(Report on the Greenhouse effect),* Tome *1, 12 April 2006,* Assemblée nationale, *France, 2006, p. 91.*

66. *The "Factor 4" strategy.*

for the industrial sector; tradable energy saving certificates and, as of 2005, more specific energy efficiency related fiscal incentives in the building sector.

The first National Programme on Energy Efficiency Enhancement (PNAEE) of 2000 outlined an information strategy for an enlarged target audience, financial support, and technical and price regulation. It proposed the establishment of local information centres throughout the country to inform households and small businesses on EE, and a new building thermal regulation which became effective in 2001, requiring a 15% increase in residential sector energy efficiency (Odyssee-MURE, 2004).

Regarding the building sector, the 2004 *Plan Climat* programme followed some suggestions made in the 2003 White Book on energy, which emphasised the need to improve the energy performance of existing buildings in order to mitigate climate change; the policy was regarded as a priority for the next several decades. The strategy in the building sector is founded on four pillars, partly interlinked and complemented by a large research programme on buildings - called PREBAT.[67] The four pillars are information, regulation, incentives and partnerships. Information measures include energy performance diagnostics presented as certificates and energy labels. Regulations cover thermal standards applicable to major renovations, mandatory feasibility studies, inspection of building technologies and regulations regarding construction products. Incentives include white certificates, tax credits, property tax deductions based on energy labels, subsidies based on energy performance, and green financial products and banking. They also seek to establish means to share the benefits of energy-saving investments between tenants and owners. Partnerships target links with industry professionals to slowly eliminate least performing technologies and ensure that professionals are trained regarding energy efficiency.

All the above mentioned specific measures are combined with a general awareness campaign that targets public opinion and points out daily opportunities to save energy. Finally the *Plan Climat* emphasises the leading role of the state regarding its own buildings (De Villepin, 2005).

The 2007 PNAEE reiterates most of the above strategies, while recognising the particular importance of targeting existing residential buildings. For existing buildings over 1 000 m^2 undergoing significant renovation (more than 25% of the building's price), energy efficiency standards will be imposed as for new buildings starting in April 2008. For buildings under this size, replaced individual building components (such as windows) must meet minimum energy efficiency standards as of 1 November 2007. New housing energy performance certificates now also apply to existing buildings for sale or rent as stipulated in the European Energy Performance of Buildings Directive (EPBD). Renovation measures in the social housing sector will be particularly encouraged, as these allow the government to meet two of its energy policy goals. Public-private partnerships to promote energy efficiency programmes are also encouraged.

The *Grenelle de l'environnement* puts forward various measures to reach its carbon emissions reduction goals, including research into more energy-efficient building materials, as well as tightening norms and regulations for buildings and appliances. It also includes financial measures, such as pricing that accounts for environmental costs and the increased use of fiscal schemes where relevant to encourage reduced energy consumption.

67. Programme de recherche dans le bâtiment *(Building Research Program), see* "Plan Climat".

Legal, administrative and institutional framework

Actors

The French state is highly centralised and traditionally plays a major role in France. The state is represented in each region and department by a prefect, who coordinates the decentralised government services. This Jacobin tradition gives ministers significant power. For example the government provides a technical assistance service for local authorities which do not have adequate internal resources (IEA-DSM, 2002a). Accordingly, French energy policy is characterised by a centralised, nation-based approach with strong government involvement (IEA, 2004). More competences, resources and independence have recently been attributed to the regional governing structures.

Energy efficiency policy in the building sector is quite complex since it involves construction, environmental, technical, financial, fiscal and social issues. Consequently a broad range of administrative actors are involved at the national level, particularly the following four ministries (IEA-DSM, 2002a).

The Ministry of Economy, Finances and Industry (MEFI) is in charge of energy. Administrative authority lies within the Energy and Raw Materials Directorate (DGEMP) which is divided in two operational divisions: the DIREM, for the supply side (petrol, gas, nuclear, etc.) and the DIDEME for matters such as energy efficiency, renewable energies, and distribution and transmission grids.

The former Ministry of Planning and Environment (MATE) – now called Ministry of Ecology and Sustainable Development (MESD), also plays an important role in elaborating energy policies, particularly those concerning climate change mitigation.

In addition, the Ministry of Equipment, Transportation and Housing is responsible for general and social housing issues. The Ministry of Interior is generally responsible for local authorities, in particular through the General Division for Local Authorities (DGCL).

Legal framework

The French legal system is hierarchically structured into codes, laws, decrees and directives. The policy axes and general framework are covered by the codes whereas the implementation, the application and technical details are covered by laws and decrees. Because the scope of EE policies may lead to inconsistencies between the purpose and legal foundation of different ministries, France created in 1974 a national Energy Conservation Agency (AEE) to manage the rational use of energy and bring together the different aspects of EE activities. The Agency was given a broader scope in 1982 to become the French Agency for Energy Management (AFME) and then merged in 1992 with other agencies to become the Agency for Environment and Energy Management (ADEME), which is discussed below. Further, in the context of climate change policy, the ministries cooperate within the Inter-departmental Mission on the Greenhouse Gas Effect (MIES).

According to the law relating to the sustainable development of the territory, regional and local authorities are encouraged to investigate the potential renewable energy sources (RES) and combined heat and power plants (CHP) within their territory. Larger involvement of the local authorities is also translated into the decentralisation of ADEME activities, in line with the PNAEE. Currently ADEME is represented in each region and works with Regional Councils through the "State/Region Contract Plans".

Energy agency (ADEME)

As mentioned above, the Energy Conservation Agency (AEE, 1973) changed into the French Agency for Energy Management in 1982 (AFME) and ADEME in 1992. The aim was to counterbalance the increasing market power of large energy producers, which was leading to low-cost energy but negative externalities, through the diffusion of energy-efficient technologies. However state support was neither sustainable nor sufficient enough to reach this long-term goal, as the French EE policy evaluation committee deplored (see Martin *et al.*, 1998). The agency's funding literally collapsed with the oil price counter-shock of 1986 (see Figure 45).

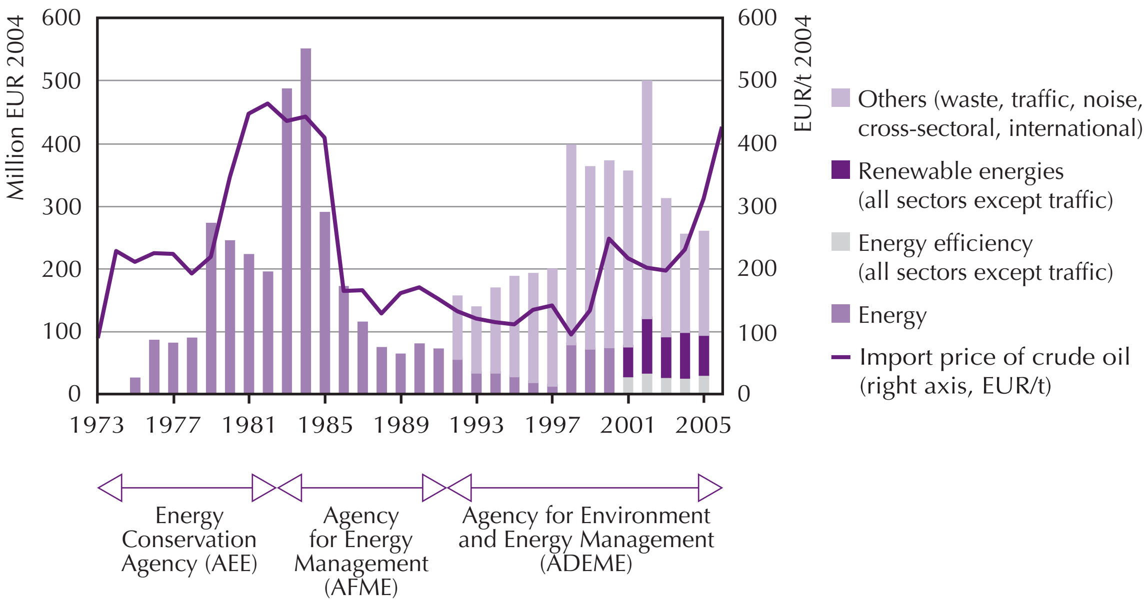
ADEME manages energy, waste, air and noise pollution policies. It provides advice and incentives to all categories of consumers and manages projects that promote renewable energy sources at the local level. Currently ADEME is a public body under the combined supervision of the Ministries of the Environment, Industry and Research and operates within a six-year agreement with the government. The latest agreement runs from 2007-13 and confirms ADEME's role in facilitating the societal change necessary to deal with climate change. In the building sector, activities targeting energy efficiency will largely focus on capacity-building. Emphasis is placed on training building professionals, providing them with tools necessary to make energy-efficient decisions, providing follow-up for energy diagnostics and evaluation tools, and supporting implementation of building regulations and white certificates. Research into energy-efficient building materials and public information campaigns will also be supported.

Energy-related programme funding started increasing in 1998, but focused on renewable energies rather than on energy efficiency (Figure 45). Energy-related fields of activity are the industry, buildings, and transport sector. The agency mainly targets national and regional co-operative efforts, provides its expertise and collects resources and funding from various partners. The Agency uses four main instruments to achieve its policy goals: i) support of public and private research bodies; ii) providing information to the general public; iii) providing financial and technical assistance and ; iv) collaborating with governmental bodies,[68] local authorities, and intermediaries,[69] in order to link EE issues to other goals.

68. *For example technical departments of the supervising ministries, the social cohesion initiative, ANAH which provides subsidies in the social housing sector.*

69. *Industry professionals (suppliers and producers of energy, energy service companies, equipment manufacturers and installers), trade organisations, such as France's building sector federation, large developers, such as the social housing office (HLM), certification bodies (AFNOR, QUALITEL), consumer associations, and banks.*

Figure 45 **• *Annual intervention budget of ADEME and its predecessors in Euro 2004***



Source: ADEME (activity reports 2001 to 2005), Martin *et al.* (1998), Insee, *Comptes nationaux, Base 2000* (GDP price index), own estimations.

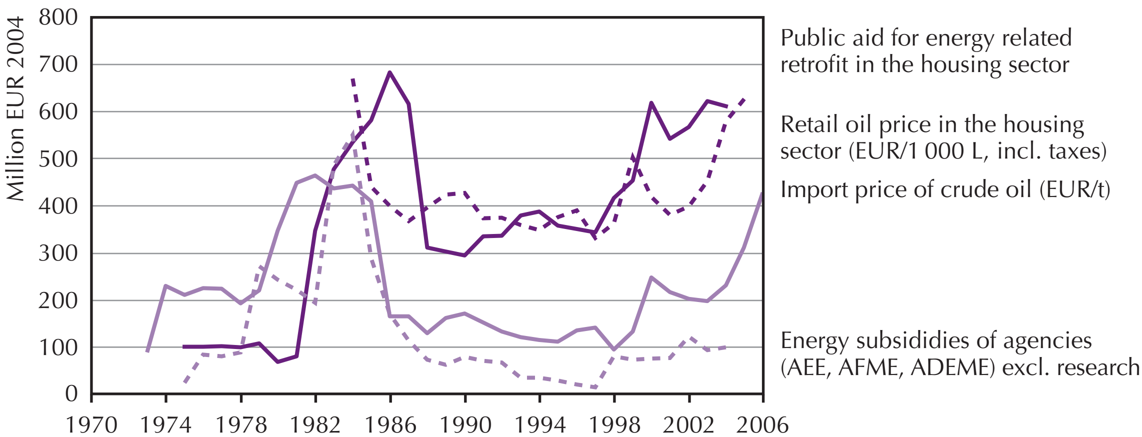
Current policies on energy efficiency in the existing residential building sector are largely shaped by climate change concerns, but form part of France's four energy policy goals. ADEME centralises efforts and provides a cross-sectoral tool to work towards CO_2 emissions reductions and energy conservation goals. The following section looks at the policy measures that seek to improve energy efficiency in existing residential buildings, by targeting the various barriers to improved EE.

Policy measures

The intensity of French EE policy can be shown by two indicators: the energy subsidies of ADEME (and its predecessors) and the public aid for energy-efficient residential sector retrofits. These two indicators closely followed the evolution of oil prices (see Figure 46). Policies that follow the business cycle restrain autonomous technical progress and effectiveness in energy efficiency, as they clearly do not stimulate market transformation. Indeed, after 1986 the financial incentives developed to stimulate energy efficiency disappeared along with high energy prices. Climate change concerns shifted priorities starting in the 1990, and ADEME's budget for energy efficiency and renewables increased by a factor of six between 1998 and 2003, reaching EUR 90 million (MURE, 2006). This budget has continued to grow, in 2006 EUR 169 million was devoted to energy-related activities, and it is estimated that in 2007 EUR 152 million were set aside for energy management and climate change programmes (ADEME, 2007a).

An overview of EE policies in the buildings sector in France is presented in Table 18. These include regulatory measures, such as minimal efficiency requirements and inspections for boilers. While district heating network regulations were simplified in 1999 to allow buildings and other energy users to connect to these networks, this regulation is not specific to the building sector and won't be discussed in this section. Financial measures include energy conservation certificates (white certificates), in place since 2006, and the financing of leasing credits for specialised financing companies (Sofergies) that take advantage of special tax schemes. This scheme began in 1980 and was extended in 2005. Finally, the promotion of cogeneration, while having a potential impact on residential buildings in the future, is not specific to the sector and won't be analysed.

***Figure 46* • Two indicators of the intensity of the French energy efficiency policy**



Source: ADEME (activity reports 2001 to 2005), Martin *et al.* (1998), Insee, *Comptes nationaux, Base 2000* (GDP price index), own estimations.

The following subsection will discuss those policy measures presented in Table 18 which affect existing residential buildings, using the policy typology outlined in the Introduction.

Table 18 • Overview of energy policy measures in the residential sector of France

Goal*	Tool	Measure type	Policies	Short description	Field	Existing/ New	Actors	Target audience	Period
A1	Legislative / Normative	Mandatory standards for buildings	Energy performance standards	Building insulation standard of 1974, 1982, 1989 and 2001	HW, SH, BSh	N	All	BP, GP, HA, Ll., manuf., PP, research, retail, tenant	(last update) 2001-2005
				Building codes (thermal regulation) of 2006	SH, BSh,	N	Cent. Gov	BP	2006-
F3		Regulation for heating/ hot water systems	Minimum efficiency standards for boilers	Minimum efficiency standards for (hot water) boilers	HW	N/(E)	Ass.	BP, GP	1994-
D1		Other regulation in the field of buildings	Maximum indoor temperature limit(s) /limitation heating period	Limit to the internal temperature of dwellings	SH	E	Cent. Gov	Owner-occupiers, tenants	1974-
B1, B3	Legislative/ Informative	White certificates		Energy certificates for buildings	HW, SH, HVAC	E/N	Cent. Gov, EA	GP, BP, Ll., OO	2006-
A1	Financial	Grants / Subsidies	Investments in new buildings exceeding building regulation	Demonstration projects in buildings	A, HW, SH	N	Cent. Gov., EA, Loc. Gov., utilities	GP	1980-
A; A1			Investments in energy-efficient building renovation	Subsidies for dwellings retrofitting: OPAH, PALULOS	A, HW, SH, BSh	E	Ass., Cent. Gov., utilities	HA, OO	1978-
A			Investment in renewables	Subsidies for solar equipment	HW, SH	E/N	Loc. Gov	GP, HA, OO	2000-
				Subsidies for wood equipment	HW, SH	E/N	Loc. Gov, Cent. Gov., EA	GP, OO	1997-2004
B1			Energy audits	Audits subsidies in buildings	A, HW, SH, BSh	E	Cent. Gov., FI, Loc. Gov	Ll., OO, tenants	1980-
B1				High environmental quality of buildings, HPE (label)	SH, HW	E/N	Ass., EA, Loc. Gov	BP, GP, HA	1990-

Goal*	Tool	Measure type	Policies	Short description	Field	Existing/ New	Actors	Target audience	Period
B4	Fiscal/ Tariffs	Tax exemption and reduction	VAT* reduction on retrofitting investment	VAT reduction	A, HW, SH	E	Cent. Gov., utilities	GP	1999-
			VAT reduction on equipment	VAT reduction	A, HW, SH	E	Cent. Gov., utilities	GP	1999-
			Income tax reduction	Tax credit for works on energy efficiency	A, HW, SH	E	Cent. Gov., utilities	OO	1990-2004
			Income tax credit	Tax credit for works on energy efficiency; credit tax for energy efficiency materials & renewable	A, HW, SH	E	Cent. Gov	GP, Ll., OO, tenants	2005-
F4	Information / Education	Information campaigns (by energy agencies, energy suppliers etc)		Information & advertising campaign	A, HW, SH, BSh	E	Ass., EA, Loc. Gov.	GP	2004-
		Regional and local information centre on energy efficiency		Local energy information centres	A, HW, SH	E	Cent. Gov., EA, Loc. Gov.	GP, Ll., OO, retailers	2000-

Source: MURE-Database (http://www.isis-it.com/mure/ as of Oct. 2006) DGEMP/DIDEME (2006a), own representation.

Goal: A = To rationalise the new building standards from the energy and environmental standpoint; B = To improve the efficiency of the existing building shells and heating equipment; C = To reduce energy consumption through actions on prices, taxes and energy billing; D = To reduce the intensity of operation of heating systems; F = To increase the average efficiency of sanitary hot water equipment
Field: A = Appliances; BSh = Building Shell; SH = Space heat; HW = Hot Water
Actors: Ass. = Associations; Cent. Gov. = Central Government; EA = Energy Agencies; FI = Financial Institutions; Loc. Gov. = Local Government; BP = Building Professionals; GP = General Public; HA = Housing Associations; Ll. = Landlords; OO = Owner-occupiers
** VAT = Value Added Tax*

Regulatory measures

Building codes and standards

In the building sector, mandatory codes and standards have proven both their effectiveness and their cost-effectiveness. They have mostly been applied to new buildings. In the case of residential buildings there are basically three main fields of application:

- heating appliances and systems;
- building envelope;
- energy service (level of use, *e.g.* level of temperature, restrictions for heating or cooling).

Historically these fields of application have been addressed quite independently. In contrast, the 2000 and the 2005 Thermal Regulation (RT) building codes pursue a whole building performance approach, including a limitation of the total energy use for heating, hot water, ventilation, air conditioning, and set standards for indoor conditions. By making certain energy efficiency standards mandatory, building regulations can overcome principal-agent problems in the rental sector. Owners or investors will otherwise not invest to improve EE since they do not benefit from energy cost savings resulting from the investments. Regulations also stimulate market transformation in the building sector by changing the behaviour of manufacturers and both building and real estate professionals. Individual regulations are discussed in more detail below.

Heating appliances and systems

The European Directive on the efficiency of new boilers (92/42/EEC) was implemented in France in 1994. Low-capacity boilers (between 4 kW and 400 kW) have to meet minimal efficiency standards at the delivery stage. For medium and large boilers (400 kW to 50 MW), minimal efficiency standards became effective along with tools for the measurement of the characteristic efficiency and fuel quality evaluation. For large boilers (>1 MW) obligatory periodic technical inspections were introduced in 1998 to ensure compliance with the above requirements. It is planned that boilers of more than 100 kW are to be inspected every two years (DGUHC, 2006a). Installations over 15 years old will be subject to an overall inspection and to recommendations in order to improve the global efficiency.

Limitation of indoor temperature (heating and cooling)

In 1979, the maximum allowed indoor temperature for residential buildings was 19 °C. This was supported by an advertising campaign which succeeded in creating awareness (MURE, 2006). The decree is formally still valid but was not effectively applied. However, the measure is not highly effective in isolation, is difficult to apply and monitor, and is not flexible enough to allow for different energy sources and constraints (MURE, 2006). The current building energy code RT 2005 sets requirements regarding summer indoor comfort conditions and defines limitations on the use of cooling. As of July 2007, only when the indoor temperature is above 26 °C may cooling technology be used. However this limitation is difficult to monitor and implement, and is such is considered a “pedagogical measure” (*mesure pédagogique*). Such a limitation could have a large positive effect in moderate climate zones where conventional cooling systems are used. However, more innovative types of cooling such as night cooling and more efficient appliance operation remain valid options.

Thermal regulation for residential buildings

A building insulation standard was first introduced in 1974 and was revised in 1982, as a reaction to high oil prices, in 1989, in 2000 and in 2005. Except for the most recent version, only new buildings were affected by this regulation (Table 45, Annex II). Previous standards nevertheless have an indirect impact on existing buildings through a spill-over effect; building codes are a major driver for the progress of building technologies and can ease their diffusion and their transposition to existing buildings (such as coated glazing, efficient lamps and ballasts, and low-temperature boilers). As a consequence the level of technologies and of energy efficiency could be similar between new and existing buildings (see Jakob and Madlener, 2004), and the French government's new action plan is pushing for the gap to be narrowed (DGEMP, 2007).

The 2005 RT is part of the transposition of the EU Energy Performance of Buildings Directive (EPBD) into national law. The EPBD stipulates the minimal requirements for important renovation in buildings over 1 000 m^2. Energy performance certification is also to be mandatory for existing buildings. The RT 2005 is therefore not only a thermal regulation regarding the building envelope or the space heating; it is an optimisation tool for planners and investors, and introduces renewable energies and primary energy aspects. The new regulation is innovative in that it targets existing residential buildings through the following measures:

- Components influencing the building's energy performance such as boilers, windows, replaced or new insulation have to comply with minimal thermal requirements.
- Minimal performance requirements are set for minor renovation measures, particularly in the case of replacement of elements of the building envelope (windows, thermal insulations) and of equipment (boilers). This applies to existing buildings under 1 000 m^2 as of 1 November 2007.
- For large buildings (>1 000 m^2) where renovation costs represent 25% or more of the value of the construction, requirements will be complemented with an obligation to meet global energy performance which is close to the one for new buildings. Work on overall energy performance of the buildings would be supported by the national agency for the improvement of housing (*Agence Nationale pour l'Amélioration de l'Habitat,* ANAH). This measure is to be applied as of April 2008.
- As of 1 April 2008, pre-studies for sustainable solutions will have to be performed in the case of major renovations to existing buildings with a surface area of over 1 000 m^2.

In sum, the 2005 RT applies not only for major rehabilitation, but also for minor renovation where building components are replaced or renewed. Further, limits of energy requirements were set independently of the type of energy in both the 2000 and 2005 RT.

Energy performance certificates

To comply with the requirements of the EBPD an energy performance certificate must be provided for all buildings at the time of construction, sale or rental. The energy efficiency diagnostic

(DPE) applies to existing residential buildings for sale (as of November 2006) or rental (as of July 2007). The consumers will thus be informed of the complete cost of the residence, taking into account energy consumption compared to reference situations. The energy labelling classification (stretching from A to G) will depend on the estimated consumption in Kwh/m² or in grams of CO_2 emitted. The DPE is valid for ten years.

The DPE must be accompanied by recommendations and suggestions on how households can make EE improvements to their residence. These are provided according to a scale of priority and may allow banking institutions to adapt their financing for renovation work, according to the level of energy efficiency or the EE improvement measures assessed by the DPE. A study conducted by Ifop for ADEME in August 2007 indicated that 92% of all households were favourable to the DPE (ADEME, 2007b).

Financial and incentive-based measures

Fiscal measures

Tax deductions and tax credits play a major role in French energy policy. Historically, the energy tax level in the housing sector followed the evolution of oil prices on the international markets. This pattern shows that energy taxation has been a means of financing general public expenditures rather than of pursuing environmental and energy conservation. There are however a number of specific tax instruments that directly or indirectly impact on the French housing sector. These instruments include:

- Income tax reductions and tax credits for maintenance, retrofit and renovation for principal residences.
- Tax incentives for investments in the rental sector for new or rehabilitated property ("Borloo" and "Robien" schemes, named after two former Ministers of Housing).
- VAT reductions.
- Property tax exemption.

Income tax reductions and tax credits

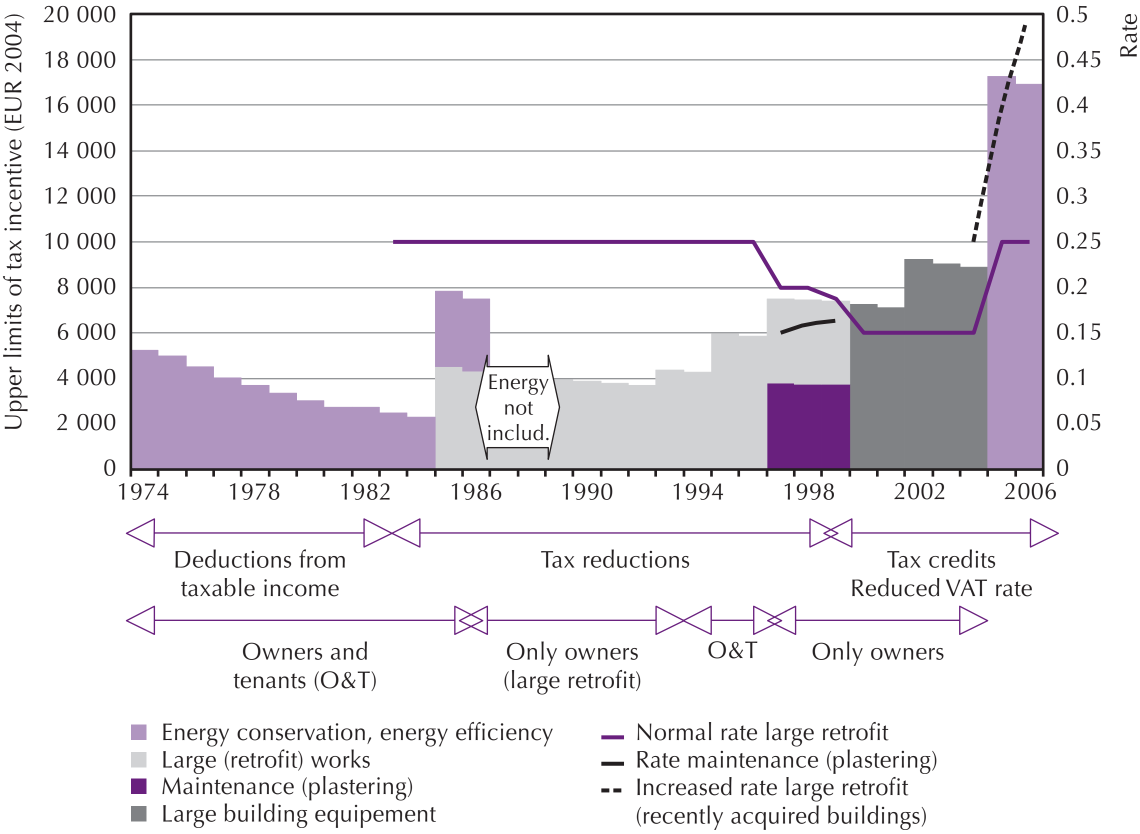
A tax incentive scheme to encourage the general maintenance and improvement of existing buildings has been implemented since the 1970s. Though schemes have varied over the decades, they all include a list of eligible expenses for maintenance and improvement works, and a multi-annual upper limit tax incentive. They differ in terms of the type of work eligible, the magnitude and the type of incentive (Figure 47). Three phases of income tax schemes can be distinguished.

The first phase lasted between the first oil crises up to the end of high oil prices in 1986. It was characterised by specific fiscal incentives for energy conservation measures. In 1985 and 1986, the tax scheme was extended to large retrofit works.

The second phase stretched from 1987 up to 2004, where EE measures were either excluded or part of a large set of general housing improvement measures. At that time, no minimal efficiency requirements were made.[70] In 1999, the tax deduction scheme was converted into a tax credit one.

The third phase started recently, in 2005. The tax scheme was seen as an important element of long-term EE goals such as Factor 4. It was updated in 2006 with an extension of eligible expenses and in increase in credit rates (Table 19). The scheme took into account energy efficiency issues. Technical requirements to obtain tax credits became more stringent though they remain relatively modest compared to available state-of-the-art technology (in particular for windows and glazing, see Table 44, Annex II).

***Figure 47* • Development of the French tax scheme for principal residences: upper limits for tax deductions or tax credits for a couple with two children in EUR/2004 (left axis) and tax reduction or tax credit rates (right axis)**



Source: Martin *et al.* (1998), MEFI, CIB, MURE (2006) (measure description FRA7), ADEME (press information of 25 January 2006), www.cohesionsociale.gouv.fr (as of Nov. 2006), Insee, *Comptes nationaux, Base 2000* (GDP index).

70. In the 1990s eligible investments for tax deductions included thermal insulation (as of 1990), heating regulation (as of 1991), the installation of central heating systems (as of 1992, see. Martin et al., *1998), and the replacement of boilers and installations of wood stoves (*Conseil Général des Mines, *CGM, 1995). Since 2004 tax credits could also be obtained for boilers with condensing technology. Some criteria were set for either the age of the building (for example thermal insulation and heating regulation only in buildings built before 1982) or the age of the boiler (only if older than 15 years) (see measure description Fra7, MURE, 2006). Further conditions included the certification of certain products ("Acermi" for insulation products and "Cekal" for glazing products). Note however that these certificates refer to product qualities and not to minimal energy efficiency requirements. There were no minimal insulation requirements set.*

The type of incentives and their beneficiaries changed over time, as seen in Figure 47. Tax credits are coordinated with other financial measures, in particular direct subsidies; the rates of Table 19 apply in this case to purchase price lowered by the amount of direct subsidies. An important change in 2005 was also that the upper limit for tax credits was more or less doubled (EUR 16 000 per dwelling for a couple).

The scheme applies to all those responsible for paying energy bills, from owner-occupiers to tenants and boarders. The fixed upper limits capping fiscal incentives may discourage building owners from undertaking large retrofit projects and making more energy-efficient choices when renovating or purchasing equipment and appliances. This limitation of up-front investments may contradict energy efficiency goals. This drawback has been partly offset with the reduced VAT scheme, to the extent that tax for building works was reduced from about 20% to 5.5% (see below). The rates of tax credits can be characterised as quite high on first sight. However this scheme only applies to energy efficiency materials or systems, but not to installation or labour costs. Since these costs could typically represent up to 50% or more of the total costs, in particular in the case of insulation work (Jakob *et al.*, 2006), this lowers by a factor of two the net financial assistance provided by the fiscal scheme.

Table 19* • *Tax credit rates for existing buildings *(older than 2 years)* ***valid in 2005 and 2006*** *(primary residence)*

	2005	2006
Low-temperature boiler for heating and hot water purpose	15%	15%
Condensing boiler for heating and hot water purpose	25%	25% or 40%*
Insulation material including windows, conditioned on thermal resistance	25%	25% or 40%*
Control equipment for heating systems	25%	25% or 40%*
Renewable energy technologies and equipment (building related and others)	40%	50%
Heat pumps (geothermal and air/water), COP>3	40%	50%
Heat pumps (air/air), COP>3	-	50%
Connection technology to district heating networks (with minimal share of renewables or cogeneration)		50%

** For buildings built before 1977, if installations are made in the first or second year after purchase of the building.*

Source: ADEME (press information of 25 January 2006), www.cohesionsociale.gouv.fr.

Tax incentives for investments in the rental sector (new or rehabilitated property)

The 2006 National Commitment to Housing defined criteria for dwellings to be considered decent. These include requirements concerning heating, safety and basic amenities. The Commitment aims to promote decent rental dwellings with moderate rents by offering fiscal advantages for investments. Such investments can affect the EE of existing buildings. The current tax schemes, “Robien” and “Borloo”, apply to the acquisition of an existing property (rehabilitated beforehand by the vendor) and the rehabilitation of an already acquired property. Four out of the twelve technical criteria that dwellings must meet after rehabilitation concern EE and/or thermal comfort of the buildings (window and heating system, solar protection, roof insulation for attic dwellings). Thus, rehabilitation measures undertaken with support from the tax scheme can improve the EE of rental sector buildings. This is particularly beneficial since this sector is affected by principal-agent problems.

The scheme applies to individuals making rental investments either directly or through certain types of real estate investment bodies. They must also abide by the conditions of lease and rent ceilings defined by the relevant law and its decrees.[71] The owner must commit to renting his property for at least nine years as a main home (this period can be extended by six years) and to maintain the rent under the ceilings specific to four different zones.[72] The "Borloo" scheme applies specifically to dwellings with low-income tenants.

The scheme offers amortisation rates of 6% of the purchase price (and/or of the rehabilitation investments) during the first seven years of the rental commitment period, and of 4% during the consecutive years. Expenses for improvement work following the start of the commitment period are to be deducted in terms of a 10% amortisation rate during ten years. In the tax declaration these amortisation amounts can be deducted from the rental revenue, and add up to 50% in the "Robien" scheme and up to 65% in the "Borloo" scheme. The latter also allows a constant deduction of 30% of the rental revenue during the whole commitment period, and even 45% if specified personal housing assistance conditions are satisfied.

The rent ceilings imposed after acquisition or rehabilitation do not encourage comprehensive or large-scale EE improvements. The higher costs incurred become more difficult for the owner/investor to recover.

Reduction of the value added tax rate

In France the normal value added tax (VAT) rate is 19.6% (BTP, 2002). Since 1999 the reduction of VAT rates has been implemented to encourage building maintenance and improvement. The reduced rate was set to 5.5% and is still valid. It is a fiscal measure that aims to affect budget constraints by reducing prices, but it doesn't change relative prices between general building improvement and specific EE measures.

Two implementing phases can be distinguished. During the first phase between 1999 and 2005, the VAT and the tax credit schemes complemented each other. The VAT scheme was not specific to EE (nor to renewable energy), but rather encouraged general maintenance and improvement work by the companies that provided and installed the materials or the equipment. This financial measure would have been more efficient if these companies were well trained and informed about energy efficiency. The second phase started in 2006 and will potentially last up to 2010,

71. Arrêté *of 19.12.03, decree No 2006-1200 of 29.9.06 and decree of 10.8.06.*

72. *Upper limits for monthly rents : Robien recentré: Zone A: 19.89 Euro/m², Zone B1: 13.82 Euro/m², Zone B2: 11.30 Euro/m², Zone C: 8.82 Euro/m²; Borloo neuf (20% lower than "Robien recentré"): Zone A: 15.92 Euro/m², Zone B1: 11.06 Euro/m², Zone B2: 9.04 Euro/m², Zone C: 6.63 Euro/m² (source: ANIL. www.ANIL.org as of Oct. 2006). Zone A includes Paris and its agglomeration, la Côte d'Azur , le Genevois français, zone B1 includes agglomerations of more than 250 000 inhabitants, the large ring ("grande couronne") around, some expensive agglomerations (Annecy, Bayonne, Chambéry, Cluses, La Rochelle, Saint-Malo), the surrounding of Côte d'Azur, the overseas departments and Corsica. Zone B2 includes the other agglomeration of more than 50 000 inhabitants, the other expensive zones at border, at the coast or at the surrounding of l'Ile-de-France. Zone C includes the rest of the territory. The zones are defined by the "arrêté" of 10.8.06.*

since the European Commission authorised member states to continue applying reduced VAT rates for labour-intensive services. The reduced rate was extended to the following services and equipment: heating installations, individual heating and hot water equipment (including internal distribution), solar energy systems, biomass systems, heat pumps, façade insulation and window replacement. Since 2006, wood and similar biomass products used for heating also benefit from a reduced VAT rate.

The scheme explicitly excludes: i) major renovation work such as extensions or increases in building size; ii) floor area increases by more than 10%; iii) renewing foundations or other elements that impact building resistance and rigidity; and iv) renewing more than two-thirds of major building components and systems, such as non-supporting floors, external door frames, internal walls, sanitary, plumbing, electrical installations and heating systems (Martin, 2006).

In some ways the scheme limits potential energy efficiency improvements since it doesn't incite comprehensive building renewal. Were the VAT scheme a stand-alone measure it would have serious drawbacks. However, the measure is combined with tax credit policy which in part sets prerequisites for energy efficiency standards and offers a financial complement.

Property tax exemptions

The property tax exemption is a supplementary measure; it supports the State Agency for the Improvement of Housing (ANAH) subsidy programme without adding a specific incentive to energy efficiency improvements.

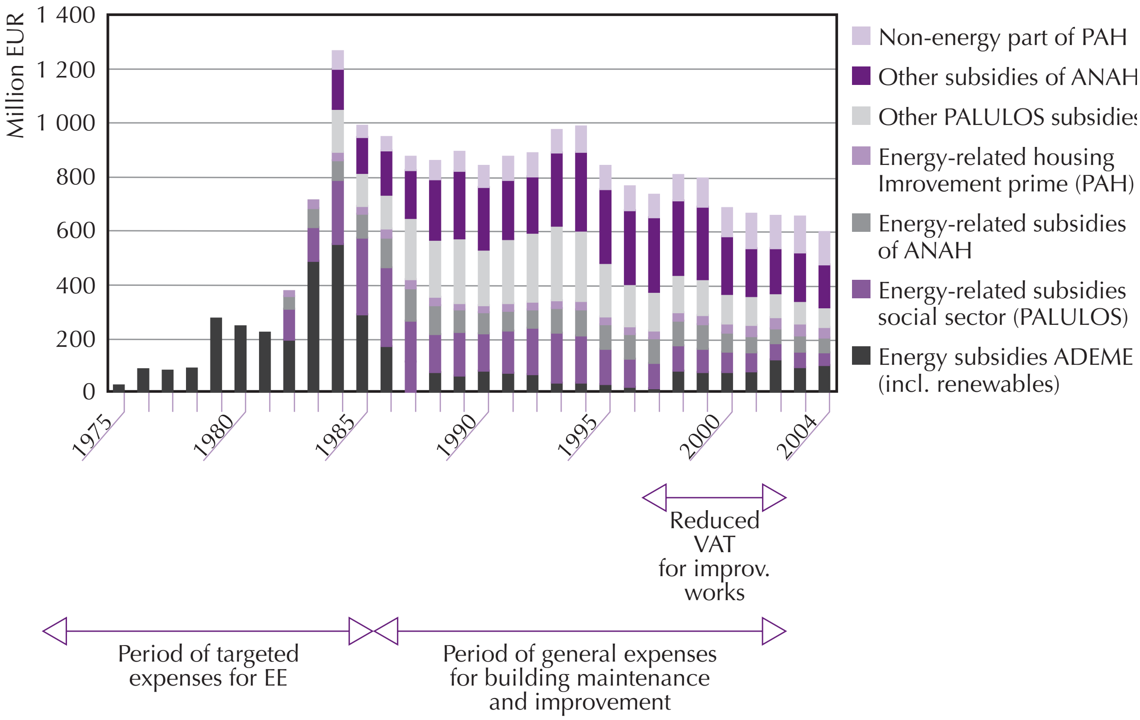
Rented dwellings may benefit from a property tax exemption for a period of 25 years if they have been improved with the aid of an ANAH subsidy and if they are part of the social housing sector. If four out of five environmental criteria are met, the tax exemption term can be extended to 30 years (Martin *et al.*, 2006). The criteria cover building conception and construction, energy and acoustic performance, renewable energy sources and materials, and fluid management. Further, privately owned buildings in special rural revitalisation zones (ZRR) and improved with the aid of an ANAH subsidy can benefit from property tax exemption for a period of 15 years.

Grants and subsidies

Overview

According to WEC/ADEME (2004), subsidies in the building sector are generally part of large retrofitting programs. An overview of the intensity of subsidy programmes for building improvement in France is given by an estimation of the annual public expenditures in Figure 48; note that EE expenditures couldn't be distinguished from other energy-related expenditures. After a period of quite specific subsidies for energy efficiency improvement purposes up to the mid-1980s, a two-way shift occurred: the volume of subsidies was reduced significantly and progressively shifted to general housing improvement works.

Figure 48 • ***Development of subsidy programmes for building improvement, in EUR/2004***



Source: *Compte de Logement,* Martin *et al.* (1998), *Comptes nationaux, Base 2000* (GDP price index) Insee, authors' own estimations. The three upper categories are subsidies for general housing renovation and not for EE improvement.

Subsidy programmes can have quite different goals, some aimed at supporting access to property or low-income households (see Auburt and Fribourg, 2005). However they can have a direct or indirect impact on the energy efficiency of existing buildings, either because they affect maintenance, renovation and retrofit measures in general or because they are specifically designed to promote EE and renewable energies. The primary subsidy programmes supporting the retrofit of existing buildings are listed in Table 20.

State Agency for the Improvement of Housing (ANAH) subsidies

Since its foundation in 1971, the State Agency for the Improvement of Housing (ANAH) allocates subsidies for the rehabilitation of existing buildings older than 15 years. The goal is to promote the improvement of privately owned buildings that are either owner-occupied or rented as primary residence. The target group of owner-occupiers is limited to those whose economic resources are beyond a certain limit.

Building and housing units eligible for subsidies are those with insufficiencies regarding safety, impacts on health, state of appliances and housing quality. Renovations that favour sustainable development also fall within the subsidy scheme, though EE improvements are not a pre-condition to obtain basic subsidies. However as of 2006 an extra bonus can be obtained for the following types of works (ANAH, 2006; ADEME, 2006a):

- Improvement of the thermal insulation of buildings.
- Insulation and regulation of heating and/or hot water systems.
- Window replacement satisfying minimal energy-efficiency requirements[73] and air exchange improvement.
- Implementation of systems using new, renewable or insufficiently exploited energy sources (such as geothermal, solar, waste heat and wood).
- Complete implementation of individual and collective heating or hot water systems, and adjustment or upgrade of existing heating system to the RT 2000 standard.

No bonus is provided for the insulation of the building envelope. Extra bonus amounts, indicated in Table 21, are the same for owner-occupiers and for owner-landlords and do not depend on building location zones.

Table 20 • Overview of EE subsidy programmes targeting the existing residential building sector

Short description	Beneficiaries	Period
Audit subsidies in buildings	Landlords, Owner-occupiers	1980-
Subsidies for dwellings retrofitting: OPAH[74], PALULOS (social rental housing improvement grant)	Social housing associations, Owner-occupiers	1978-
State Agency for the Improvement of Dwellings ANAH	Private owners in the rental sector, owner-occupiers (only social sector)	1979-
PAH (prime for housing improvements) including elimination of unhealthy conditions		
Subsidies for wood equipment	Owner-occupiers	1997-2004
Subsidies for solar equipment from local governments	Owner-occupiers	2000-

Source: MURE-Database (http://www.isis-it.com/mure/ as of Oct. 2006).

Pre-studies are also eligible to obtain subsidies if the improvement work is executed within a period of two years. The goal of such pre-studies, executed by qualified professionals, is to promote optimal technical, architectural and cost-effective projects. Eligible expenses include material and installation costs, excluding taxes, which must be provided and installed by designated professionals.

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73. Label ACOTHERM Th5, or Trade-Mark NF-CSTBat Uw≤2.6 W/m²K, or Uw≤2.4 W/m²K, or Vitrage CEKAL marquee TR Uw≤2.0 W/m²K.

*74. The Program OPAH (*L'Opération programmée d'amélioration de l'habitat*, Programmed Operations to Improve Dwellings) is a special procedure managed by ANAH to allow communities or other local entities to improve the conditions in local neighbourhoods. The procedure is based on a contract between a group of actors (community or other or other local entities, state and ANAH). OPAH does not impose improvement works, but creates favourable conditions and undertakes supporting activities.*

Table 21 • Extra bonus of ANAH subsidies for energy efficiency improvements

Item	Extra bonus (EUR)
Individual window (OPAH and PIG)	80
Individual boiler (condensation technology) *	900
Individual boiler (wood energy) *	900
Individual thermal solar plant for hot water *	900
Thermodynamic system (heat pump), air/water *	900
Thermodynamic system (heat pump), geothermal *	1 800
Combined solar systems *	1 800

**The extra-bonus is doubled if the system is used by at least two dwellings (that are eligible for ANAH subsidies).*

Source: ANAH (2006), p. 13, and www.ADEME.fr, section financial aids, as of Oct. 2006.

PALULOS subsidy programme for improving rented social housing

In 1977 a policy to address the lack of maintenance in rented social housing was launched. This policy's main tool is the subsidy programme called PALULOS. Only social housing owned or managed by social entities (members of the *Union sociale pour l'habitat,* social housing association) are eligible.

As with ANAH, eligible works include improvements in safety and comfort, upgrades for compliance with regulation and housing norms, and work resulting in energy savings.[75] Generally buildings must be at least 15 years old, but for energy conservation works they must date from July 1981 or before. The subsidies are attributed as a percentage of the renovation cost up to a maximum amount, which in most cases is EUR 13 000 per housing unit. Subsidy rates have been as follows:[76]

- From 1981 onwards, energy conservation works became a priority and the subsidy rate rose to 40%. In August 1986 the upper limit of the subsidy rate was reduced to 20%.
- In 1998 when the reduced VAT rate for building rehabilitation in the social housing sector was introduced, the subsidy rate was reduced to 10%.[77] Subsidies may be complemented with a preferential loan from the *Caisse des dépôts et consignations* or similar financial institutions. As of mid-2004, the rate was 2.95% for a redemption term of 15 years.
- In 2002 the upper limit for energy saving measures and thermal or acoustic insulations was increased to 15%. The measures covered are solar water heater, glazing, window and glass wall with thermal characteristics specified by the Ministry of Housing.[78] The rates are lower

*75. See. Art. R.323-1 and following of the Housing construction code (*Code de construction de l'habitat, *CCH), the* arrêté *of 30 December 1987 for the list of eligible works, newsletter N° 88-01 of 6 January 1988.*

76. Consecutive modifications of article R323-7 of the CCH, see. www.legifrance.gouv.fr.

77. J.O n° 302 du 30 décembre 1997.

78. See. J.O n° 105 of 5 May 2002, page 8849 text n° 257 modifying article R.323-7 of the CCH.

than those of the ANAH programme and also less extensive, as thermal insulation, efficient heating systems and heat pumps are not included.

While the PALULOS programme has provided some strong incentives for general and energy-specific building improvement, it does so on a lower level and less extensively than other subsidies. Its main goal is to improve the living conditions of social housing tenants, rather than improve EE in buildings.

Retirement fund subsidies

Owners and tenants who are considered retired persons with limited economic resources (according to the social security and other social schemes) may apply for subsidies from their departmental pension aid funds for their main home. Subsidies address adaptation and renovation including plumbing, sanitary, heating, thermal and acoustic insulation.

Planned Operations for the Thermal and Energy Improvement of Buildings (OPATB)

In 2002, coordinated aid of ANAH, ADEME and the Ministries of Housing, Ecology and Economy led to the Planned Operations for the Thermal and Energy Improvement of Buildings (OPATB). The programme aims to achieve general involvement in the renovation of the buildings concerned (MIES, 2001) and was launched at the initiative of project managers in local communities (DGUHC, 2006b). The programme's objective is to co-ordinate, in a given area – neighbourhood, town, department – over a period of up to several years, an operation that combines organisation and consulting, traditional action on the part of competent organisations (ANAH and ADEME) and additional grants awarded local authorities. Local public authorities that apply to run an OPATB operation must: i) carry out a study on the energy profile, the targeted buildings, the stakeholders and the objectives of the programme; ii) obtain the support of relevant local partners; iii) undertake communication and training campaigns and evaluate their results; and iv) commit to financing the project.

The law on the guiding energy policy gives new powers to local governments in order to contribute to energy efficiency improvement. Regarding existing buildings, the local authorities can extend their requirements in the case of restorations of private and social patrimony.

The programme targets both the residential and tertiary sectors and seeks to mobilise all local participants in the building sector, from energy suppliers, companies, research consultancies, to owners and public and private leasers.

Voluntary agreements and partnerships

Negotiated and voluntary agreements

According to the World Energy Council and ADEME (2004), there are multiple voluntary agreements to improve energy efficiency in all sectors, including industry, municipalities, buildings, transport and energy. However savings are mainly reported from industry (3.5 TWh/year in 2002).

Preferential loans

Some housing loan schemes specifically target energy or sustainability issues, while others have wider targets such as social issues, the promotion of home ownership and of general housing improvement. Even in these EE aspects are included and may play a major role, in terms of the eligible improvement measures or loan conditions. These indirectly affect tax schemes, as tax deductions or credits cannot be obtained if preferential loans are received. Preferential loans are issued both by public bodies and private institutions, primarily banks at the local and regional levels, or in some cases jointly by both entities.

Certain preferential loans specifically dedicated to improve buildings' energy efficiency are described below (ADEME, 2006a; Drouet, 2005; DGUHC, 2006a). A description of other types of loan programmes is provided in Annex II.

Loans from the Banque Populaire d'Alsace (BPA)

The loan is attributed for new buildings and the renovation of existing ones. Fifteen project characteristics are eligible for preferential financing, including optimisation studies, individual solar plants, etc. The interest rate generally is 2%, but may be as low as 0%. According to Drouet (2005), BPA's proposal is a pathfinder in France. It was initiated by the Banque Populaire du Haut-Rhin in 1999 and then enlarged to the Alsace region. The loans are refinanced by special saving products ("ethical savings"), public credits from ADEME and the region of Alsace, and the bank's own resources, such as by accepting lower margins.

Region Nord-Pas-de-Calais (NPC)

The loans are targeted to the renovation of existing buildings constructed before 1975. Beneficiaries are owner-occupiers, owner-landlords and small private social landlords. The requirements are beyond the RT 2000 for some elements (roof insulation, windows). The refunding pattern is the same as the BPA one.

A major utility provider, Electricité de France (EDF), also provides preferential loans for heat pumps. In 2006, several other institutions from the private sector launched preferential loans for energy-efficient and/or environmentally improved housing; it is expected that the relevance of such innovative financing products will increase as of 2007. Indeed, since January 2007, France is encouraging individual "green savings" products through fiscal incentives through CODEVI. In this scheme, banks may re-issue the revenues in terms of preferential loans to other household clients. The leverage is expected to be EUR 1 billion.

White certificates

Based on its July 2005 orienting law on energy policy, France implemented in 2006 a tradable energy certificates scheme that imposes energy savings amounts on energy supply companies.[79]

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79. *Legal base are (i) the* Arrêté *of 26 September 2006 fixing the energy repartition of the national energy saving goal for the period from 1 July 2006 to 30 Juin 2009, (ii) the* Arrêté *of 19 Juin 2006 defining the standardised energy saving operations, (iii) the* Arrêté *of 19 Juin 2006 fixing the list of items of an application for a energy efficiency certificate, (iv) the* Arrêté *of 30 May 2006 regarding the term of application of the energy efficiency certificate scheme, (v) the Decree n° 2006-603 of 23 May 2006 regarding the energy efficiency certificates, (vi) the Decree n° 2006-600 of 23 May 2006 regarding the energy saving obligations in the context of the energy efficiency certificate scheme, and (vii) the Decree n° 2006-604 of 23 May 2006 regarding the establishment and the maintenance of a national register of energy efficiency certificates. See www.industrie.gouv.fr (http://www.industrie.gouv.fr/energie/certificats.htm) as of Nov. 2006 and the circulaire of 18 July 2006 regarding the issue of energy efficiency certificate for further details.*

Subject to the scheme are electricity, natural gas, LPG and thermal energy (heat or cooling) supply companies active in the residential or tertiary sector, as well as domestic oil suppliers. Under such a system, suppliers can undertake energy efficiency measures for the final user that are consistent with a pre-defined percentage of their annual energy sales. The DGEMP is responsible for defining the field of application, the conditions of eligibility and the amount of certified energy, which varies according to climate zone. White certificates are given to the producer whenever the energy savings target is attained. The building sector is eligible to participate in the scheme by generating certificates.

Generating energy efficiency certificates (EEC)

Suppliers may fulfil their obligations by undertaking measures that result in energy efficiency certificates (EEC), by purchasing EECs from other actors or by paying a penalty of EUR 2 cents per excess kWh. The scheme creates a market for EECs through providing an offer, measures taken to produce EECs, and a demand, by the companies under obligation (Jacq, 2006). Once EECs are generated and registered, they are eligible to negotiated transactions between different accounts.

The following measures are among those that comply with EEC requirements (DGEMP/DIDEME 2006b):

- Energy saving measures undertaken by energy suppliers or public communities.
- Energy saving measures undertaken by a legal person not bound by the scheme (for whom the measures are not part of their principal field of activity and are not generating direct income).
- Measures that substitute renewable for non-renewable energies for heating and hot water use in the residential and tertiary sector.

Energy suppliers can encourage third parties to carry out energy savings so as to obtain EECs; they provide incentives for construction work that reduces energy demand in existing residential buildings. This includes subsidising the installation of efficient boilers, appliances using renewable energy or any other certified products. The MEFI established a set of standardised operations, consisting of a variety of energy efficiency measures whose savings can be calculated and certified. Surprisingly, external wall insulation is not included in the standardised certification scheme as of November 2006.

Global and individual energy efficiency goals

The national energy savings target and its contents are established by decree and will be periodically updated. This determines the conditions and manners for energy suppliers to achieve the target, based on the type of energy, the number of clients, the categories of clients and the volume of activity. The first of these decrees was published in September 2006 and established an energy saving goal of 54 TWh for a three-year period between 1 July 2006 and 30 June 2009. For each energy supplier subject to the scheme, an energy efficiency goal was fixed and made public. The overall target of 54 TWh for a three-year period is equivalent to 2.8% of cumulated annual sales. The energy savings target varies for different types of energy: it is more ambitious for electricity (3.9%) and LPG (3.1%) than for fuel and thermal energy (Table 22).

Table 22 • ***Global energy efficiency goal and its breakdown to the different energy types (residential and tertiary sectors)***

Type of energy	Sale in 2004 (TWh)	Reference price assumed (EUR cents per kWh)	Distribution of global energy savings target (TWh)	Equivalent fraction of annual sales (%)
Electricity	265.5	11.01	31	3.9
Natural gas	239.3	4.28	13.94	1.9
Domestic fuel oil	109.3	4.78	6.84	2.1
LPG	16.5	8.27	1.53	3.1
Heat/cooling energy	10.3	5.26	0.69	2.2
Total	**640.9**		**54**	**2.8**

Source: *Arrêté* (decree) of 26 September 2006 (NOR INDI0608389A), authors'own calculations.

The energy savings goal can be characterised as quite ambitious given the 26% increase in residential and service sector energy consumption between 1980 and 2005. It is too soon to tell whether a three-year period is sufficient to create a market for EECs and whether the penalty of EUR 2 cents per excess kWh is a strong enough incentive for suppliers to implement energy-saving measures.

Information and capacity-building programmes

Audits and information programmes

Information for the general public

Up to the mid-1980s information campaigns on energy efficiency issues targeted both professional stakeholders and the general public. After this and up to the year 2000 it was more focused on professionals. With the national debate on energy in 2003 the target audience was once again enlarged. An important part of the Climate Change Programme involved the *Faisons vite, ça chauffe* (Act fast, it's getting warm!) information campaign. The campaign was launched in 2004 with a budget of EUR 3 million to run for a minimum of three years. The most important intermediaries for providing information on the technical, financial and social aspects of energy-efficient building renovation are ADEME, ANAH and the Ministry of Housing and Social Cohesion.

Information centres and websites

Communicating with individual citizens is seen as a relevant means of improving residential sector energy efficiency, since they are often those requiring proper information regarding improvement measures. To this end ADEME decentralised its activities through the creation of local information centres. According to WEC/ADEME (2004), 155 local information centres employing 275 advisers were created in France between 2001 and 2003. The budget for their creation was reported to be EUR 15 million per year. Besides campaigns targeting the general public and local information centres, websites are becoming an increasingly relevant information instrument. The ADEME, Ministry of Housing and Urbanism and ANAH websites are well designed to provide specific information regarding energy efficiency improvements in the residential building sector.

Energy audits

Grants for audits were introduced in France in the early 1980s and became significant within a few years. Energy audits that support decisions regarding energy efficiency improvements are potentially an effective policy instrument, especially when combined with other policy measures such as preferential loans, guarantee funds, or subsidies. ADEME subsidises energy audits to support the investment decisions of individuals and institutions. After a period of low activity, subsidised audits re-emerged as a policy instrument in 1999. These include light audits (quick and low-cost decision help), detailed audits (quantification and organisation of technical solutions), as well as feasibility studies, with respective shares of 67%, 23% and 10% between 2000 and 2001. Audits play a role in combination with other measures, for example ADEME's subsidy programme for renewable energy covers up to 50% of pre-diagnostic feasibility studies (ADEME, 2006a). Between 2000 and 2005 about 43 000 buildings were audited. The budget for this activity was on average about EUR 4.4 million with up to 50% of audit costs being subsidised, and the average subsidy per audit was EUR 760.

Labelling

Labels and building energy codes are mutually reinforcing: label requirements provide a basis for future reinforcements and labels, while referring to the mandatory codes in application, and sometimes by surpassing them to a certain degree. Labelling measures are important in enhancing transparency regarding energy efficiency; as for appliances, they can indicate the true energetic cost and impact of a building.

In France a voluntary label for highly efficient buildings, the high insulation label, was created as early as 1980. The label has versions which cover two levels of efficiency, the *Haute Performance Energétique* (HPE) (high energy performance) and the *Très Haute Performance Energétique* (THPE) (very high energy performance). Two others labels have recently been introduced. The low consumption buildings (BBC, *Bâtiments Basse Consommation*) label identifies buildings with between 30 and 50 kWh/m^2 per year of conventional energy consumption. The Effinergie label created by a group of ten institutions limits residential building primary energy consumption to 50 kWh/m^2 per year. Although renovated buildings could in principle obtain these labels they are mainly attributed to new buildings. The label is awarded by organisations certified by the Ministry of Housing and Social Cohesion. To date, there is only one organisation *(société Cerqual)* that attributes HPE labels according to the RT 2005. There are further voluntary labels for building components, for example the NF and *Flamme verte* labels for energy-efficient wood heating systems.

The market penetration rate of the label is particularly high in the social housing sector as compared with the private housing sector (around 19 000 and 4 100 dwellings in 2005, respectively).

Research and development

ADEME currently subsidises demonstration and "exemplary" projects. The latter are projects undertaken for certain building types for the first time on a regional level. The fields covered include high performance building envelope (with a special emphasis on thermal bridges and on air tightness), ventilation, heat generation, electricity efficiency measures, energy systems management, renewable energy use in buildings, and cross-sectoral issues.

Impact analysis and evaluation

The impact of EE policy measures largely depends on their context and the number of barriers that hinder their diffusion. Consequently the real impact of measure can be between 0% and 100% of its potential or anticipated impact (see WEC/ADEME, 2004). A comprehensive quantitative impact evaluation of energy efficiency programmes and policies is difficult to perform accurately. The challenge is to separate the effect of the policy from a hypothetical reference scenario that excludes the EE policy instruments, as well as a variety of other factors. These can include drivers, structural changes, prices, new energy services and autonomous technical progress. Policies can also result in certain effects, such as the free-rider and spill-over effects, which are difficult to separate from policy measure effects proper and can also enhance or reduce their anticipated effects. This difficulty has been all the more present in France; systematic evaluation of public policy has been implemented only since 2001 with the Organic Law relative to Financial Laws (LOLF). Prior to this, *ex-post* assessments of public policy occurred sporadically, leading to a lack of empirical information.

Regarding quantitative evaluation, this section is based on two major sources of information: the evaluation report on the energy efficiency policy of France between 1973 and 1993 (Martin *et al.*, 1998) and the evaluation performed by ADEME in the ODYSSEE-MURE project (ODYSSEE-MURE, 2006). These evaluation studies are complemented with the authors' own estimations based on the ODYSSEE database. According to the first evaluation report, the overall observable energy conservation in existing buildings was estimated to be 460.5 PJ between 1973 and 1993, which corresponds to about 30% of the consumption of 1973; these improvements are the combined result of policy intervention and exogenous factors.

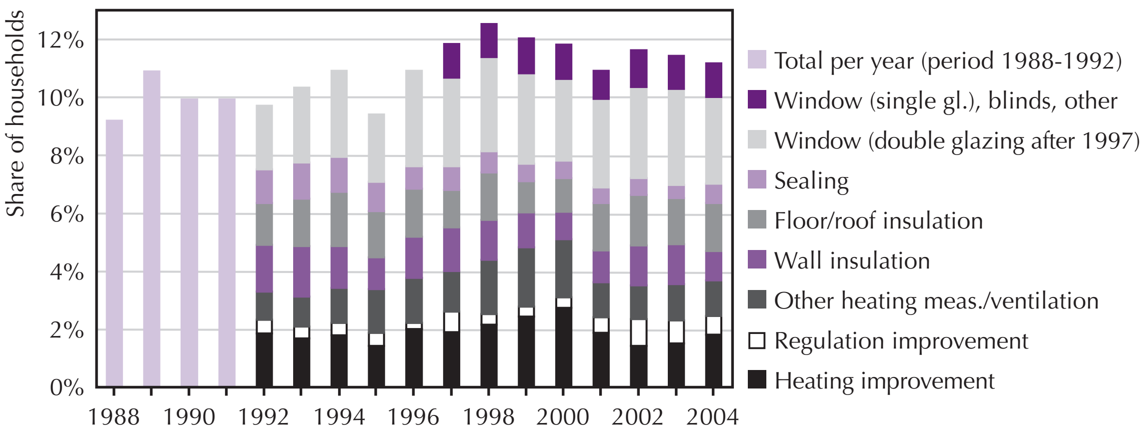
An attempt has been made to estimate the energy efficiency gains in existing residential buildings since 1973. The impact has been assessed using various indicators as a proxy such as EE building improvement works undertaken and the diffusion of energy-efficient building components. Energy consumption level is also examined, since the stated aim of EE policies is often to reduce consumption. Finally, the policies are briefly evaluated using the criteria outlined in the introduction.

Impact analysis

Financial and incentive-based measures

Since 1986 SOFRES has conducted an annual survey of households on behalf of ADEME. The survey shows that since the early 1990s between 9% and 13% of buildings have been affected by energy efficiency improvement works (Figure 49). As can be seen, the major maintenance works undertaken in 2004 concerned window replacement and heating system improvement. At the end of 1999 the reduced VAT rate for building improvement works was introduced, however this did not increase the rate of improved buildings. One could infer that this scheme didn't have a significant impact or at least has been offset by other effects. The VAT rate scheme does not apply to very large renovation work; it might therefore be difficult to see its overall impact, which could affect the quantity of certain types of smaller EE improvement measures. In 2002, 61% of households that invested in energy efficiency improvements benefitted from a VAT reduction; in total 7% of all 25 million French households have invested in renovation work with VAT reduction.

***Figure 49* • Share of households that conducted energy-improvement work**



Source: *Chifftres clés du bâtiment* (ADEME), various years; ADEME (2005b).

Since 2005 fiscal policies have more specifically supported EE improvements in existing buildings, rather than general renovation works. Tax credits are now related to more stringent minimal energy efficiency standards. While the tax scheme has become more specific, there is so far little empirical evidence regarding its impact. First results of the tax credit programme of 2005 showed an increase in individual wood boilers of 127%, an additional 100 000 m² of solar thermal collectors and a doubling in the sale of condensing boilers.

Regarding subsidies, in 2006 ANAH distributed EUR 7.37 million (26 274 grants) to improve the energy performance of dwellings. This represents a 26% increase in the number of grants awarded and a 59% increase in the funding amount from 2005 (Table 23). This marks an increase from the 2004-05 operating year, when the number of grants awarded went up by only 11% despite a funding increase of 59% (ANAH, 2007).

Table 23 • Break down of the number and the amount of grants regarding owner type and energy efficiency category

	Owner-leaser		Owner-occupiers		Total	
	Number	Amount EUR million	Number	Amount EUR million	Number	Amount EUR million
Window grants	11 114	0.9	6 365	0.5	17 479	1.4
Heating grants	1 244	1.1	2 168	2.1	3 412	3.2
Total	**12 358**	**2**	**8 533**	**2.6**	**20 891**	**4.6**

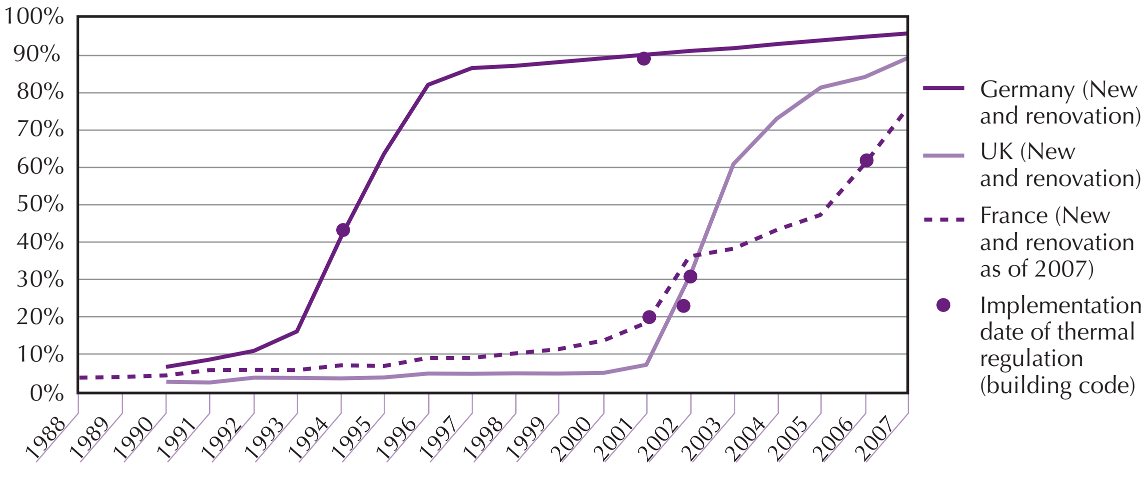
Source: ANAH (2005), *Activity Report for the Year 2005.*

Regulatory measures

In France giving impetus to efficient heating appliances and systems could stimulate technical progress and ensure efficient operation. The evaluation report on the French EE policy (1973-1993) emphasised that the potential of this measure was not tapped since the efficiency standards were far from the current state-of-the art technologies available (Martin *et al.*, 1998). Building codes are relevant in increasing EE and the improved market share penetration of coated glazing (Figure 50).

Energy-efficient coated glazing gained a market share of over 80% in only five years in the UK and Germany, whereas in France the more lenient regulation and low enforcement meant that even the 2000 standards did not lead to significant market transformation (Martin *et al.*, 1998).

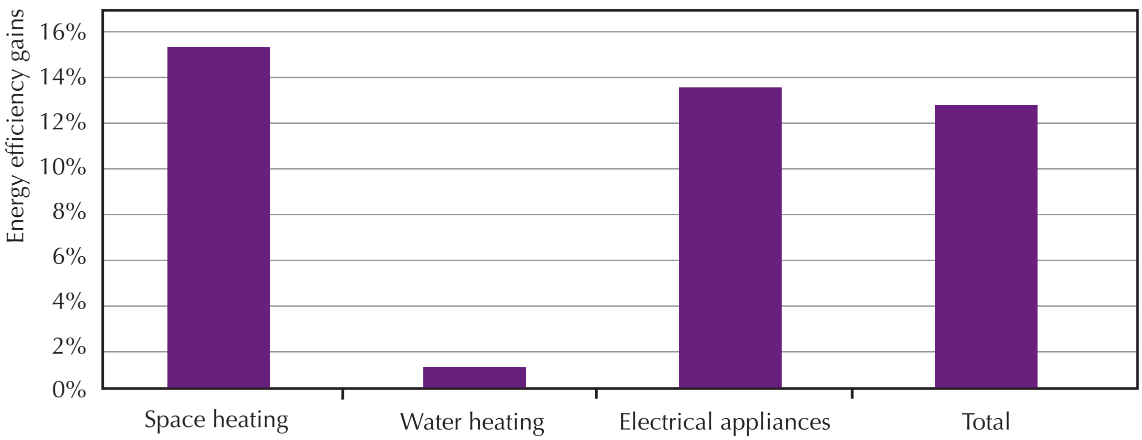
Figure 50 • Market penetration rate of coated glazing following regulation in France, Germany and the UK



Source: Saint-Gobain (2007), personal communication.

Currently less energy is required every year per dwelling for space heating. This is mainly explained by the increasing share of more efficient new dwellings in the total housing stock (MURE, 2006). A quarter of the building stock in 2003 was built after 1982, when the second version of the building code applying to new constructions was implemented. The overall energy efficiency in the household sector improved by 12.6% in 2004 compared to 1990 baseline, due to progress in space heating (15% improvement in EE) and large electrical appliances (13% improvement), whereas water heating and cooking basically remained unchanged (Figure 51) (ODYSSEE-MURE, 2006). Most progress took place until 1997 and since then energy efficiency performance has been relatively stable.

***Figure 51* • Energy efficiency gains in the household sector in France between 1990 and 2004, in %**

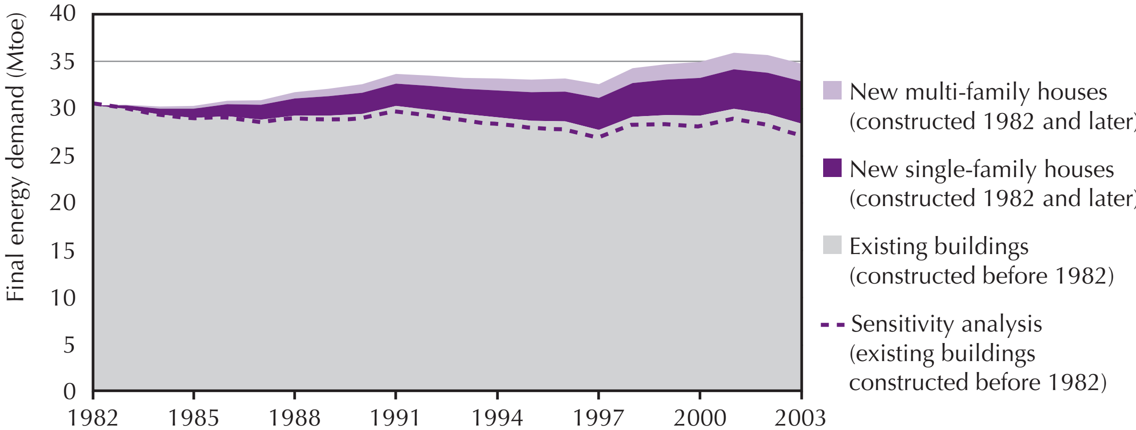


Source: Adapted from ODYSSEE-MURE (2006).

As a result of these changes the average final energy demand was reduced from 18.8 koe/m^2 in 1982, to 15.7 koe/m^2 in 2003, though the figure specific to existing buildings remains unknown. A portion of this efficiency gain is due to autonomous developments, such as the unavoidable replacement of boilers and windows and attic insulation, which implies that policy effects proper may be lower than the figures suggest.

The total final energy demand for space heating in existing buildings can be estimated by using the number of new constructed dwellings and assuming that new buildings meet the requirements of the French building code of the corresponding year and that new buildings were not improved after their year of construction (1982 or later) . The final energy demand for space heating of the existing building stock is then obtained by subtracting the one of the new buildings from the total space heating demand (climate corrected). The result of such estimation is shown in Figure 52 choosing 1982 as a reference year. The final demand for space heating of the existing building stock is reduced by 6% between 1982 and 2003. It can be assumed that this reduction is achieved by the replacement of old heating systems, by thermal renovation of the building envelope, demolition of buildings (eventually counterbalanced by more central heating systems) and/or a change of user behaviour. Presumably, a reduction of 4% to 6% could have been reached by the replacement of heating systems alone,[80] although the diffusion of condensing heating technology is very limited in France (2% and less up to 2003). This would mean that the other EE measures mentioned above haven't shown much effect.

Figure 52 • *Final energy demand for space heating in the residential sector in France*



Source: authors' own calculations, using data from Odyssee Database (Version 4.1).

A sensitivity analysis was made assuming that new buildings do not comply with the version of the thermal regulation that is in force at the year of construction, but only with the previous version. In this case the final demand for space heating of the existing building stock would have been reduced by 11% (instead of 6%) between 1982 and 2003.

Voluntary agreements and partnerships

Creating a market for energy efficiency certificates could be an effective and cost-efficient policy, similar to renewable quotas in the case of electricity. It is too soon to estimate whether a market can be created successfully. It remains to be seen whether penalties for energy suppliers are high enough and transaction costs low enough to create sufficient incentives for EE improvements to be undertaken in existing residential buildings. The specific requirements of the certificates for the buildings sector remain rather moderate; they target insulation measures requiring five to ten cm of insulation and window replacement with windows with an upper limit U-value of 2.0 W/m^2. Very few white certificates were available in France in 2007: only 280 kWh cumac have been generated, that is, 0.05% of the fixed triennial goal (2006-2009).

Information and capacity-building programmes

The technical advice proposed by audits was implemented in a large number of buildings during the early 1980s (Martin *et al.*, 1998).

80. For instance, in Switzerland the weighted average efficiency of the stock of oil heating systems increased from 72% in 1990 to 82% in 2000 and the one of natural gas heating systems from increased from 75% in 1990 to 87% in 2000 (including the effect of new buildings), see Aebischer et al. *2002.*

According to the MURE case study on financial measures across the EU (Fenna, 1999), 12% of dwellings were audited between 1983 and 1988. It was estimated that 80% of these audits were followed by improvement works, saving 62.8 PJ. The social housing sector gained the most from these subsidies. Between 2000 and 2005, about 43 000 buildings were audited; the budget for this activity was about EUR 4.4 million on average. The rate of subsidies was up to 50% of audit costs, with an average subsidy per audit of EUR 760.

Auditing activity was resumed only at the end of the 1990s, but at a lower level than in the 1980s, especially in the residential sector. Audits mainly concerned the service sector, dwellings and associations accounted for 10% of buildings audited. An impact analysis regarding the period 2000-2001 showed that recommended actions were implemented in 55% of cases. Not all the recommended actions for each case were actually implemented, resulting in a rate of 36% of measures actually undertaken. Moreover the implemented projects were on a small scale; a quarter of them involved no investments and the average investments made were of EUR 8 900 per building. However, it is unclear whether the audits directly triggered the adopted measures. In this case audits would play an advisory role for those already decided on undertaking improvements rather than stimulating the decision. WEC/ADEME (2004) summarises the impact of audit programmes as follows: "The success of audit schemes probably depends greatly on the general context of energy prices and the availability of other measures, such as financial incentives."

As for local energy information centres, a recent poll shows that 80 000 contacts were taken with the 115 local information centres, of which 84% from households with a 90% rate of satisfaction. Of the recommended investments, 25% were actually implemented (including large investments) and the average sum invested on the recommendation of each advisor amounts EUR 730 000. According to the most recent MURE report regarding France (2006), 26% of households actually invested after having consulted a local information centre, with an average investment of EUR 7 650 per action and EUR 9 130 per household; 14% decided not to invest. As with the audits, it is unclear whether these measures would have been taken regardless of the information centres.

Evaluation

Regulatory measures

According to an expert from ADEME, recent policy has not changed the number of renovation projects undertaken, but rather the scale of the works: when work is conducted, the extent of renovation is larger. More stringent regulations can lead to more comprehensive renovation being undertaken, particularly when combined with financial assistance and tax incentives.

The example of diffusion of coated glazing in the UK and Germany shows it is possible for glazing and window manufacturers to adjust their production facilities in a relatively short time period, providing that clear and reliable boundary conditions are formulated and updated regularly. Hence, a further stimulus is expected from the reinforcement of the building code of 2005, which for the first time makes these mandatory for existing building renovations. More ambitious standards and mandatory replacements of boilers after their economic lifetime (typically 15 to 20 years) rather than their technical lifetime (20 to up to 30 years) would increase tenfold the efficiency of space heating (ADEME, 2005b). Concerted action with professional associations representing manufacturers and building professionals is planned. Clarity and flexibility, along with close cooperation with the relevant actors, are necessary to make this policy sustainable.

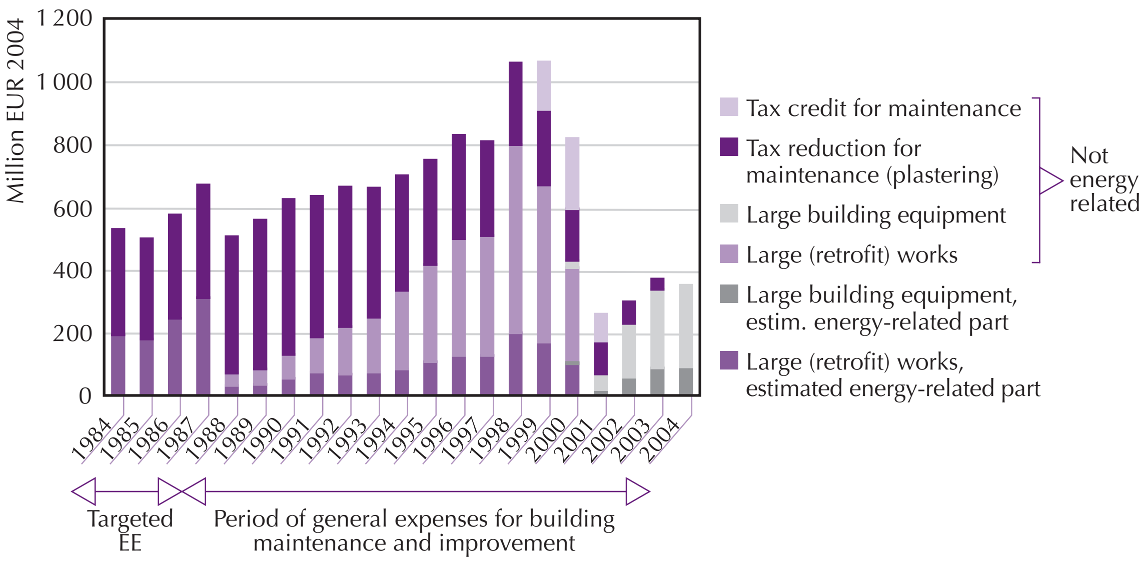
On the whole building codes, being clear and relevant, potentially have a very large long-term impact on improving EE in existing residential buildings, depending on their implementation. Were they mandatory for the entire building stock or for the portion of least efficient buildings, the impact could be very large.

Financial and incentive-based measures

Fiscal measures are potentially powerful instruments to improve the energy efficiency of buildings. Between 1987 and 2004 this instrument was hardly used to its full potential; tax schemes changed the relative prices between energy efficiency measures and energy costs, but not between general renovation work and EE improvement renovation. Fiscal measures have become more relevant to addressing barriers to EE since 2005, which tax credits being related to more stringent minimal energy efficiency standards.

The forgone tax revenues can serve as an indicator of the impact of a fiscal policy measure (Figure 53). The various versions of the tax schemes did not specifically encourage energy efficiency. At best, energy efficiency was promoted parallel to the rest of the retrofit market. Assuming a price elasticity of 0.4 to 0.6, the retrofit market would have been presumably 5% to 15% lower without the tax schemes.

Figure 53 • Breakdown of public effort (forgone income taxes) of building maintenance and retrofit tax schemes of principal residences (Euro 2004)



Source: *Compte de Logement* (Table 314), Martin *et al.* (1998), Insee, *Comptes nationaux, Base 2000* (GDP price index), authors' own estimations.

Fiscal schemes that target the rental sector can be particularly relevant for overcoming the principal-agent problem which often leads to the energy-efficient potential of existing buildings not being fulfilled. These are often combined with subsidy schemes, like those for property tax exemption. However these schemes do not always specifically target EE, their aim being to improve the living standards of low-income households.

Subsidy schemes increase their relevance when targeted at both owner-occupiers and owners of rented housing units, as with ANAH subsidies. These do not as yet specifically target EE improvements and it is too soon to determine the impact of bonus amounts awarded for measures that improve EE in place since 2006. In the social housing sector however, subsidies are increasingly targeting EE, and acting as leverage for preferential loans with financial institutions. However EE requirements and the amount subsidised for these measures remain limited.

It is hoped that fiscal incentives will continue to be more relevant and targeted at improving EE. To ensure these policies are clear, they must be combined with more active information campaigns to make them known, and to provide advice regarding the types of measures to be undertaken and the financial assistance and incentives available. Fiscal incentives in combination with other policies more effectively address the financial barriers to undertaking EE improvements.

Voluntary agreements and partnerships

Preferential loans are becoming increasingly relevant in directly targeting EE improvements in the existing residential sector. The launch of saving products designed for sustainable development investments in 2007 will provide financial institutions with the means to develop housing loan offers aimed at improving energy efficiency. Individuals are encouraged to use these saving products through fiscal incentives. Financial institutions can use established regulations such as the RT 2000 to determine their loan schemes. Various policy measures thus must come together to be relevant and effective. Loan conditions can also be modified to account for changes in regulations and technology, making it a flexible measure. Several institutions offering the loan also leads to competition and therefore increased consumer choice. This can stimulate greater specialisation in housing loans targeting energy efficiency. Transaction costs must however be kept low, and clarity is important in ensuring various stakeholders are aware of the financing options available to them.

White certificate type schemes have resulted in significant energy efficiency improvements elsewhere, such as in the UK and in California. Current white certificates are not highly ambitious in the measures that target existing residential buildings. Given that once a building is well insulated the marginal costs of further improvement are very high, maintaining current white certificate requirements could in the long run hinder France's ambitious long-term energy and climate change policy goals (see Jakob *et al.*, 2002). The tradable nature of the certificates can potentially create a sustainable market for energy efficiency. The demand for certificates can stimulate the activity of energy service companies, training schemes for professionals, and provide impetus for energy efficiency auditing and certification in the residential building sector. The scheme's review after three years should ensure that it remains flexible while still being clear to stakeholders. To be sustainable it must also be prolonged beyond this period and be kept in place long enough.

Information and capacity-building programmes

Information programmes are essential in supporting other policy measures; they can contribute to making them clear to relevant actors and therefore more likely to be implemented. Thus far it appears that local information centres are successful in reaching stakeholders concerned with improving EE in existing residential buildings, and tackling the information barrier that often impedes decisions to invest in improving energy efficiency.

Implementation of the EPBD requirement for energy performance certificates should stimulate economic activity in this domain. The current regulation's application is limited in regards to existing residential buildings, which is why the voluntary schemes which currently exist remain relevant. The new mandatory standards can potentially stimulate a shift in the housing market toward more voluntary audits and certificates, since these are still not widely used for renovated or existing buildings. The current price of an energy performance audit is between EUR 150 to EUR 300, which is relatively affordable. It is expected that new certification measures for auditors starting on 1 November 2007 will improve the reliability of audits as well as structure the energy services sector (ADEME, 2007b).

Conclusion

From 1996 onwards, France undertook policies targeting improved energy efficiency, spurred by concern regarding climate change and environmental issues. A national debate on energy and the fear of decreasing commitment to climate goals resulted in the White Book on energy in 2003 and the Climate Action Plan in 2004. In these documents energy efficiency was recognised as a major pillar to reach environmental goals, security of supply and competitiveness. Accordingly, a multitude of actions were re-enforced or newly created and led to a comprehensive set of economic (preferential loans, tax credits, reduced VAT, direct subsidies), regulatory (code reinforcement, labels) and information measures, implemented by public authorities and the private financial sector. Several of these measures were specifically designed for the improvement of existing buildings.

Though it is premature to predict the reaction of the markets and the different market actors, the potential impact of this coherent set of policy measures should be considerable. A constant activity pattern, one that is independent of the business cycle, as well as tightened EE technical requirements would be needed to ensure a significant impact and reach overall societal optima.

Although considerable public funding has been allocated to the housing sector, only a minor part is allocated to energy efficiency improvement. In terms of consumer behaviour theory, measures in the residential sector act on the income effect, that is, they attempt to increase income available for undertaking energy efficiency improvement measures. For energy-efficient building improvement, they have not affected the price of energy-efficient options as compared to regular ones. Market transformation is necessary to stimulate this shift, and the package of policy measures put in place has the potential to stimulate this. Energy efficiency has nevertheless improved and had an impact on energy use. Given the various drivers in the residential sector, without any EE improvement the rise in residential sector energy demand certainly would have been higher.

France has given impetus to its policies and put in place some promising instruments, most of them coming into effect as of 2005 or 2006. The strength of these policies is that they are packaged together. Comprehensive information measures include general information campaigns, local information centres, labels and decision support tools. These are combined with specific economic incentives including tax credits and tradable certificates that are conditioned to energy efficiency criteria. Higher energy prices would promote increased energy efficiency, as it has in the past. However it is important that policy activity be sustained, even at a counter-business cycle pace, in order to achieve market transformation and become integrated in economic activity. A sustained policy approach is necessary to reach overall societal optima and avoid partially tapped potentials.

Chapter 7 • GERMANY

Introduction

Germany has a long history of targeting energy efficiency (EE) in existing buildings. Ordinances aimed at lowering energy consumption in buildings have been in place since the mid-1970s. Policy packages aimed at addressing barriers to improved EE in existing buildings took off mainly starting in the year 2000, with tax reforms, information programmes and low-interest loan programmes all taking hold. Germany has one of the most ambitious carbon dioxide (CO_2) emissions reduction targets and climate change mitigation programmes amongst EU member states. Its renewed emphasis on tackling barriers to EE in existing buildings forms part of this initiative.

This chapter will provide an overview of both past and present policies targeting EE in existing residential buildings, taking into account Germany's particular historical and political context and energy policy aims. Key actors, both governmental and non-governmental, will be identified. Major policies will be outlined, followed by an assessment of their impact to date and an evaluation of their potential effects.

National context and policy framework

National context and energy profile

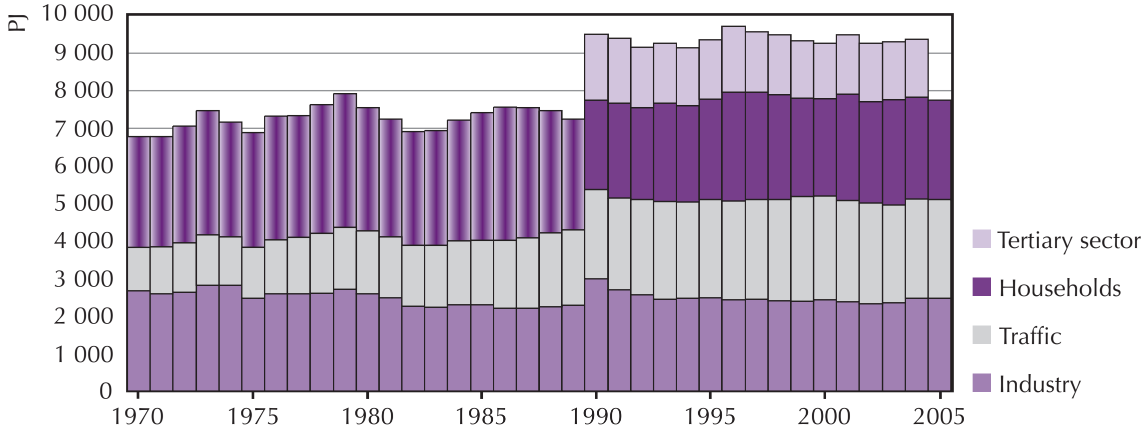
The 1973/1974 oil price shock led to Germany's first regulation of energy consumption. This chapter will begin with an overview of the context that energy efficiency policies addressing existing residential buildings are enacted within. Germany's energy profile and housing market will be examined to establish whether such policies are relevant.

Energy profile

In 2004, the final energy demand in Germany amounted to 9.329 PJ. The share of the residential and tertiary sectors amounts to more than 40% of the final energy demand (Figure 54). The drop in consumption after the oil price shocks of 1973/1974 and during the period of high prices in the mid-1980s can clearly be discerned in the figures for the former Federal Republic of Germany (FRG). However each of these periods was followed by a more sustained increase in consumption once the prices dropped again.

The long-term trends reveal that German industry managed to decouple energy consumption from economic growth as early as the 1970s. Energy consumption in West German industry decreased almost constantly until 1990 due to efficiency gains and structural changes, and was

Figure 54 • ***Breakdown of final energy consumption into sectors; figures from 1970-1989 for the former FRG (tertiary sector and households together), 1990-2005 for Germany***



Source: *Arbeitsgemeinschaft Energiebilanzen* (2006), *Arbeitsgemeinschaft Energiebilanzen: Energiebilanzen 1970 – 2005* (Working group on energy balance, 1970-2005); BMWi (2006), *Energiedaten 2006* (Energy Data 2006), *Bundesministerium für Wirtschaft und Technologie* (BMWi) (Federal ministry of economics and technology), Berlin.

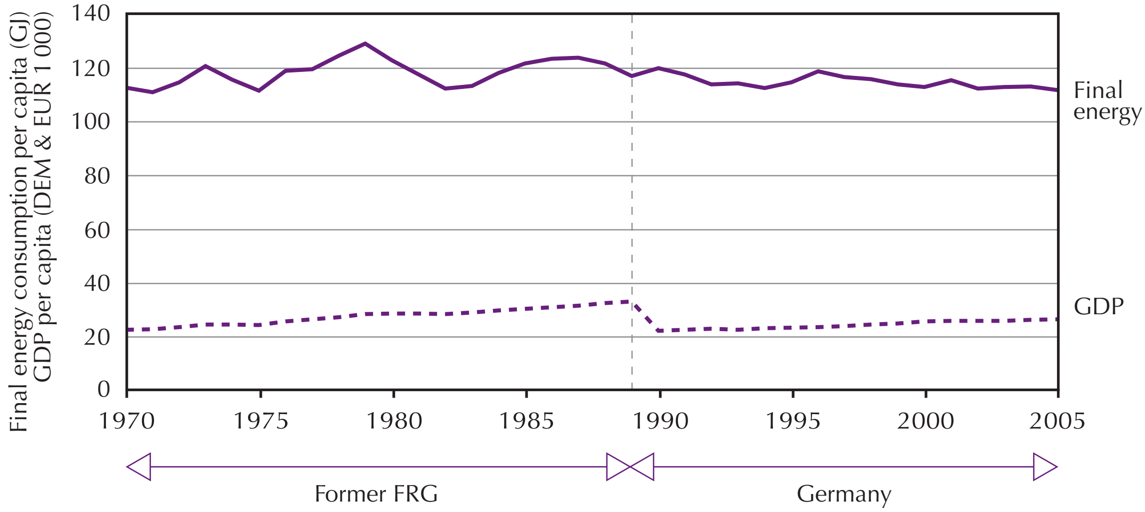
not greatly influenced by the oil price shock. The steep drop in industrial energy consumption from 1990 to 1993 is related to the collapse of industry in the former German Democratic Republic (GDR).

The consumption of households and the tertiary sector has remained constant in the long term; only the transport sector has shown a rising trend since 1970. This indicates that energy efficiency gains can limit energy consumption. As indicated in the above figure, households form a significant portion of final consumption, and thus are a valid target for energy efficiency improvement policies.

The oil price shocks also affected final energy consumption per capita (Figure 55, upper curve). The highest per capita consumption was 128.6 GJ in 1979, with an FRG population of 61.4 million. Since 1990 per capita energy consumption has been decreasing slightly; in 2005 it was 111.2 GJ with a total population of 82.5 million, and has remained more or less constant since 2002. The GDP per capita (Figure 55, lower curve) increased steadily from 1970 to 1989 at a rate of 2.27%; since 1990 the average increase has fallen to 1.47%.

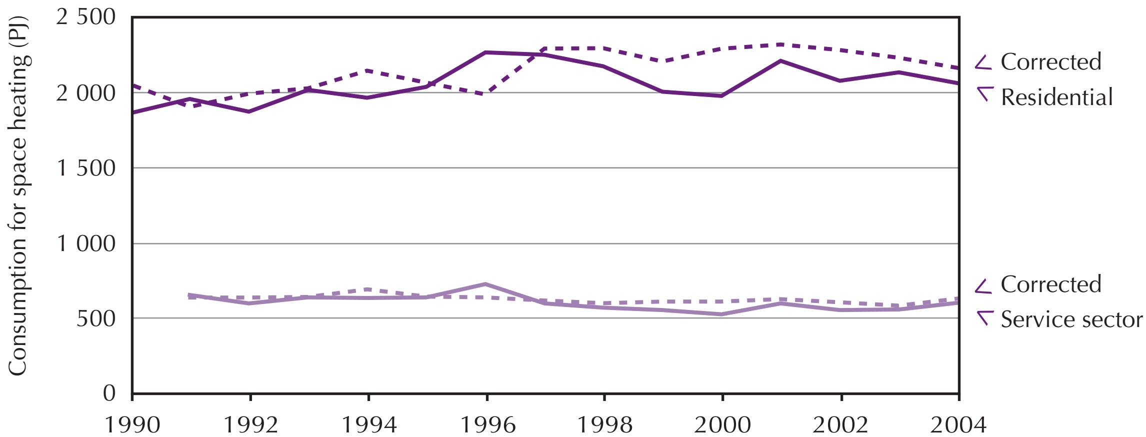
Most energy is consumed for mechanical purposes (transport, machinery); space heating is the second biggest end-use energy consumption source followed by process heat (see Table 24). The residential sector accounts for a significant portion of space heating consumption, as seen in Figure 56, which shows both total consumption and calculated consumption accounting for climate factors from 1990 to 2004. Apart from 1991 and 1996, each year was warmer than the long-term average, meaning that actual consumption was lower than indicated by consumption calculated to account for yearly climate variations.

Figure 55 • *Total final energy consumption per capita and GDP per capita*



Source: Stabu various years. GDP per capita up to 1989 is a 1 000 DEM/1985 and from 1990 is in 1 000 EUR/2000.

Figure 56 • *Consumption of final energy for space heating in residential buildings and in the service sector, with and without adjustment for climate influence*



Source: Odyssee, 2006.

Despite its widespread use in existing residential buildings, energy consumption for hot water and lighting remains marginal in terms of final energy consumption (Table 24 below).

Table 24 • ***Final energy consumption 2004*** *(all sectors)*

Application	PJ	Percentage
Mechanical energy	3 678	39.4
Heating	3 057	32.8
Process heat	1 920	20.6
Hot water	484	5.2
Lighting	191	2
Total	**9 329**	**100**

Source: BMWi (2006), *Energiedaten 2006* (Energy Data 2006), *Bundesministerium für Wirtschaft und Technologie* (BMWi) (Federal ministry of economics and technology), Berlin.

Next, an overview of the housing sector in Germany will help identify whether targeting the existing residential building sector is relevant to reducing energy consumption and CO_2 emissions, and whether policies that do target this sector are viable.

Housing sector

Age and heating structure

Official statistics only cover the number of residential buildings, none exist for the tertiary sector in Germany. Table 25 shows the number and age structure of residential building units in Germany. Although the average lifespan (with external influences) of the buildings is estimated to be about 100 years due to the solid construction style, fewer than 30% of the dwellings are older than 50 years mainly due to the destruction resulting from the Second World War.

Nearly half of all dwellings in Germany were built between 1949 and 1978. Shortly after World War II buildings tended to be put up quickly, without much care or planning and with only marginal insulation. In 1978, the first German Thermal Insulation Ordinance came into force; it was later amended in 1986 and 1995.

Energy use in the residential sector

In 2002, about half the dwellings in Germany were heated by natural gas and one-third by domestic fuel oil; 14% were heated by district heating and 4% by electricity. Lignite heated 1.3% of dwellings, most of them in the East German *Länder,* and about 1% were heated by wood and other renewable energies (StaBu, 2002).

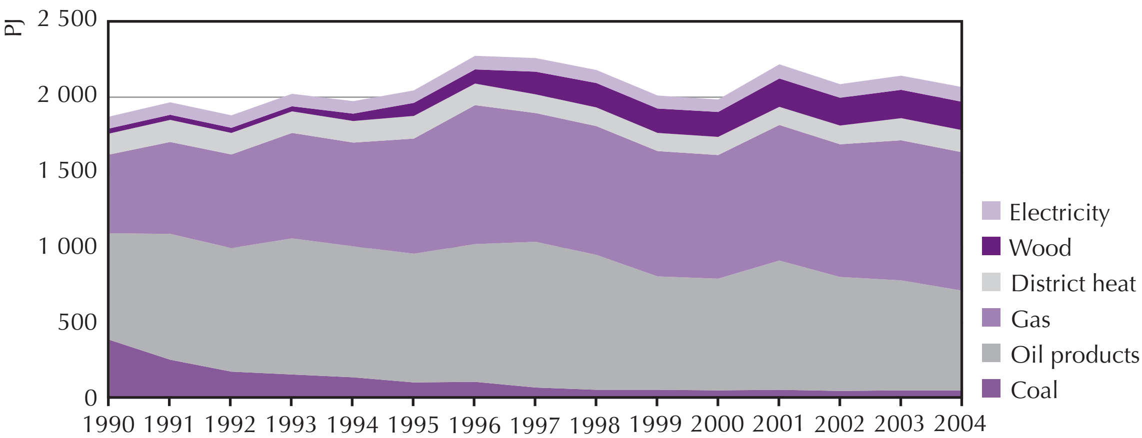
The use of hard coal and lignite dropped sharply starting in 1990, but has remained almost constant at about 50 PJ since 2000 (see Figure 57). During this period the share of gas in final energy consumption for space heating increased from 28% to 44%, while electricity and district heat have remained steady since 1990. The share of wood and other renewables is now five times higher than in 1990, but still only made up 9% of the final energy consumption in 2005. Overall growth in the use of other energy sources was at the expense of heating oil which fell from over 40% in 1990 to 32% in 2005.

Table 25 • ***Age structure of dwellings in residential buildings in Germany 2002***

	Number of dwellings (in 1 000) for different building size categories (expressed as number of dwellings per building)						Total	
Age	1	2	3-6	7-12	13 - 20	> 21	Number	%
Before 1900	1 050	736	639	302	66	20	2 813	8
1901-1918	490	443	621	552	133	28	2 267	6.5
1919-1948	1 338	957	1 188	807	94	45	4 429	12.6
1949-1978	4 012	2 900	3 771	3 722	785	1 452	16 642	47.4
1979-1986	1 226	648	610	806	227	329	3 846	10.9
1987-1990	390	171	190	238	84	62	1 135	3.2
1991-2000	1 357	546	800	692	201	142	3 738	10.6
2001 or later	116	36	45	44	8	7	256	0.7
Total	**9 979**	**6 437**	**7 864**	**7 163**	**1 598**	**2 085**	**35 128**	**100**

Source: StaBu (2002), *Microzensus 2002* (Microcensus 2002), Federal Statistical Office, *Fachserie* 5, *Heft* 1, Berlin.

Figure 57 • ***Breakdown of space heating in residential buildings by type of energy 1990-2004***



Source: Odyssee, 2006.

Potential of refurbishing existing buildings

The technical potential of refurbishing old buildings was estimated to affect about 70% of total heating energy consumption, and thus about 2 000 PJ, by the first Enquete Commission of the German Parliament in 1990 (Enquete, 1992).

Taking the renovation cycles of the building envelope into account (windows, outside walls, roof etc.), existing older buildings could potentially reduce total energy consumption by about 19 PJ of useful energy (5.275 GWh) annually between 2002 and 2012, if the Energy Conservation Ordinance (EnEV) building component standards were applied; in ten years the annual savings would add up to about 190 PJ (IFEU and IWU, 2005). This is economically viable since all the measures demanded by the EnEV have been tested for economic efficiency.

However in practice this potential cannot be fully exploited. Firstly because the implementing regulations in the EnEV contain many restrictions, and secondly because owners do not always follow renovation cycles even if doing so is profitable. The potential is thus reduced to 8.2 PJ (2.284 GWh), or to 6.1 PJ (1.688 GWh) annually if deficiencies in implementation are also taken into account. In ten years, this results in an annual achievable saving of 61 PJ.

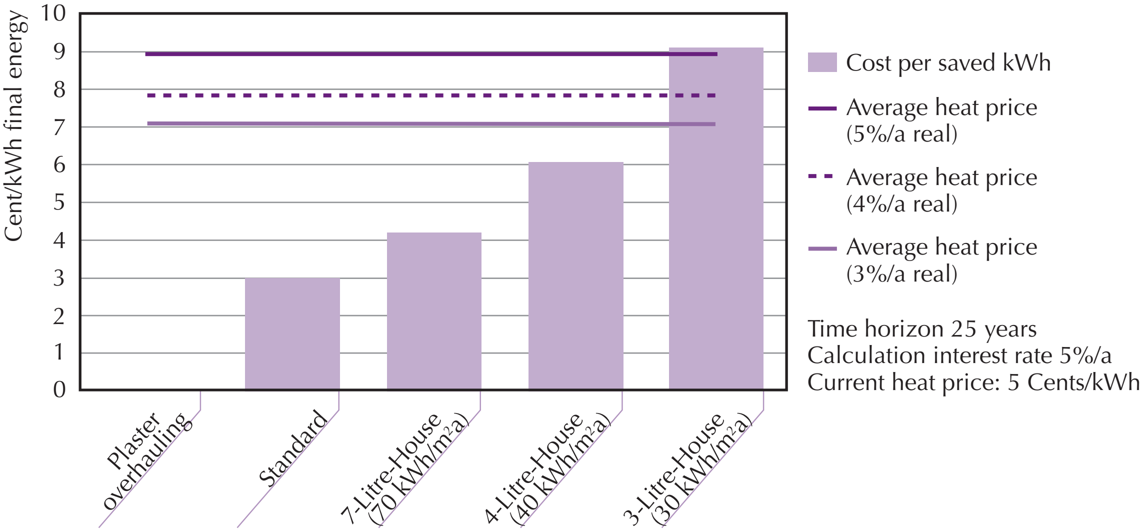
Economics of renovation

A study of the Institute for Housing and Environment *(Institut Wohnen und Umwelt GmbH)* (IWU, 2006) analysed the economic efficiency of different refurbishment measures undertaken in a residential district in Ludwigshafen. The study concluded that, under the assumed frame conditions, measures which result in an energy consumption as low as 40 kWh/m²a are economically viable. This is valid for owner-occupiers and does not apply to rented accommodation in buildings, since building owners who lease out property can only regain their invested capital to a certain extent by raising the rent due to legal restrictions. Eleven percent of the costs for comfort related measures can be passed on in rent increases.

The result of the cost-effectiveness estimation for the case of owner-occupiers is represented in Figure 58. The discounted renovation costs per kWh of saved energy are compared with the average price of useful heat for three different scenarios. The price for heat is assumed to be EUR 5 cents per kWh at the beginning of the considered period and then assumed to rise at three different rates per year. The left-hand column shows the reference case where only plasterwork is renewed without additional thermal insulation and where savings, and thus the additional energy costs, are zero. The variants "Standard" (insulated according to EnEV) and *"7-Liter Haus"* (7-litre house, consumption 70 kWh/m²a) with costs of approximately EUR 3 and 4 cents per kWh saved are economic today even without price increases (the costs are below the average price of heat). The *"4-Liter Haus"* (4-litre house, consumption 40 kWh/m²a) becomes economic in the case of the scenario of low energy price increases (3% per annum), whereas the 3-litre house (consumption 30 kWh/m²a) only becomes economic at price increases of more than 5% per annum.

Renovations that improve EE are therefore economical, even when undertaken beyond current EnEV regulations. The following section looks at the housing market in Germany, including ownership status. This helps determine who invests in EE measures in the residential sector, and therefore whom policies should target.

Figure 58 • *Price for the kWh of final energy saved after the necessary refurbishment of a house and the base cost of refurbishment separated from the additional cost of insulation*



Source: IWU (2006) (ed.), *Energetische Gebäudesanierung und Wirtschaftlichkeit: Eine Untersuchung am Beispiel des "Brunck-Viertels" in Ludwigshafen,* (Energy retrofit and economics: An analysis using the example of the "Brunck" neighbourhood in Ludwigshafen), Institut Wohnen und Umwelt (IWU), Darmstadt.

Market assessment

The rate of home ownership is rising strongly in Germany (see Table 26). This is due to a conversion of previously rented dwellings in multi-family buildings into private property (including co-property) rather than to an increase in the number of single-family houses being built. Co-properties in multi-family buildings represent an additional barrier to renovation of shared parts of the building, such as the building envelope, due to the larger number of owners and therefore decision makers involved.

Table 26 • *Home ownership rate 1993-2002*

	1993	1998	2002
Ownership rate	38.8 %	40.9 %	42.6 %

Source: StaBu (2006), *Statistisches Jahrbuch 2006* (Statistics Yearbook 2006), Federal Statistical Office, Berlin.

Most of the approximately 10 million single-family houses are probably occupied by their owner, apart from which there are about another 5 million owner-occupied dwellings (multi- and single-family). With the change in ownership of 1% per year given above, the resulting market has approximately 150 000 single-family homes and owner-occupied apartments and about 70 000 multi-family homes. With 20 million rented accommodation units, about 2 million apartments change tenants each year according to the above calculation. Tenant changes occur more frequently than home ownership ones, at rate of 10% per year.

In 2004, a total of EUR 78 billion was invested in the modernisation of residential buildings in Germany (Heinze Wohnbau, 2006). The market for modernisation thus exceeds the market for new houses by 60%. The owners of single-family homes made the largest share of investments with EUR 40 billion, followed by private landlords of multi-family homes with EUR 18.5 billion.

The investments were spread across many product areas, some of which are listed in Table 27.

Table 27 • Investments in products in residential buildings, 2004

Product	Billion EUR	Percentage
Roof modernisation	8.7	11.2
Extensions/conversions	8.4	10.8
Heating	8.3	10.6
Facade	7.4	9.5
Sanitary	6.5	8.3
Floors	5.3	6.8
Windows	5.2	6.7
Other	28.2	36.1
Total	**78**	**100**

Source: Heinze Wohnbau (2006), *Modernisierungsmarkt im Wohnbau, Studie der Heinze Marktforschung* (Residential building modernisation market, study of Heinze Market Research), Celle 2006.

EWI/Prognos (2005) estimate the frequency of energy-related refurbishment of older buildings to be about 1% per year for one- and two-family houses and about 1.2% for multi-family houses. These rates apply to measures necessary for building preservation and not to specifically targeted measures such as EE improvements.

Climate indicators

The climate in Germany is fairly uniform, with 3 919 heating degree days (HDD) being the mean of the past 30 years.[81] When performing heating demand calculations, Germany is divided into 15 climatic zones represented by 42 meteorological stations.

The mean HDD of the zones vary from 3 370 to 5 369, those of the locations from 3 125 to 6 052. HDD which are noticeably above 4 000 are located in low mountain ranges, but most people live in areas with HDD between 3 200 and 4 000, represented by a mean HDD value of about 3 600. Cooling degree days are not used or defined in the German climate.

81. HDD are computed as the difference between the mean temperature of a day when above 15 °C and the mean indoor temperature of 20 °C according to VDI 2067 page 2.

The overview provided above shows that existing residential buildings form an important part of the housing market, and represent a large potential for cost-effective energy efficiency improvement measures to be undertaken. Policies that address barriers to existing buildings meeting their energy-efficient potentials are therefore relevant and viable. The following section exposes the framework for measures targeting energy efficiency in existing buildings and Germany's overarching energy policy goals.

Policy and institutional framework

Introduction

The first political efforts in the domain of energy efficiency occurred in the early 1970s. Prior to this, energy had been available in sufficient quantities and at an acceptable price. Even so, regulations on the thermal insulation of buildings already existed as stipulated in the DIN 4108 "Thermal insulation and energy economy in buildings". These were however of minimum impact, intended only to avoid structural damage. In 1976, the EnEG (*Energieeinsparungsgesetz,* German Energy Conservation Act) was passed which formed the legal foundation for further measures – in particular the WSchVO (*Wärmeschutzverordnung,* German Thermal Insulation Ordinance) which became effective in 1978. The primary objective at that time was to reduce Germany's dependence on mineral oil imports. The focus was on security of supply problems and reducing the strain imposed by the import budget. Political interest then shifted towards sustainability and environmental protection with the establishment of the Ministry of the Environment in 1986 (following the Chernobyl disaster). The second large increase in the price of oil at the beginning of the 1980s led to the first amendment of the WSchVO in 1984. By the time the second amendment of the WSchVO took place in 1995, the political objective had moved towards sustainability and climate protection. The enormous energy saving potential of building renovation was identified early on, and subsequently quantified in large-scale studies (Enquete, 1992).

Germany's plan to reduce CO_2 emissions, presented in 1990, had the most ambitious objectives when compared internationally. In the 1992 Rio Convention and Agenda 21 discussions, Germany strove for a global reputation as a pioneer in environmental policy. Since the end of the 1980s, energy efficiency policies aim to mitigate climate change by reducing CO_2 emissions. In the EU burden sharing agreement based on the 1997 Kyoto Protocol, Germany agreed to a substantial emission reduction share of 21% in the 2008-2012 period. In the long term, up to 2050, the aim is to cut CO_2 emissions by at least 80%, according to the Climate Protection Enquete Commission of the German parliament.

Past and present goals

The energy efficiency measures first taken following the oil price shocks targeted savings in the transport sector. It was soon recognised that existing buildings harboured a large, perhaps the largest, saving potential. Unfortunately, the technologies required to exploit this potential either did not exist at that time, or were not yet mature market products and had to be developed first. Through supporting technological development and demonstration projects, the foundations were laid to tackle the energy saving potentials in buildings by the mid-1980s. This also allowed energy saving target estimates to be elaborated as these were both clearer and achievable.

Since the beginning of the climate debate, German policy – more or less independent of political party factions – has approached reducing CO_2 emissions seriously and worked hard towards realising this. As early as 1990, the federal government decided to reduce CO_2 emissions by 25% by 2005 and take the measures necessary to do so. This target was modified to 21% for Germany by 2008-2012 in the Kyoto Protocol, which was unanimously accepted by the German Parliament in 2002. Increasing energy efficiency in all sectors, particularly in existing buildings, forms an important element in reaching these ambitious goals.

The Coalition Agreement of September 2005 established goals targeting EE improvements in existing buildings. The energy efficiency level of 5% of buildings built before 1978 is to be increased every year. This is to be achieved through an increase in funding of the CO_2 Building Modernisation Programme (also known as the Building Rehabilitation, Renovation or Retrofit Programme) to at least EUR 1.5 billion per year, by extending its duration to 2011, and by significantly improving its efficiency and attractiveness (for example by switching to investment grants and tax relief measures and by including rental accommodation). It also planned to introduce an "energy passport" (energy performance certificate) for buildings. In the international arena, the Agreement proposed to further develop the national climate protection programme and to introduce additional measures to ensure Germany reaches its Kyoto target for 2008-2012, with the EU committing itself to a 30% reduction in its greenhouse gas emissions by 2020 compared with 1990 levels. Given this, Germany would be willing to strive for an even greater reduction in its emissions.

The German federal government has, in its National Climate Protection Programme, committed itself to reducing CO_2 emissions in its portfolio by an average of 30% in the 2008-12 period compared to 1990 levels. This clear signal is intended to show that the government is living up to its image as a role model and contributing to meet the national climate protection target.

Maintaining the structure of the housing stock while modernising and adapting it to people's changed housing requirements, along with reducing energy consumption, is a prioritised measure for achieving climate change mitigation goals.

In addition, the EU Directive 2002/91/EC (EPBD – Energy Performance of Buildings Directive) is bieng implemented, which will see the EnEV adapted to EU standards. This consists in specifying the information contained in the energy performance certificate label (discussed further below), since the EnEV's requirements are otherwise more stringent than the EPBD.

Policy framework

Legislation is the responsibility of the federal government. However, the majority of laws have to pass through the *Bundesrat* (German Federal Council) – the second chamber which represents the *Länder,* or states, at the federal level. As a result, the *Länder* also have a say in federal laws. The German Federal Building Code (*Baugesetzbuch,* BauGB) forms the basis for building legislation, which stipulates the urban land use planning procedure and thus also the EnEG and the EnEV. The

German *Länder* are subject to federal law but have planning sovereignty in their region. Each *Land* has its own state building code, although these are to be increasingly harmonised as a result of the *Musterbauordnung* (Model Building Regulation) passed by the Construction Ministers' Conference *(Bauministerkonferenz)* in 2002. Local authorities represent the final level of jurisdiction in building construction; it is they who grant building permits and inspect construction work.

At the beginning of the 1970s, the general framework for an effective energy efficiency policy had to be created. This was done by passing a framework statute, the 1976 *Energieeinspargesetz* (EnEG) (Energy Conservation Act on energy conservation in buildings) which made it possible to enact the Thermal Insulation Ordinances.

The EnEG, which was amended in 1980 and 2005, forms the basis for the federal government to pass detailed ordinances on energy conservation. These prescribe the thermal insulation of new and existing buildings, the installation and servicing of heating systems and other special regulations. In the 2005 amendment, the government is required to implement the EU directives (particularly the EPBD) and introduces energy performance certificates. An important clause of the EnEG specifies that stipulated measures have to be economically justifiable.

The EnEG led to the Thermal Insulation Ordinances (*Wärmeschutzverordnung* of 1978, 1984 and 1995), to the 2002 EnEV with amendments in 2004, and other regulations such as the decree on the consumption-based billing of heating and hot water costs for multi-family homes, and the heating systems regulation.

The first *Wärmeschutzverordnung* (WSchVO) was passed in 1977/1978[82] under the influence of the first oil price shock. It was revised and intensified in 1982/1984 during the second period of high oil prices. Pressing concerns about climate protection led to a further increase in the standards for building envelope insulation in 1994/1995. The requirements were raised by about 30% in these three stages and an energy certificate was introduced in 1994/1995.

In 1990 the federal government set up an inter-ministerial task force (IMA) on CO_2 reduction headed by the Federal Ministry for the Environment. Its reports contain analyses of the situation and propose policy measures which define the national climate protection programme. The sxith report of the IMA CO_2 Reduction of 2005 presents the current national climate protection programme; improving EE forms part of the CO_2 emissions reduction strategy.

The measures aim to raise the energy conservation standards set for newly constructed buildings in the WSchVO or the EnEV by approximately 30% every ten years or so. Increasing energy conservation standards for individual building components in existing buildings is also planned. This stage-by-stage improvement plan is limited by the EnEG requirement that the measures proposed must be "economically justifiable". Obstacles to improved EE in the legal framework are also to be removed as much as possible.

Financial constraints, restrictions for building owners and other financial market deficiencies are some of the biggest obstacles to improved EE in the building sector. Financial support programmes therefore constitute a main component of the strategy.

82. Two years are cited to avoid confusion, the first designates the year of publication, the second the year it came into force.

Establishing a law as the framework and having an ordinance with detailed requirements is advantageous because requirements can be adjusted relatively quickly to changes in technology and circumstances. This is because ordinances can be passed by government without involving the legislative body (the parliament). However laws are more difficult to change quickly, since they must undergo the longer legislative process of passing through parliament.

Administrative actors

At the national level, responsibility for energy efficiency policy is split between two ministries. The Federal Ministry of Transport, Building and Urban Affairs (BMVBS) is responsible for the preparation and planning of the laws and ordinances concerning the construction of buildings. The Ministry has a budget (2005) of EUR 23 billion but the largest share of this goes to transport. The Ministry is aided by the Federal Office for Building and Regional Planning (BBR) with 1 100 members of staff, which manages the federal government's buildings and is responsible for handling projects.

Important aspects of energy policy, notably economic efficiency, supply safeguards and environmental sustainability fall under the responsibility and guidance of the Federal Ministry of Economy and Technology (the BMWi), which, together with the Ministry of Transport, Building and Urban Affairs, manages the development of the EnEV.

At the regional level, the German *Länder* are theoretically allowed to deviate from the EnEV and set stricter requirements, since they may not fall below the standards of the EnEV (apart from special requests in exceptional cases, known as the hardship clause). In practice however this has not yet happened. Different ministries are responsible for the building sector in the German *Länder*, frequently the Ministry of the Interior (see Table 46 in Annex III).

Each *Land* has its own building code which mainly contains rules and regulations for fire protection, safety, noise insulation and the like. Reference is made to the technical provisions for structural thermal insulation. Several *Länder* have their own programmes to promote energy efficiency in residential buildings. These programmes take different forms and target various barriers; in some *Länder* they exclusively provide advice and information. This often extends to training for building professionals such as plumbers, gas fitters, architects and electricians. In some cases loans and grants for energy efficiency improvements in residential buildings are provided.

Finally, at the local level municipal building authorities are responsible for implementing the EnEV. They make sure that plans adhere to current regulations and issue building permits. They are also meant to supervise the construction work, but this seldom takes place in practice. One main reason for this is that they do not have the personnel necessary to do so. As a result, building inspections for both residential and non-residential buildings are rarely carried out.

In addition, many German towns and local authorities are active in the *Klima-Bündnis* (Climate Alliance), an alliance of European cities which was established in 1990 and whose goal was to halve CO_2 emissions by the year 2010 and then reduce them even further. They also aim to immediately stop all production and use of SEEC propellants. As of May 2006, 375 German towns and local authorities form part of the 1 129 cities that are Climate Alliance members. In principle, their activities encompass all the possibilities of efficient energy use, but in practice these are usually limited to measures in the transport sector.

Many municipalities and local authorities also provide funding independently of the Climate Alliance for EE improvements, for example to help finance the conversion of existing heating systems to gas and to condensing technology.

Other actors

Some of the most important and well known actors implicated in a variety of fields affecting EE in existing buildings are listed below.

Agencies

The German Energy Agency (*Deutsche Energie-Agentur GmbH,* DENA), was established in 2000 by the Federal Ministry of Economics and Technology and began operations in 2001. DENA was set up as a GmbH, a private company. The stakeholders are – both with 50% – the KfW Bank *(Kreditanstalt für Wiederaufbau)* and the Federal Republic of Germany represented by three ministries (BMWA – Federal Ministry of Economics and Labour, BMVBS – Federal Ministry of Transport, Building and Urban Affairs, BMU – Federal Ministry for the Environment, Nature Conservation and Nuclear Safety).

DENA was set up to promote energy efficiency, climate protection and sustainable development policies, and to promote renewable energy sources. Besides directly dealing with efficient energy use in buildings, its main areas of concern are renewable energies, efficient use of electricity and transport, and power plants and electricity grids.

Non-profit organisations

Bund der Energieverbraucher e.V. (Federation of Energy Consumers) is an organisation of private energy consumers in Germany. It is a non-profit, politically neutral, consumer association active on a national level in the energy sector.

Professional associations

In Germany, laws and ordinances are strongly based on *Deutsches Institut für Normung e.V.* (German Institute for Standardisation - DIN) standards. Among many other fields, DIN edits standards in the field of energy and buildings, such as the new version of the standard series DIN V 18599 (as of February 2007) "Energy Evaluation of buildings – calculation of useful, final and primary energy demand for heating, cooling, ventilation, hot water and lighting".

The *Verein deutscher Ingenieure* (Association of German Engineers) (VDI) is a broad professional association of German Engineers (130 000 members) in different fields. VDI establishes technical and economic guidelines and handbooks and co-edits periodicals. It has sections dealing with building and energy technologies, and organises workshops and conferences in this field (heating systems, hot water, and others).

Zentralverband Elektrotechnik- und Elektronikindustrie e.V. (Confederation of the Electrotechnology and Electronics Industry) (ZVEI), is also becoming active in the field of energy efficiency (*e.g.* heat pumps) and energy contracting.

Besides engineering associations, there exist several energy service associations:

- The *Bundesverband Gebäudeenergieberater Ingenieure Handwerker* (Federal Association of Building Energy Consultants, Engineers and Craftsmen) (GIH) was founded in 2001 with five member organisations.[83] It currently has 18 member organisations along withabout 2 000 energy advisors.
- The German Facility Management Association (GEFMA). Founded in 1989, this association regroups services related to facility management. Next to cleaning, security, catering and IT, facility management increasingly includes energy services, including contracting.
- The *Bundesverband Privatwirtschaftlicher Energiecontracting-Unternehmen e.V.* (Federal Association of Private Energy Contracting Companies) (PECU) is mainly active in the real estate sector.
- The *Verband für Wärmelieferung* (association of heat suppliers) (VFW). This is an association of contracting companies, aiming at the further dissemination of energy supply and energy saving contracting (heating, cooling, compressed air, electricity).
- The ESCO Forum is a common forum of PECU and the energy service companies (ESCOs) section of ZVEI, established to better place the needs of the ESCO sector on the political agenda.

Financial institutions (banking sector)

All the government's funding programmes are managed by the *Kreditanstalt für Wiederaufbau* (Bank for reconstruction), or KfW. The KfW is a non-profit public banking group. The federal government owns 80% of the Bank while the *Länder* own the remaining 20%. Any surplus from the bank's business is earmarked and transferred to its different areas of activity, enabling favourable borrowing conditions. The KfW *Förderbank* (KfW Promotional Bank) promotes housing construction and modernisation, energy conservation, environmental protection on the part of commercial enterprises, local communities, along with infrastructure and education.

In the first three quarters of 2006, the total financing volume of KfW *Bankengruppe* rose to EUR 51.8 billion, compared to EUR 37.4 billion for the same period in 2005. Part of this was due to the KfW Promotional Bank's highly successful programme for the refurbishment of old buildings and ecological construction.

The number of applications and credit approvals for the various programmes of the KfW promotional bank are given in Tables 33 to 35 later in the chapter for 2002 to 2005. They range between EUR 1.6 billion and EUR 3.2 billion per year for roughly 37 000 to 74 000 applications.

83. VNGE Verein Norddeutscher Gebäude-Energieberater eV., Verein der Gebäude-Energieberater im Handwerk in Rheinland-Pfalz eV., Gebäude-Energieberater des Handwerks Thüringen eV., EVEU Eurospäischer Verband der Energie- und Umweltschutzberater eV., Gebäude-Energieberater im Handwerk eV.

Financing for projects is channelled exclusively through regular banks; private individuals cannot apply directly to the KfW. The loan agreement is signed by the applicant and his or her bank which pays out the KfW loan and transfers the applicant's repayment instalments to the KfW *Förderbank*. Apart from the interest, no further costs such as handling fees are incurred. Since 2007, direct grants can be paid out upon application by private individuals.

Energy service companies (ESCOs)

In Germany, several municipal utilities were initially forced to offer energy services, and later developed this as a business activity. Generally, with the gradual restructuring of electricity and gas markets, utilities have been seeking to provide energy services as added value, especially given the low electricity and gas prices and the reduced sale profit margins (Bertoldi *et al.,* 2006).

Energy service companies have not yet quite fulfilled initial expectations in the residential building sector, whether for new buildings or for the modernisation of existing ones. Their only activity in this sector has been contracts in some public housing facilities (such as homes for the elderly and children, student hostels etc.) which can be classified as residential buildings. The many successful contracting examples almost exclusively concern non-residential buildings, particularly in the public sector. The public sector is perceived as having "safer" clients that do not normally go out of business, because local authorities and energy agencies have been taking the lead with retrofitting public sector buildings (Bertoldi *et al.,* 2006).

In 2003, there were around 480 ESCOs in Germany with an overall annual turnover of about EUR 3 billion (Brand and Geissler, 2003). Energy services are being implemented at 120 000 sites in 2003, estimated to be less than 9% of the existing market potential. The number of concluded energy performance contracts (EPC) is much lower due to the grouping of up to 100 buildings within each of the EPCs. It is estimated there were over 200 EPCs from the mid-1990s up to 2003.

Various facilities also play a role in the development of new building technologies and methods which can influence policies encouraging EE improvements in existing residential buildings. A summary of primary research, development and testing facilities is presented below in Table 28.

Table 28 • Research, development and testing facilities

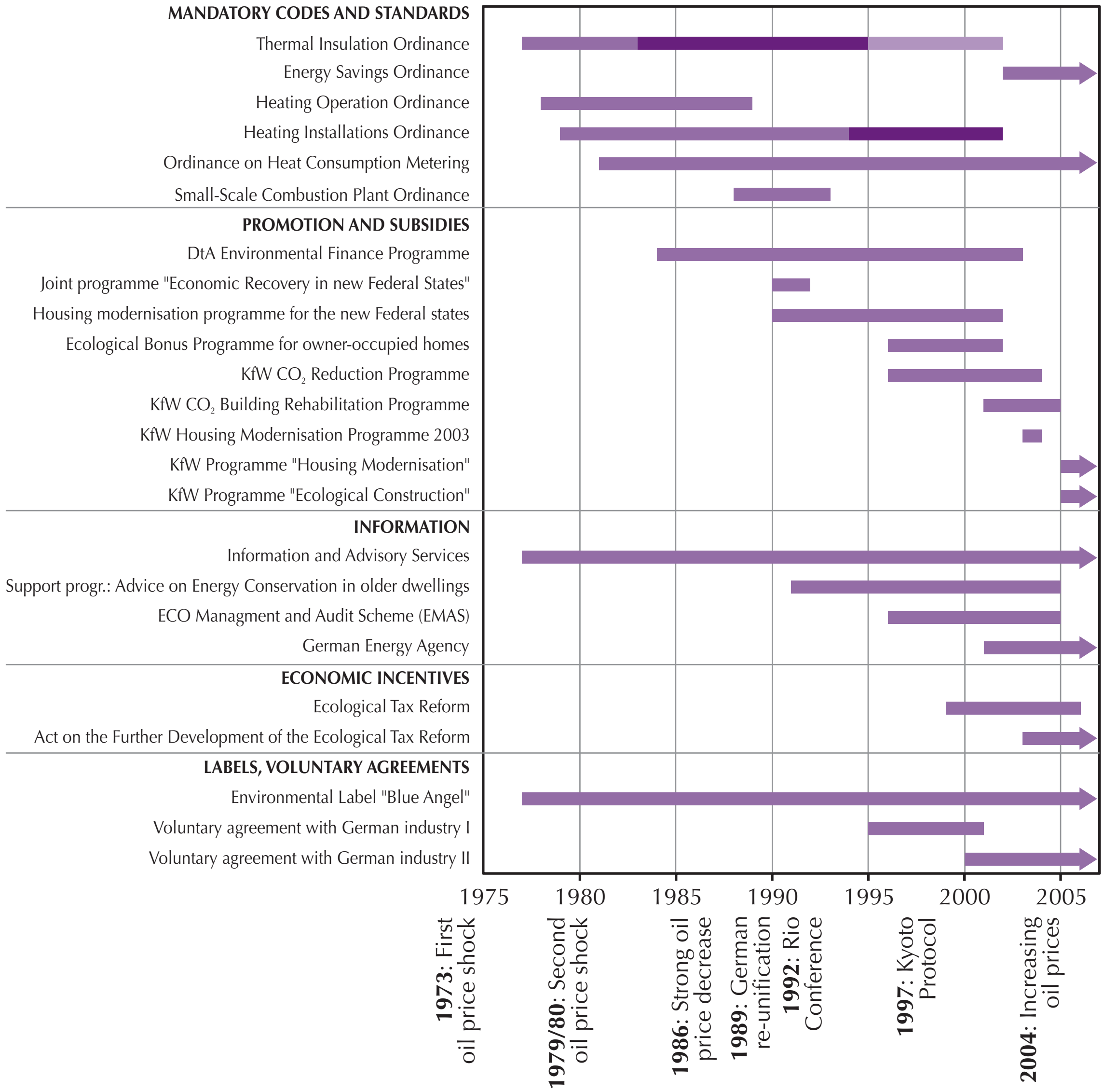
Name of facility	Research fields/ Activities
Fraunhofer Institut für Bauphysik (Fraunhofer Institute for Building Physics) (IBP)	Research, development, testing, demonstration, and consultancy in the field of building physics: acoustics, sound insulation, lighting, energy conservation, indoor climate, durability, hydrothermics, building chemistry, building biology, hygiene, new building materials, preservation of buildings
Fraunhofer Informationszentrum Raum und Bau (Fraunhofer Information Centre for Planning and Building) (IRB)	Provides specialised information resources for all fields of building planning and construction
Institut Wohnen und Umwelt GmbH (Institute for Housing and Environment) (IWU)	An interdisciplinary non-profit research institution in the field of housing (*e.g.* improving living conditions, development of ecological renting schemes, energy saving analysis, and others). It was founded 1971 by the state of Hesse and the city of Darmstadt and currently has 40 employees
Institut für Bauforschung e.V. (Institute for Building Research) (IFB)	Based in Hannover, the IFB works mainly on curbing costs in the building sector
IFEU	An independent ecological research institute
University centres	Civil engineering departments at universities and technical universities, *e.g.* University of Kassel, Technische Universität München (Technical University of Munich), University of Karlsruhe, Universitiy of Stuttgart. These conduct research into various aspects of building technologies
Zentrum für umweltbewusstes Bauen e.V. (Center for environmentally conscious construction) (ZUB)	An independent institution close to university research centres and that cooperates with the Fraunhofer Project Group Kassel, working in the field of building physics, technical building equipment and experimental construction
Fensterinstitut Rosenheim (The Institute of Window Technologies) (IFT)	A research institute and a recognised test surveillance and certification body for windows, doors and other building components financed by contracts and members from industry and the building sector

Policy measures

Figure 59 and Table 29 below show the measures taken by the federal government to increase efficiency in the building sector since this topic became politically relevant in the 1970s.[84] The individual measures regarding residential buildings are discussed below, as per the classification developed in the Introduction.

84. Programmes run by the Ministry of Environment to promote renewable energy in the building sector are not included.

Figure 59 • *Overview on energy policy measures regarding the case of Germany from the MURE database*



Source: MURE-Database (http://www.isis-it.com/mure/), complements by the authors, ETH Zurich. Different colours represent different versions of the measures (amendments).

Table 29 • Overview on energy policy measures regarding the case of Germany

No	Title	From	To	Measure type	Sector
	Mandatory codes and standards				
1	Thermal Insulation Ordinance *(Wärmeschutzverordnung)* of 1977	1977	1983	M	Res, Serv.
2	Heating Operation Ordinance *(Heizungsbetriebsverordnung)*	1978	1989	M	Res, Serv.
3	Heating Installations Ordinance *(Heizungsanlagenverordnung)* of 1978/82	1979	1994	M	Res, Serv.
4	Ordinance on Heat Consumption Metering *(Heizkostenverordnung)*	1981		M	Res, Serv.
5	Thermal Insulation Ordinance *(Wärmeschutzverordnung)* of 1982	1982	1994	M	Res, Serv.
6	Small-Scale Combustion Plant Ordinance *(Kleinfeuerungsanlagenverordnung),* amendment 1994	1988	2002	M	Res, Serv.
7	Heating Installations Ordinance *(Heizungsanlagenverordnung)* of 1994	1994	2002	M	Res, Serv.
8	Thermal Insulation Ordinance *(Wärmeschutzverordnung)* of 1994	1995	2002	M	Res, Serv.
9	Energy Conservation Ordinance (*Energieeinsparverordnung* - EnEV)	2002		M	Res, Serv.
	Promotion and subsidies				
10a	DtA Environmental Finance Programme *(DtA-Umweltprogramm)*	1984	2003	S	Serv.
10b	KfW Environmental Protection Programme *(DtA-Umweltprogramm)*	1990	2002	S	Serv.
11	Joint programme "Economic Recovery in the new *Länder*"	1990	1992	S	Res (Serv.)
12	KfW Housing modernisation programme for the new *Länder (Wohnraum-Modernisierungsprogramm neue Bundesländer)*	1990	2002	S	Res
13	Ecological Bonus Programme for owner-occupied homes	1996	2002	S	Res
14	KfW CO_2 Reduction Programme *(KfW-Programm zur CO_2-Minderung)*	1996	2004	S	Res
15	KfW CO_2 Building Rehabilitation Programme *(KfW-CO_2-Gebäudesanierungsprogramm)*	2001		S	Res
16	KfW Programme "Housing Modernisation" *(Wohnraum-Modernisieren)*	2003		S	Res
18	KfW Programme "Ecological Construction" *(Ökologisch Bauen)*	2005		S	Res

Nº	Title	From	To	Measure type	Sector
19	KfW Programme "KfW-Municipal Loan Programme" *(KfW-Kommunalkredit - Energetische Gebäudesanierung)*	2007		S	Serv.
	Information				
20	Information and Advisory Services	1977		I	Res, Serv.
21	Support programme for on-site advice on energy conservation in older dwellings *(Vor-Ort-Beratung)*	1991		I	Res
22	ECO Management & Audit Scheme (EMAS), 85% Industry, 15% Serv.	1996		I	Ind., Serv.
23	German Energy Agency *(Deutsche Energie-Agentur – DENA)*	2001		I	Res, Serv.
	Economic incentives				
24a	Energy taxes	1999		E	Res, Serv.
24b	Ecological Tax Reform, Act on the Further Development of the Ecological Tax Reform *(Gesetz zur Fortentwicklung der ökologischen Steuerreform)*	1999/ 2003		E	Res, Serv.
25	Energy contracting				
	Labels, voluntary agreements				
26a	Environmental Label "Blue Angel" *(Umweltzeichen "Blauer Engel")*	1977		A	Res, Serv.
26b	Energy performance certificate of WschVO and EnEV	1995		A	Res, Serv.
27	Voluntary agreement with German industry I (*Erklärung der deutschen Wirtschaft zur* Klimavorsorge I)	1995	2001	A	Serv.
28	Voluntary agreement with German industry II	2000	2005	A	Serv.

M: Mandatory codes and standards, S: Promotion and subsidies
I: Information E: Economic incentives (other than subsidies)
A: Labels and certificates and voluntary agreements

Source: Mostly MURE-Database (http://www.isis-it.com/mure/), complemented by the authors, ETH Zurich.

Regulatory measures

Building codes and standards

Starting from the early 1970s and up to the introduction of the Energy Conservation Ordinance (*Energieeinsparverordnung,* EnEV) in 2002, mandatory codes and standards addressed the heating energy demand of the building (on the level of useful energy) and the conversion efficiency of the heating system (from useful to final energy) independently of each other. The heating energy demand was regulated by the Thermal Insulation Ordinance of 1977 and its amendments of

1982 and 1994. The heating system was addressed by the Heating Installations Ordinance *(Heizungsanlagenverordnung)* of 1978 and its amendments of 1982 and 1994, the Heating Operation Ordinance (*Heizungsbetriebsverordnung*), and the Small-Scale Combustion Plant Ordinance *(Kleinfeuerungsanlagenverordnung)*.

In 1978, two ordinances aimed at increasing the energy efficiency of heating systems came into force, one regarding their installation and the other regarding their operation. These ordinances were amended in 1982 and combined in 1989 into the Heating Installations Ordinance and again amended in 1994. This did not cover the limitation of the maximum exhaust losses of boilers which are described exclusively in the Small-Scale Combustion Plant Ordinance of 1988 (see Eichhammer and Schlomann, 1998).

Heating system regulations

The Heating Operation Ordinance *(Heizungsbetriebsverordnung)* concerned boilers and equipment for sanitary hot water production with a rated output greater than or equal to 11 kW. Depending on the date of installation and on the equipment capacity, the maximum exhaust losses of boilers as a percentage of fuel input were limited (MURE, 2007).[85] Landlords had to ensure monthly control and maintenance by trained personnel for boilers with a rated output of over 50 kW. For central heating systems, the rate of water flow must be regulated by chimney sweeps every eight years, or the system has to be equipped with thermostatic valves.

Based on the Energy Law of 1976, the first Heating Installations Ordinance came into force. The ordinance applies to both new and existing buildings with newly installed, renewed, or significantly renovated boilers or heating systems with a boiler capacity of more than 4 kW (MURE, 2007). This capacity limit covers not only large buildings and multi-family homes, but also single-family homes. There is however no monitoring of the ordinance's actual implementation in Germany.

The Small-Scale Combustion Plant Ordinance *(Kleinfeuerungsanlagenverordnung)* of 15 July 1988, the first Ordinance for the Implementation of the Federal Emission Control Act, concerns "small" boilers, those with an operation capacity of 4 kW to 1 MW for coal, up to 6 MW for oil and 10 MW for gas. The Ordinance was amended in 1993, 1994 and 1996.[86] It defines new chimney gas limits for old equipment, valid from October 1993 and October 1995 for the old and new federal states[87] respectively. Although clean air was the actual goal of the Ordinance rather than energy efficiency, the latter was also considerably affected by the limitation of heat losses.[88] There is a period of transition of up to eight years for older equipment and for the new

85. For the installation dates "before 12/1978", "1979-1982", and "after 1.1.1983", these limits were 18%, 16%, and 14% respectively for heating capacities between 11-25 kW and 15%, 13%, and 11% for heating capacities of more than 120 kW (and in between for capacities between 25 kW and 120 kW).

*86. Under the version of 27.7.1994, the regulations for hard coal also apply for brown coal. The use of additives (*e.g. *lime) must ensure that the sulphur content of the fuel is compounded in the combustion residues. The maximum level of concentration of sulphur dioxide (SO_2) in flue gas is 1% by weight.*

87. Old states are the states of the former Federal Republic of Germany (FRG).

88. The most recent version of 1 November 1996 tightens the standards of heat loss carried by chimney gas for new oil and gas furnace equipment (valid from 1.1.1998): 11% for operation capacities between 4 and 25 kW, 10% between 25 and 50 kW, and 9% for larger furnaces.

federal states. The standards are based on heat loss and operating capacity, not on the age of the equipment as in former versions.

Hence, before the EU boiler Directive 92/42/EEC became effective (with a transition period lasting up to December 1997), Germany reinforced its regulation regarding heating systems in 1994. Moreover, Germany was the only member state to introduce additional requirements compared to the European regulation (Eichhammer and Marscheider-Weidemann, 1999). These included:

- boiler capacity adapted to the heat consumption of the building;
- limits specified for the consumption of auxiliary electricity, in particular for warm water pumps;
- as of 1 January 1998 only low-temperature or condensing boilers are permitted for installation;
- all single houses had to be equipped with thermostatic valves by 31 December 1997.

These requirements are regulated in the Heating Installations Ordinance *(Heizungsanlagen-verordnung)*[89] of 1994. Beginning on 1 January, new boilers had to carry the CE mark pursuant to the EC hot-water boiler directive as low temperature boilers or gas condensing boilers. On 1 February 2002, the Heating Installations Ordinance was replaced by the new Energy Conservation Ordinance.

Thermal Insulation Ordinance of 1977 and its amendments of 1982 and 1994

The first Thermal Insulation Ordinance was introduced in 1977 and affected only new buildings. It became valid for existing buildings after its 1982 amendment if particular retrofitting measures were undertaken. The Ordinance limits a maximum value for heat transmission either as an average transmission through the building shell (average U-value), or as specific U-values for each of the building components. These were tightened by 25% compared to the previous 1977 regulation. A similar reinforcement was put in place in 1994.

The chronological development of the essential requirements made by the WSchVO, its amendments and by the EnEV is given in Tables 47 and 48 in Appendix III. The double glazing requirement for windows of the first two versions of the WSchVO is equivalent to a U-value of about 3 W/m^2K, since glazings of this period were not coated and inert gas filled.

Energy Conservation Ordinance (*Energieeinsparverordnung,* EnEV)

The Energy Conservation Ordinance for dwellings[90] of EnEv came into force on 1 February 2002. This replaced both the 1994 Thermal Insulation Ordinance and the existing Heating Installation Ordinance. The basic concept of the EnEv being a fully integrated approach covering heating supply as well as heating demand, it merged the existing Ordinances on thermal insulation and heating installations (MURE, 2006). The EnEV was updated in 2004

89. The amended version of the Ordinance of 22 March 1994 (BGBl. I p. 613) came into force on 1 June 1994 (last amendment: 4 May 1998; BGBl. I p. 852). It tightened the requirements for heating and hot-water systems compared to the original Ordinance of 1978 and the first amendment of 1982.

90. BGBl. I p. 3085.

and a further update was necessary to implement the EPBD; the current version dates from 26 July 2007 (BGBl. I 2007, S. 1519).

With the EnEV a new approach was taken by incorporating the previously valid heating systems regulation and introducing an energy performance indicator based on the primary energy demand. The latter offered more space for optimisations. There was no general increase in the insulation standards associated with this, since lower insulation of the building could now be selected if a highly efficient heating system or an additional solar energy system were chosen. The insulation standards were only higher if a conventional low-temperature boiler (instead of a more efficient condensing boiler) was used.

The EnEV differentiates between new and existing buildings. For existing buildings establishing maximum values for the building's primary energy demand, as is done for new buildings, is not feasible; the EnEV therefore stipulates the U-values for structural element features, as outlined in Table 30.

Table 30 • Maximal U-values for construction elements of existing residential buildings (mandatory if at least 20% of an exterior structural element of the same orientation is renovated)

Structural element	Max. U-value W/(m²K)
Outer walls	0.35 – 0.45
Windows and glazing	1.5 – 1.9
Ceilings, roof slopes and roofs	0.25 – 0.30
Walls adjacent to unheated rooms or soil	0.40 – 0.50

The ranges in the U-values are a result of differentiations in the various possible building types.

The U-values of Table 30 must be complied with if at least 20% of an exterior structural element of the same orientation is renovated. What counts as renovation is listed in detail in the EnEV; applying a new coat of paint does not force anyone to install thermal insulation, but new plasterwork does. Buildings with lower indoor temperature are subject to less strict values.

In addition there are requirements for retrofitting existing heating systems and buildings:

- Boilers with between a 4 kW and 400 kW capacity installed before 1 October 1978 had to be replaced with new ones by 31 December 2006. Exceptions were made for low-temperature and condensing boilers, and boilers which have had their burners replaced since 1 November 1996; these only have to be replaced by 31 December 2008. This requirement affects all building types.
- In residential buildings, hot water pipes and fittings in unheated rooms had to be thermally insulated by 31 December 2006. Owners of residential buildings with normal inside temperatures had to insulate upper storeys above heated rooms (which are not used but accessible) by 31 December 2006 for the heat transition coefficient of the ceiling to not exceed 0.30 W/m²K.

Originally, an amendment of the EnEV was planned for 2006 according to the EPBD. In October 2006, a draft version of the new ordinance was submitted. EnEV requirements are more stringent than the EPBD, in order to comply with the EPBD it had to be adapted to include the new, obligatory "energy passport" (energy performance certificate). The U-values given in Table 30 are not expected to change.

The EnEV is to be reformed in May 2008; its main provisions will be for energy standards to be tightened by 30% on average by 2009. A further 30% tightening is planned for 2012 (BMU, 2007).

Ordinance on Heat Consumption Metering *(Heizkostenverordnung)* of 23 February 1981

The Ordinance on Heat Consumption Metering concerns all buildings with central heating and central hot water systems. Such heating systems hold much potential for increased EE since individual user consumption is not calculated and therefore not monitored. Since July 1984 existing buildings must be equipped with heating meters that measure the proportional heat consumption of each user. Since January 1996, rooms in occupied buildings in the Eastern states must also be equipped with heat consumption metering instruments. In buildings with collective heating systems, the occupants must be able to regulate the supply of heat according to the outside and inside temperature in each individual dwelling. Hot water meters must also be installed to monitor the hot water consumption of each user. The revision of 20 January 1989 also regulates special cases like failure of meters, change of tenants, inaccessibility of dwellings and the delivery of heat and hot water. Between 50% and 70% of total costs of heat and hot water supply are billed according to consumption, with the remaining costs calculated based on living space.

Energy performance certificates

A heat consumption certificate was first introduced in the 1995 amendment of the WSchVO. It documents the building features related to energy and contains its energy demand calculated according to the methods used in the WSchVO.

The requirements were tightened in the EnEV of 2002: the specific values of transmission heat losses, the installation factors of the systems for heating, hot water preparation and ventilation, the final energy demand by individual energy source and the annual primary energy demand had to be listed.

The new EnEV 2007/2008 is to be modified according to the EPBD requirements. The party leaders of the coalition came to an agreement on the key points of amending the Energy Conservation Ordinance on 24 October 2006:

- The energy passport (energy performance certificate) will become obligatory in residential buildings from the middle of 2008 (postponed from 1 January) and one year later in non-residential buildings.
- In all existing buildings, the energy passport becomes mandatory if they are sold, if new tenants move in or if "fundamental" changes are made. These are modifications to at least three structural elements in combination with a modernisation of the heating system, or an

extension of the building by more than 50%. The energy passport can also be issued on a voluntary basis.

- Either a demand-based passport (energy use calculated based on intrinsic building potential) or a consumption-based (measured energy use) passport can be chosen for residential buildings which have undergone energy efficiency measures that raise their energy status to at least the standard of the first Thermal Insulation Ordinance of 1978. This choice also applies to larger buildings with five units or more.
- The demand-based energy passport is mandatory for buildings with fewer than five accommodation units constructed prior to 1978. This is also valid for buildings or building modernisations which are publicly funded.
- Energy passports issued before 1 January 2008 may be displayed as either option (demand- or consumption-based). These are also valid for ten years.

The German Energy Agency developed and tested an energy passport in 33 regions across Germany from November 2003 until the end of 2004. The DENA manages a nation-wide database for Germany of persons and offices certified to issue energy passports, so as to prevent a bottleneck when the new EnEV comes into effect and a large number of energy passports have to be issued.

The energy passport is ultimately an implementation of the requirement of the EBPD, although efforts and attempts to introduce an energy passport have been underway in Germany for a long time (for example in Hesse). At present, it is seen as one of the policy instruments to raise the renovation rate of old buildings from 1% to the desired 5%.

Financial and incentive-based measures

Fiscal measures

Taxes affecting the price of energy, subsidies, preferential loans and direct grants are the economic instruments implemented in Germany that affect the building sector. Reduction of income taxes has only been used for particular products such as solar collectors in the 1970s.

The current policy in Germany is to privilege economic incentives other than tax. Firstly, the cost is paid by the Ministry of Finance instead of the ministries that run the programmes. Secondly, changes and adjustments to respond to market and technical developments are difficult to implement if finance and fiscal laws have to be changed. For this reason, incentive promotion was transferred progressively to more flexible institutions such as ministries (BMWi) or banks (KfW). Substantial fuel taxes were introduced in Germany in the late 1980s. Taxes on heating oil - and to a smaller extent on natural gas - were introduced in 1989 and increased slightly in 1992. These were introduced and increased as a response to the growth in energy demand in the 1980s, to mitigate local air pollution and to support the German economy, particularly the sector of technology producers and exporters.

During the period of low fossil fuel prices during the 1990s and the early 2000s, the taxes corresponded to about 10% to 15% of the consumer prices. Tax levels on heating oil and natural gas for heating were again raised within the context of the "Ecological tax reform" in 1999, when a tax on electricity was introduced and subsequently raised in several steps (BMF, 2005).

Ecological Tax Reform *(Ökologische Steuerreform)*

With its Ecological Tax Reform, the German government aimed to encourage energy conservation and promote renewable energies, as well to create jobs. Following the concept developed by the economist Binswanger in the 1980s, the tax burden of the economic input factor "labour" was to be shifted to the economic input factor "energy".

The law initiating the Ecological Tax Reform of 24 March 1999 increased the price of energy as of April 1999 by:

- DEM 0.04/L (EUR 0.002/kWh) for heating oil.
- DEM 0.0032 /kWh (EUR 0.0016/kWh) for natural gas.
- DEM 0.02/kWh (EUR 0.01/kWh) for electricity (DEM 0.01/kWh electrical storage heating systems and electricity for transportation, DEM 0.004/kWh for producing industry and agriculture and forestry).

Parallel to the introduction of the "eco-tax", the contribution rates for statutory pensions insurance – and consequently the non-wage labour costs – were reduced by 0.8% points, the reduction being split equally between employees and employers.

The Law Continuing the Ecological Tax Reform of 18 December 1999 provided for a further four-step increase in taxation from 2000 to 2003. The mineral oil tax for heavy heating oil underwent a one-time increase of DEM 0.005/kg, introduced on 1 January 2000. The increase in electricity tax amounted to DEM 0.005/kWh on 1 January each year from 2000 to 2003.

The revenues from the Ecological Tax Reform are to be returned in full to the taxpayers. Approximately 90% of the revenue is used to lower social security contributions by employers and employees, specifically pension fund contributions. The additional revenue of the mineral oil tax and of the new electricity tax amounted to DEM 8.5 billion (EUR 4.3 billion) in 1999 and to DEM 17.4 billion (EUR 8.7 billion) in 2000 and rose further in the following years (Table 31 below). Only about 10%, representing DEM 200 million (EUR 100 million) in both 1999 and 2000 and DEM 300 million (EUR 150 million) in 2001, were to be used for the promotion of renewable energies and cogeneration (BMF, 2000).

Act on the Further Development of the Ecological Tax Reform (*Gesetz zur Fortentwicklung der ökologischen Steuerreform)*

The Act on the Further Development of the Ecological Tax Reform came into force on 1 January 2003. It aimed to dismantle environmentally harmful tax reductions and to adapt taxes on natural and fluid gas and on heavy heating oil (BMU, 2003).

The Act provides for the following concrete measures:

- Adaptation of the regular mineral oil tax rate for natural gas when used as a heating fuel to EUR 0.55 ct/kWh (previously EUR 0.3476 ct/kWh), for liquid gas to EUR 60.60/1 000 kg (previously EUR 38.34/1 000 kg) and for heavy heating oil to EUR 25/1 000 kg (previously

EUR 17.89/1 000 kg); efficient heat power cogeneration plants and gas-steam power plants are exempted.

- Increase in the tax rate for night storage heating systems installed before 1 April 1999 from 50% (EUR 1.02 ct/kWh) to 60% (EUR 1.23 ct/kWh) of the regular electricity tax rate; abolishment of tax relief on 1 January 2007; use of EUR 10 million to assist the phase out of night storage heating systems. These are insulated boxes containing electrical circuits which heat up bricks, meant to be used to store heat during night-time "off-peak" electricity tariff hours. They are more expensive to the consumer and less energy efficient than most of their counterparts.

Table 31 • Energy tax income between 1999 and 2005 *(Million EUR)*

	1999	2000	2001	2002	2003	2004	2005
Mineral oil tax	36.444	37.826	40.69	42.192	43.188	41.782	40.1
Electricity tax	1.816	3.356	4.322	5.097	6.531	6.597	6.5

Source: *Bundesministerium der Finanzen* (Ministry of Finance), various years.

Energy Tax Act (Energiesteuergesetz)

Energy tax legislation was revised in 2006 to implement the EU energy tax (*Richtlinie* 203/96) into national law. The new Energy Tax Act replaced the Mineral Oil Tax Act in August 2006 and the Electricity Tax Act was changed in July 2006. Besides mineral oil, coal products are also covered. General tax levels were not affected by these changes, to ensure social policy cohesion and stable energy prices.

Grants and subsidies

Among early subsidy programmes is the Window Programme *(Fensterprogramm)* which was used in the 1970s and the 1980s to promote the introduction of different improvements in windows into the market place. After 1978, when the first generation of thermal panes became mandatory for new buildings with the WschVO, the Window Programme was used to introduce improved glazing in the stock of existing buildings. Although this generation of glazing did not include coated glass and inert gas filling, it nevertheless contributed to reducing energy consumption in the building sector (Eichhammer and Schlomann, 1998).

The joint programme "Economic Recovery in the New Federal States"

The joint programme "Economic Recovery in the New Federal States" (*Gemeinschaftswerk "Aufschwung Ost")* provided subsidies of 20% or a maximum of DEM 500 per m^2 (EUR 250 per m^2) in the new federal states to modernise heating systems, thermal insulation and other housing related energy saving measures. In 1991 and 1992, federal authorities provided a total of DEM 1.5 billion (EUR 0.75 billion) for the programme (BMU, 1997). The programme ran from 1990 to 1992.

Ecological Bonus Programme for owner-occupied homes

The so-called "eco-bonus" was an element of the Owner-Occupier Allowance *(Eigenheimzulagengesetz)* which aimed at increasing the home ownership rate in Germany for both new construction and for the purchase of existing homes. The eco-bonus supported the installation of solar heating systems, heat pumps and equipment for heat recovery. The programme started on 1 January 1996 and was originally expected to expire at the end of 1998. The programme was extended twice and was valid for all installations carried out before 1 January 2003. In January 2006, the owner-occupier allowance was repealed in Germany by the new government.

Two support measures were relevant for financing energy efficiency improvements in existing buildings:

- An annual grant of 2% of the investment costs (maximum of EUR 256 or DEM 500) given over a period of eight years for the installation of heat pumps, solar facilities and heat recovery facilities; the grant equalled 16% of the investment costs (up to a yearly limit of EUR 256).
- Houses built according to a low energy standard, where the annual space heating requirement remained at least 25% under the Thermal Insulation Ordinance of 1994, were supported with an additional EUR 205 (DEM 400) per year.

According to an estimation of the Federal Ministry of Buildings, between 1996 and 1998, 50 to 60 thousand new buildings and 20 to 30 thousand existing buildings were supported by the programme (MURE, 2007, measure GER20).

Voluntary agreements and partnerships

Preferential loans: The programmes of the bank for reconstruction (KfW)

The Promotional Bank programmes of the KfW banking group were initially set up in 1996 to mitigate CO_2 emissions and to increase energy efficiency (Kleemann, Heckler *et al.,* 2003). These were later complemented by other goals such as the preservation of cultural heritage and the improvement of living standards.

Up to 2005, the KfW programmes provided long-term low-interest financing of energy efficiency improvements and CO_2 emissions reduction measures. Next to a low interest rate, applicants were freed from credit repayment during the first years. The credit could include up to 100% of the investment costs, including auxiliary costs.[91] The KfW raises funds from the financial market and transfers this capital, via commercial banks, to programme applicants in the form of lower interest loans. The bank faces low-interest rates in the financial market since KfW is triple A

91. The KfW does not run a deposit business or any other income-generating business; it re-finances the approved loans through the regular capital market. The capital is then lent to applicants at a lower interest rate. The repayments of the applicants are used to pay back the liabilities to the capital market. The difference between the market interest rate and the promotional interest rate awarded to the applicants is an important part of KfW's programme costs. The degree of difference with the market interest rate depends on the type of programme, the type of applicants and the time scale (it is usually larger at the beginning of the programmes).

rated due to the guarantees accorded to it by its public status. In addition, federal funding is also used to further decrease interest rates. Loan repayments are used to pay back the bank's liability on the financial market.

While KfW loans must be repaid, they offer lower interest rates than regular commercial loans. They can only be estimated since they vary over time and programme type. This reduced interest rate results in savings equivalent to about 7-12% of the loan amount (KfW, 2007).

Since 2005, additional subsidies from the federal government are used by the KfW both to improve the financial conditions of the programmes and to expand their volume. The subsidies are used to pay the difference between the interest rate awarded to applicants, and the interest rate paid by KfW for capital raised form the financial market. It is possible to be in receipt of different KfW loans, as well as to combine these loans with other financial support programmes, including grant applications for single- and two-family house owners and private apartments in home-ownership associations. These can include any other financial support programme, such as grants offered at a community or state level. As of 2008, the KfW has extended the maturity period of their long-term loans from 30 to 35 years. Fixed interest-rate periods of up to 15 years are now also offered, along with the 5 and 10 year periods already offered (KfW, 2008). Further details on the different KfW programmes are given in the following sections.

KfW CO_2 Reduction and Building Rehabilitation programmes
(KfW CO_2 Gebäudesanierungsprogramm)

The KfW CO_2 Reduction Programme (KfW *Programm zur CO_2-Minderung*) started in January 1996 and was restricted to the West German *Länder;* from 2001 it was valid throughout Germany. The programme finished at the end of 2004. Since 2003, it is combined with the new KfW programme "Housing Modernisation". The CO_2 reduction programme covered 56.8 million m^2 in 685 000 dwellings between 1996 and 2004.

The programme provided support to those responsible for investment measures in residential buildings, for example private individuals, housing companies, housing cooperatives, municipalities and districts. If energy saving was an essential part of contracting projects, they could be supported as well. The investors were granted long-term, low-interest loans with fixed interest rates and repayment-free start-up years. At any time, the loan could be repaid in one payment without costs. During the observation period 2001 to 2003, 66% of the loans of the KfW CO_2 Reduction Programme were used for thermal insulation measures (walls, roofs, windows etc.), about 20% for the installation of energy-efficient boilers and about 14% for renewable energies and district heating (Kleemann and Hansen, 2005).

The CO_2 Building Rehabilitation programme targets old buildings requiring substantial energy saving investments. The technical prerequisite for receiving a loan is the renovation of the building to the EnEV standard for new buildings. They target buildings completed before 1984 (category A) and before 1995 (category B). Subsidy rates are as follows:

- 17.5%, up to EUR 8 750 per dwelling if the energy consumption is at least 30% below the new construction standard.

- 10%, up to EUR 5 000 per dwelling if the energy consumption is below the new construction standard.
- For category B applicants, 5% or up to EUR 2 500 per dwelling for other bundles of measures "with considerable savings".

Incentives are provided both for climate protection investments in existing buildings, such as thermal insulation in walls and windows or boiler replacements, as well as in the framework of the programme "Okologisch Bauen" in constructing new energy saving houses.[92] The credit period, the length of time within which loans must be repaid, is limited to 20 years. At the start of this period repayment can be delayed for a period of up to three years. For houses built before 1984, partial debt relief of 5% of the loan is offered if the EnEV level for a newly built house is achieved. This is extended to 12.5% if the level of energy consumption reached is 30% below the EnEV standards (KfW, 2008). From 1996 to 2004, the CO_2 Building Rehabilitation Programme approved loans for about 16.3 million m^2 in 196 000 dwellings.

KfW Housing Modernisation Programmes *(KfW Programm Wohnraum Modernisieren)*

From the start in 1990 to 1999 and between 2000 and 2002 the KfW Housing Modernisation Programmes were for the new East German *Länder*. The programme (called *Wohnraum-Modernisierungsprogramm neue Bundesländer*) provided low-interest loans for housing renovation and modernisation, as well as the creation of new rental apartments in existing buildings in the new *Länder*. The interest rates, guaranteed for a ten-year period, were up to 2% lower than market rates and were funded exclusively from the federal budget (MURE, 2006). About 15% of the funds were committed to energy conservation (Prognos/IER, 2004).

The programme was extended in April 2003 to include West German *Länder*, funding EE improvements in the form of low-interest loans. Programme funding amounts to EUR 6 billion for the 2006 to 2011 period.

In January 2005, the KfW bank restructured its programmes in the areas of housing construction, modernisation and energy conservation. Of three new programmes the "Housing Modernisation" programme aims to finance CO_2 reduction and modernisation measures in existing residential buildings.[93] The investor, that is whoever invests in owner-occupied or rented residential buildings, receives a long-term, low-interest loan with a fixed interest rate and repayment-free start-up years.

In addition to low-interest loans, direct grants are also available since 2007. The subsidies support three areas including the modernisation and renovation of owner-occupied and rented residential buildings according to a given energy consumption reduction. The grant cannot be

92. *So-called KfW "40" and "60" Energy Saving Houses, which are defined by maximum standards concerning yearly primary energy consumption (not more than 40 or 60 kWh per m^2 useful heated area, respectively). KfW 40/60 Energy Saving Houses are sponsored with up to EUR 50 000/30 000 per unit.*

93. *The other ones are the programmes "Ecological Construction Programme" which supports the construction of energy-saving houses and passive houses and the use of renewable energies in the construction of new housing, and the "Solar Power Generation programme" which was designed to help finance photovoltaic systems. The programme "Ecological Construction" has the objectives to promote the design, construction and acquisition of a KfW energy saving "house 40" or "60" (40 or 60 kWh/m^2 consumption respectively) and of a passive house, and the installation of new heating technology based on renewable energies, combined heat and power and local and district heating in new buildings.*

combined with a KfW loan programme. Loans awarded by the KfW thus specifically target EE. Loan amounts increase as the EE standards met increase, and just how preferential the interest rate obtained can be depends on the energy performance achieved.

Information and capacity-building programmes

Audits and information

Information and advisory services

Since the end of the 1970s, the German Federal Ministry of Economics and Technology funds independent information and advisory services on all questions related to efficient energy use, including the use of renewable energies by the German Consumer Organisation *(Verbraucherzentrale Bundesverband [vzbv])*. The Organisation currently runs 455 centres. Since 2006, a small fee (EUR 5) is charged for a 30 to 45 minute consultation, and EUR 45 charged for more detailed advice, including on-site visits. In 2005, over 75 000 consultations were provided, lasting on average 30 minutes. The advisory services of the consumer associations in major cities are supported by buses that systematically visit smaller and medium-sized communities throughout the country. Advisory services are also provided at trade fairs (Krawinkel, 2006). The BMWi also funds DENA's energy advice call centre, established in 2001. Since then the centre has received 9 000 calls per year, this figure doubling in 2005 to over 23 000 calls (SErENADE, 2007).

The Ministry itself also issues leaflets and other information materials. Extra funds are provided for the *Stiftung Warentest,* an independent foundation for testing various consumer goods, to enable additional testing of energy-related goods and services. The establishment of DENA by BMWi, BMVBS, BMU and KfW in 2000 was part of the goal to further improve consumer information on energy efficiency and renewable energies.

Support programme for advice on energy conservation in older dwellings (on-site consultation)

A support programme offering advice on energy conservation in residential buildings was in place from 1991 to 1997, when it was terminated for funding reasons. It was reintroduced in 1998 and ran till the end of 2002 while financing continued until 2006. This service covered building insulation, heating installations and renewable energies. It was only valid for buildings built before 1984 in the West German *Länder* and before 1989 in the East German *Länder.* Under this programme, housing owners received a grant if they followed on-site advice given by professional experts on potential energy conservation measures. The maximum grant amounted to EUR 327 for one- to two-family homes and between EUR 350 and EUR 450 for multi-family homes. The difference between the consultation fee and the grant was paid by those receiving the service. During the last few years of the programme, about 5 000 consultations were carried out per year. Programme spending amounted to around EUR 1.6 million in 2002 and EUR 1.76 million in 2003 (Kleemann and Hansen, 2005).

The Federal Office of Economics and Export Control (BAFA), part of the BMWi, offers an on-site consultation programme for all existing buildings built before 1984 or 1989. Funding is provided for consultations on whole buildings and heating systems. Certified advisors provide a detailed written diagnostic survey, along with a face-to-face meeting to provide recommendations and an action plan to improve energy efficiency, including options to use renewables. The cost for the consultation is heavily subsidised, and comes to EUR 175 for detached and semidetached houses and EUR 250 for a building with three or more units. Recommendations must be technically up-to-date, which means adoption of new energy-saving technologies is promoted. In 2005, 12 000 consultations were provided, which increased to 21 000 in 2006 (SErENADE, 2007; BMWi, 2008).

Deutsche Energie-Agentur GmbH (DENA)

Providing information is a major part of DENA's activities. In 2002, the energy efficiency campaign *(Initiative EnergieEffizienz)* was launched. The campaign is a public-private partnership and has been undertaken in co-operation with energy supply companies. Their financial contribution is part of their voluntary commitment to CO_2 reduction as agreed with the Federal Government.[94] The programme was first focused on the household sector, it aimed at reducing the standby losses of brown goods (small household electrical appliances) and office equipment, increasing market share of high-comfort and energy-efficient lighting, and raising the EE of white household appliances (large appliances such as refrigerators). The programme then extended to the tertiary sector, where one of the goals was to improve the EE of lighting. Regarding buildings, DENA set up an umbrella trade mark called *zukunft haus* (future house). The aim of *zukunft haus* is to increase awareness about responsible use of energy in the building sector by informing principals, real estate professionals and homeowners, communities and professionals about up-to-date energy efficiency options for both existing and new buildings. DENA also showcases pilot projects aimed to influence decisions made by private and public property developers, as well as homeowners. Their message is "Save Energy – Gain Value". For example, DENA's "Low energy standards for existing buildings" project began in 2003 and has been implemented in 143 residential buildings. Using best practices and innovative technologies, the project was able to demonstrate that cost-effective refurbishment could reduce the energy requirements of a building by up to 80% on average.

Labelling: environmental product label "Blue Angel"

Since 1977 the "Blue Angel" *(Blauer Engel),* a national environmental label, has been used in Germany to raise consumer awareness about environmentally optimal products and services. This includes criteria such as excellent product quality and long service life, but also efficient energy use and renewable energies. Products which impact the energy efficiency in existing residential buildings include:

- SEEC-free and energy-efficient refrigerators and freezers;
- low-emission oil-atomising burners;

94. *The campaign has been in co-operation with energy supply companies (EnBW Energie Baden- Württemberg AG, E.ON AG, RWE AG, Vattenfall Europe AG) and is supported by the BMWi. The whole budget of the first phase of the campaign was EUR 13 million: EUR 8 million being provided by the electricity supply companies, EUR 2.8 million by the Federal Ministry of Economics and Labour and EUR 2.2 million by the Federal Environment Foundation* (Bundesstiftung Umwelt) *(IEA 2003; MURE-database, measure GER34).*

- special gas-fired boilers;
- combination water heaters and circulation heaters for gaseous fuels;
- solar powered products;
- natural gas condensing boilers;
- gas room heaters and gas heating elements.

Altogether, about 3 800 products and services from approximately 710 label users in Germany and abroad are entitled to carry the Blue Angel label. There is a clearly defined procedure regulating the environmental criteria which have to be fulfilled before the label is issued.

The Blue Angel label is not thought to be particularly effective, even though it has been successfully used to promote certain products and is widely used (Ziesing *et al.,* 1997).

Impact analysis and evaluation

This section is divided in two parts. First, the impact of individual energy policy measures is evaluated and then a general estimation of their overall impact is discussed.

Impacts of individual measures

Table 32 below provides a compiled evaluation of individual measures based on literature review. The evaluations are based on *ex-post* estimations (analysing data from the past and the present) and some on *ex-ante* estimations (projections of the impacts in the future). *Ex-post* estimations can be more reliable if data is available and up-to-date data evaluation methods applied. The methods followed are not fully comparable between the different studies. In some cases free riders, autonomous development and technical progress are taken into account, effects which can considerably act on the net impact of a measure. In other cases these effects are not taken into account. Some of the estimations include not only fuel, but also electricity savings.[95]

Table 32 includes only measures that directly or indirectly affect the existing building stock. However, some measures also affect new and non-residential buildings (new heating equipment) and some measures affect most buildings (the first versions of the Thermal Insulation Ordinances). For example, the estimated impact of the 1994 Thermal Insulation Ordinance covers only new buildings; although the ordinance also applies to existing buildings in the case of substantial renovation work, no quantitative data showing the relevance of such renovations is available. In some cases, a separation of the impact between new and existing buildings was not possible. Indirect effects such as the transformation of the window market through the EnEV are rarely

95. The duration of the policy measure is important to account for; some are in place longer than others. The energy savings also have a certain lifetime, their impact can lessen following the evaluation period. This can depend on the technical lifetime of the measures and on technology replacement. The evaluation period is not necessarily congruent with the measure's period of enactment. The former depends on data availability and the date of the cited evaluation studies. For instance, the impact assessment of the 1978 Heating Installations Ordinance covers only the period up to 1982, since there is no evaluation available regarding the amendment of 1982. Hence, adjustments to the results as reported by MURE were necessary, for instance if the assumed time horizons of a certain ex-ante *estimation lasted beyond the actual effective period (because a measure was amended or replaced earlier than projected), the impact was accordingly reduced (for example Small Scale Combustion Plant or Heating Installations Ordinance).*

reported in the cited studies. To interpret the relevance of the various measures it is helpful to keep in mind the energy demand of the respective sectors. The final energy consumption for space heating in households is assumed to be 1 750 PJ (old federal states) and 220 PJ (new federal states) in 1994, the most recent year with separate figures. The total energy demand of the residential sector (including hot water, electrical appliances etc.) was 2 380 PJ in 1990, 2 560 PJ in 1994 and 2 670 PJ in 2004. The energy demand of the trade, service and business sectors was 1 730 PJ in 1990 and about 1 530 PJ in 1994 and 2004.

Table 32 • Impact of energy policy measures: savings in terms of reduced annual energy demand at the end of the respective evaluation period (savings of different measures are not cumulative)

Nº	Title	Evaluation period	Sector, (Source)	Energy saving R (PJ)	Energy saving S (PJ)
	Mandatory codes and standards				
1	Thermal Insulation Ordinance (1977 – 1982) (only new buildings)	1978-1980	R(1), S		-28.9
2	Heating Operation Ordinance	1978-1989	R(1,2,3), S	12.6	
3a	Heating Installations Ordinance of 1978	1979-1982	R(1), S		53.6 PEp
4	Ordinance on Heat Consumption Metering	1981-1990	R(1), S	62.0 PE	
5	Thermal Insulation Ordinance of 1982 (mostly new build.)	1982-1994	R, S	(high)	(med.)
6	Small-Scale Combustion Plant Ordinance (first effective 1988): Amendment of 1994	1994-2002	R, S(4+)	7.9	3.2
7	Heating Installations Ordinance of 1994	1994-2002	R, S(4+)	64.6	25.8
8	Thermal Insulation Ordinance of 1994 (mostly new build.)	1995-2002	R, S(4)	-41.4	-17.2
9	Energy Conservation Ordinance (EnEV, mostly new build.)	2002-2010	R(5), S (10)	(20.6)a	-95
	Promotion and subsidies				
10	DtA Programmes/KfW Environmental Protection Programme	1984/1999-2003	S		low
11	Joint Programme "Economic Recovery in the new *Länder*"	1990-1992	R(4)	12	
12	KfW Housing modernisation progr. for the new *Länder*	1990-2002	R(4)	54.2a	
13	Ecological Bonus Programme for owner-occupied homes	1996-2002	R(4)	2.0*a	
14	KfW CO_2 Reduction Progamme	1996-2004	R(4)	14p, 22a	
15	KfW CO_2 Building Rehabilitation Programme	2001-2005	R(5,6,7)	20pa	
16	KfW Programme "Housing Modernisation2003"	2003-2005	R(6,7)	24pa	

Nº	Title	Evaluation period	Sector, (Source)	Energy saving R (PJ)	S (PJ)
17	KfW Programme "Housing Modernisation"	2003-2010	R(5)	9.6a	
19	KfW Programme "KfW-Municipal Loan Programme"	2007	S		
	Information				
20	Information and advisory services (1977-)	2004	R(8), S	3.6-7.2a	
21	Support programme for on-site advice on energy conservation in older dwellings (Vor Ort-Beratung)	1991-1997	R(4), S	1.1p	
22	ECO Managment and Audit Scheme (EMAS)	1996	Ind, S		low
23	German Energy Agency (DENA)	2008-2012	R, S (9)		11a)
	Economic instruments				
24a	Energy taxes	1989-1999			
24b	Ecological Tax Reform (1999), Act on the further Development of the Ecological Tax reform	1999-2003	R, S(11,12)	28.2a/ 44.4a/NA	12.4a /NA/ 55.4a
25	Energy contracting		R, S(13)		1/05/03
	Labels, voluntary agreements				
26a	Environmental label «Blue Angel»	1977	R, S	low	low
26b	Energy performance certificate of EnEV	2005-2010	R(5)	6a)	
27	Voluntary agreement with German industry I (Erklärung der deutschen Wirtschaft zur Klimavorsorge I)	1995-2000	S(4)		61.5a
28	Voluntary agreement with German Industry II	2000-2005	S		low

R: Residential Sector; S: Service (tertiary) sector; p: ex-post estimation; a: ex-ante estimation.
** Proportion of existing buildings; PE: Primary energy*

Source: (1) Karl *et al.* (1982), (2) Gruber *et al.* (1982), (3) Fraunhofer-ISI (1982), (4) Ziesing *et al.* (1997), (5) Kleemann and Hansen (2005), (6) Kleemann *et al.* (2003), (7) Brockmann (2006), (8) Duscha (2006), (9) BMU (2005), (10) Markewitz and Ziesing (2004), (11) Prognos and IER (2004), (12) Bach *et al.* (2001), calculations Fraunhofer ISI, as reported by MURE-Database (http://www.isis-it.com/mure/), compiled and partially adjusted by (13) CEPE, ETH Zurich.

Regulatory measures

Regulatory measures have the advantage of being clear to all actors involved and relevant in that they have improved the EE in residential buildings. Increased harmonisation of code standards between states will likely increase the impact of these measures. Ensuring implementation remains a barrier to energy efficiency being improved in existing buildings through codes. This requires capacity-building at the local level. It is hoped that implementation of the EPBD and the mandatory three-year energy efficiency action plans will provide the means to improve follow-up and implementation of regulatory measures. This lack of implementation has been recognised; the ministries responsible for implementing Germany's climate and energy programme, which includes energy efficiency policies affecting buildings, must now report to the Cabinet on implementation progress in 2010 and every two years thereafter (BMU, 2007). In both the residential and the service sector, considerable savings have been achieved by mandatory codes and standards, particularly regarding the installation and the operation of heating systems. Each of these measures yielded savings between about 0.5% and 3% of the heating energy demand in the residential sector. The Thermal Insulation Ordinances had some indirect impact through window energy efficiency and insulation practice (Kleemann and Hansen, 2005). These measures have been sustainable given their positive impact on market diffusion rates for efficient boilers and windows, as well as improving professional practices.

However these evaluations cannot be taken without consideration of other measures such as the financial programmes of the KfW and the information and advice programmes. Though the general approach of the study was to avoid interactions and to count the individual measure savings, the double-counting was deliberately accepted in the case of the EnEV following a request of the client (Kleemann and Hansen, 2005).

Financial and incentive-based measures

The impact of the various promotion and subsidy programmes varies considerably, depending on the duration, the type and the amount of subsidies. The average of the programmes is about 1% of the residential heating demand. In the short term the impact of the ecological tax reform was about 1%. In the mid-term, its impact is expected to increase to about 4% up to 2010 in the case of the service sector (Prognos and IER, 2004; Bach *et al.,* 2001). Generally speaking, earlier programmes yield larger benefits since efficiency gains were more easily achievable due to less efficient reference technologies and practices. A 2005 study showed that the eco-tax achieved its aims of increasing employment and reducing CO_2 emissions: the policy was credited for the mitigation of 20 million tonnes of CO_2 and the creation of 250 000 jobs (Ecologic, 2005).

Taxation is no longer a preferred means of financing energy efficiency improvements. The lack of flexibility and clarity of these measures were progressively transferred to preferential loan programmes. The eco-tax is not highly relevant in targeting barriers to increased energy efficiency in residential buildings, not targeting specific efficiency thresholds. Moreover it is not equitable from a societal point of view, impacting low-income households more than others. The broad exemptions to the tax awarded to industry, manufacturing and agriculture also diminished the law's ecological impact. By raising the cost of energy, it has been attributed to changing consumption patterns, and increasing the market penetration rate of energy-efficient goods and the demand for energy services (Ecologic, 2005). While subsidy schemes do exist, they target a limited number of existing residential buildings and do not provide large financial incentives. Rather, funding support by the various federal ministries has been directed toward the KfW funding programmes for building renovation, which address approximately 95% of existing buildings in Germany. It must also be noted that various subsidy schemes exist at the *Länder* level, which are not covered here.

Voluntary agreements and partnerships

Regarding the relevance and impact of the KfW programmes, Tables 33 to 35 show the amount of loan approvals, the renovated floor area and the number of applications for the KfW *Förderbank* building programmes from 1996 to 2005.

The total volume of low-interest loans over the lifetime of the "Housing Modernisation Programme for the New Federal states" from 1990 to 2002 amounted to EUR 42 billion. About 700 000 loans were extended and approximately 4 million flats in the new federal states were modernised, rehabilitated or newly constructed (KfW, 2003). About 15% of the funds were committed to energy conservation (Prognos/IER 2004). Between 1996 and 2004, the total volume of approved loans within the KfW CO_2 Reduction Programme and the CO_2 Building Rehabilitation Programme amounted to EUR 10 billion with another EUR 1.8 billion in 2005. Note that the figures given in Table 33 include all types of renovation; the share of EE measures as such is estimated to be about 25% of the amounts given. From 1 February 2006, the financial conditions of the CO_2 Building Renovation programme, including "Housing Modernisation" and "Ecological Construction", have been considerably improved due to a common initiative of the new federal government of 2006 (grand coalition between CDU and SPD) and the KfW bank (KfW, 2006). Public funds for these three programmes have been raised to EUR 1.5 billion per year (MURE, 2006).

Table 33 • Loan approvals between 2002 and 2005 of various programmes of the KfW Förderbank *for existing buildings in million current EUR*

Programme name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CO_2 Reduction Progr.	716	436	386	685	564	824	575	675	1 136	87
CO_2 Building Renovation						508	736	1 332	1 470	1 195
Housing Modernisation(*)							162	298	526	567
Total	**716**	**436**	**386**	**685**	**594**	**1 332**	**1 473**	**2 305**	**3 132**	**1 849**

(*) Without the first two phases (Housing Modernisation Programme for the new Federal states) where about EUR 42 billion were approved between 1990 and 2000.

Source: CO_2 programmes up to 2004: Kleemann, M. and P. Hansen (2005), *"Evaluierung der CO_2-Minderungsmaßnahmen im Gebäudebereich"* (Evaluation of the CO_2 mitigation measures in the building sector), study on behalf of the Federal office for building and regional planning (BBR), Jülich research centre series, Environment, Volume 60, Jülich Research Centre. CO_2-programmes in 2005, Modernisation programme: KfW (diff.years), MURE database (2007).

The programmes in Table 34 covered a total 73.1 million m^2 of living space in existing buildings in about 880 000 dwellings whose energy efficiency was improved. This is equivalent to about 2.2% of the total building stock of 3.3 billion m^2. In view of the ambitious CO_2 reduction goals this might appear to be quite low for a period of nine years. However this trend is increasing. Between 2000 and 2004, about 10 million m^2 were renovated with support of the two CO_2 programmes, equivalent to 16% of the annual renovation market of 60 million m^2, as estimated by Kleemann, Heckler *et al.* (2003).

Table 34 • *Cumulative space of living with energy efficiency improvement promoted by the* **KfW Förderbank,** *in million m²*.

Programme name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CO_2 Reduction Progr.	8.9	14.2	18.6	24.5	29.8	37.8	43.2	49.8	56.8	N/A
CO_2 Building Renovation						2.6	6.2	11.1	16.3	N/A
Total	**8.9**	**14.2**	**18.6**	**24.5**	**29.8**	**40.4**	**49.4**	**61**	**73.1**	**N/A**

Source: Kleemann, M. and P. Hansen (2005), "*Evaluierung der CO_2-Minderungsmaßnahmen im Gebäudebereich*" (Evaluation of the CO_2 mitigation measures in the building sector), study on behalf of the Federal office for building and regional planning (BBR), Jülich research centre series, Environment, volume 60, Jülich Research Centre.

Table 35 • *Number of applications between 2002 and 2005 for various programmes of the* **KfW Förderbank**

Programme name	2002	2003	2004	2005
CO_2 Reduction Programme	22 616	29 202	36 450	1 964
CO_2 Building Renovation Programme	14 252	22 213	24 761	24 545
Housing Modernisation Programme	937	8 430	12 452	20 383
Total	**37 805**	**59 755**	**73 663**	**57 167**

Source: KfW (different years).

For the period 2000 to 2004, the annual CO_2 mitigation of the CO_2 programmes was estimated to be 2.72 million tonnes (Kleemann and Hansen, 2005), which corresponds to about 2.2% of the 2001 emissions of the German residential sector. In 2006, the KfW estimates its programmes resulted in 1 million tonnes less of CO_2 being emitted, due to building renovation; for 2007 the figure is estimated to be 0.7 million tonnes. The programmes have also led to market stimulation by creating demand for services in energy efficiency improvements. In 2006, 500 000 jobs were created as a result of the kfW programmes, and in 2007 the figure is estimated to be 440 000 (KfW, 2008).

The preferential loan programmes offered by the KfW are a relevant measure in targeting the upfront financial barrier to investing in energy efficiency improvements in existing residential buildings. Only a portion of the loans were designated toward EE improvements, though the new financial conditions and structure of the KfW programmes should increase funding for these types of improvements. The advantage of loan programmes is their flexibility; they have already been restructured with success. They are also potentially sustainable, being able to transform housing loan provision and the real estate market so as to include energy efficiency and make it financially viable for housing owners, buyers and renters.

Information and capacity-building programmes

Estimation of the impact of soft measures is filled with uncertainty for two main reasons: their less clear target, and their high interaction with other programmes. An example is the work of DENA, which consists mainly of pilot projects and information campaigns. A rough indication can be derived from the new German National Climate Protection Programme 2005 (BMU 2005), where the total CO_2 reduction potential of public relations campaigns, counselling and innovation in the period 2008-2012 is estimated at 0.7 million tons of CO_2, which corresponds to about 11 PJ. These savings are a result of various capacity-building measures such as: training courses and quality improvement initiatives; supporting research into improved energy efficiency of building materials; and developing the energy savings contracting system of the heating market. They also include large-scale public information campaigns and upgrading DENA to be a centre of expertise for energy efficiency.[96] Information and advice centres can be sustainable in that they encourage demand for energy services. Energy advisors working for information centres must be trained, and standardised procedures have been elaborated for providing energy advice and conducting on-site assessments. The increase in energy advice consultations seen in 2005 was accounted for mostly by enquiries relating to building certification (SErENADE, 2007); it is hoped implementation of the EPBD and EPCs will increase the role these centres play in guiding those making energy improvement decisions affecting residential buildings.

Currently energy advisors do not give information regarding energy certification or financial support schemes available, as these are covered by other organisations. This would need to be modified to increase the sustainability and relevance of these measures. However, energy advisors consider that in most cases the advice they give is useful and that most measures recommended are implemented (SErENADE, 2007).

The creation of DENA made the provision of information and capacity-building programmes more effective, ensuring their coherence and clarity. Cooperation with various actors is also a strong point since it increases the potential that policies will be sustainable. An example is the involvement of energy supply companies in energy efficiency information campaigns. The DENA hotline is also considered an effective measure, as it is free, simple to use and open 24 hours, making it a useful point of first contact for those seeking advice (SErENADE, 2007). As for the "Blue Angel" label programme, though widely used and successful in promoting certain products, overall it has not been considered particularly effective in promoting energy efficiency (Ziesing *et al.,* 1997). However, it might contribute to increased transparency and promote shifts in the market for appliances, particularly given it is a long-running programme.

Overall impacts

Since the relative maximum level of energy consumption in 1987, on average final energy consumption has been slowly decreasing. It is difficult to measure the precise impact of each policy individually. These include structural changes (more new buildings which are relatively more efficient), autonomous technical progress (in particular more efficient boilers) and autonomous renovation activity as well as the effect of policy measures.

96. *More details on assumptions of the individual estimations are available from the measure descriptions of the MURE-database (available: http://www.mure2.com) or from the cited sources.*

A company record of heating meters in rented housing, which recorded the amount of heat consumed for the heating bill according to the Ordinance on Heat Consumption Metering (Techem, 2006) supports these findings. The record covers more than 200 000 oil-heated multi-family dwellings in both existing and new buildings. The average, climate-corrected consumption of the housing stock fell from 28 L/m^2a (approximately 280 kWh/m^2a) to about 18 l/m^2a (approximately 180 kWh/m^2a) between the heating periods 1977/78 and 2001/02, that is by about 35% (Techem, 2006). In principle, the heating-oil consumption of the housing stock shows the same trend and relative dependency on oil prices as the final energy consumption of all sectors.

This drop in heating consumption is primarily due to the much stricter insulation standard for new buildings, to increased heating efficiency (new buildings, replacement and operation) and only secondarily to the renovation of the older building stock.

Further, evidence supports the idea that combining different policies was much more useful than individual policies standing alone. The standards of the Thermal Insulation Ordinances which have been tightened at different stages, reducing the annual energy demand for heating by approximately 30% at intervals of about ten years, would not have been as effective without the implementation of concurrent information programmes to prepare the customers. Equally important was the further education and vocational training of building professionals and equipment fitters so that the new technologies were correctly installed and used, and not hindered by price increases due to ignorance or uncertainty. Here, what had happened during the market introduction of solar technology served as a lesson. Applications for this technology were often rejected by firms because they did not know how to install the systems. There were also the loan programmes of the KfW to overcome market obstacles. These were only taken up very hesitantly to start with and the funds available were often not fully used in the 1980s and 1990s. Only at the beginning of this century did these programmes find greater acceptance once the application procedure had been simplified, the rather confusing mix of diverse programmes concentrated and, above all, targeted information campaigns conducted. Thus, sustainability of policies can be obtained only through a combined policy approach. In the example of Germany regulatory measures such as the EnEV are used in determining KfW loan funding amounts, and an evaluation of improvement measures to be undertaken is effectively provided through information and advice centres.

Conclusion

For more than 30 years, a policy to increase energy efficiency in buildings has been pursued in Germany. This already targeted the existing buildings of that time, some of which had very low insulation quality. In the first phase policy measures were mainly focused on codes and standards, supported by some information activities. Promotional measures, mainly in terms of preferential loans, became relevant in the 1990s.

In 1976, the EnEG created the framework for a series of ordinances aimed at lowering the energy consumption of buildings.

Each time regulations were updated, the energy demand for new buildings was lowered by approximately 30%. For existing buildings, higher insulation values were stipulated for roof, walls and windows in the case of large retrofits, if the building structures underwent extensive renovation of more than 20%. In 2002, the WSchVO and Heating Installations Ordinance was replaced by the Energy Conservation Ordinance, which used the primary energy demand as an efficiency criterion for the first time. Although these legal requirements are primarily focused on new buildings, they have a certain indirect effect on existing buildings. The transformation of the boiler and window markets is a case in point; the regulations resulted in sustainable transformation of condensing boilers and low-e glazing windows, whose production costs reduced dramatically and resulted in high penetration of the construction market. These impacted existing residential buildings as well, in the case of replacements and renovations.

At the end of the 1980s, an energy tax was introduced for heating oil. The Ecological Tax Reform of March 1999 and the Law Continuing the Ecological Tax Reform of December 1999 set further economic incentives for energy conservation with taxes specifically targeting final energy use. Taxes for heating oil and gas were increased and a tax for electricity consumers was introduced. Programmes to inform both the public and building sector professionals, the craftsmen, planners, architects and engineers involved, were initiated to run alongside these legislative measures in order to increase the acceptance of the measures and to familiarise the participants with the new technologies. These activities were bundled and extended in 2000 with the creation of the German Energy Agency (DENA).

Well aware that these legislative and informative measures are not sufficient to achieve a breakthrough in building renovation of older buildings, funding programmes at the state-owned KfW Promotional Bank have been designed to give low-interest loans to those willing to refurbish their homes or non-residential buildings. The offered low-interest loans were only taken up very hesitantly to start with and the funds available were often not fully used in the 1980s and 1990s. Starting in the year 2000 the programme began to take off, once the application procedure had been simplified, the rather confusing mix of diverse programmes concentrated and, above all, targeted information campaigns launched. The impact of the individual measures varied considerably, depending on their duration, their approach and their scope. The policy measures yielded energy savings between 0.5% and 4% of the heating or the total energy demand of the sector, with an average of about 1%. A larger number of measures targeted the residential sector more than the service sector, such as preferential loans which for a long time mainly targeted the residential sector. Although the impact of the individual measures are not cumulative, one can state that the energy demand of the existing building stock would be some 10% to 20% higher if the different policy measures would not have been implemented.

Overall the German case stands as a direct illustration of the notion that sustainable market transformation and effective reduction in energy consumption can only be achieved through a mix of policies. Here the combination of regulatory instruments, with information programmes, public-private partnerships, and capacity building proved very effective.

Chapter 8 • THE UNITED KINGDOM

Introduction

The United Kingdom (UK) provides a useful case study as it has a proven and successful track record of energy-efficient policies. UK energy policy is primarily shaped by environmental objectives, with most measures relating to reductions in carbon dioxide (CO_2) emissions and being developed within the framework of the UK's European and international environmental commitments. Other factors shaping UK energy policy are sustainable economic growth and social commitments to ensure all homes are affordably heated. Increasing energy efficiency is one of the government's energy policy priorities. The existing residential sector is particularly targeted since it offers a means of cost-effectively reducing energy consumption while fulfilling social commitments. It is seen as a cost-effective means to reach the government's greenhouse gas emission reduction target. More recently reference to energy efficiency's contribution to the UK's energy security has also been emphasised.

This chapter provides an overview of policies aiming to improve energy efficiency in existing residential buildings, along with the institutions and conditions which impact their implementation. Individual programmes which implement the policies are also administered at the devolved administration level, meaning that separate but similar programmes co-exist in England, Wales, Scotland and Northern Ireland. Where programmes apply only to particular administrations this will be indicated in the text. Finally, it provides a summary of existing impact studies, highlighting particularly successful programmes or instruments.

National context and policy framework

National context and energy profile

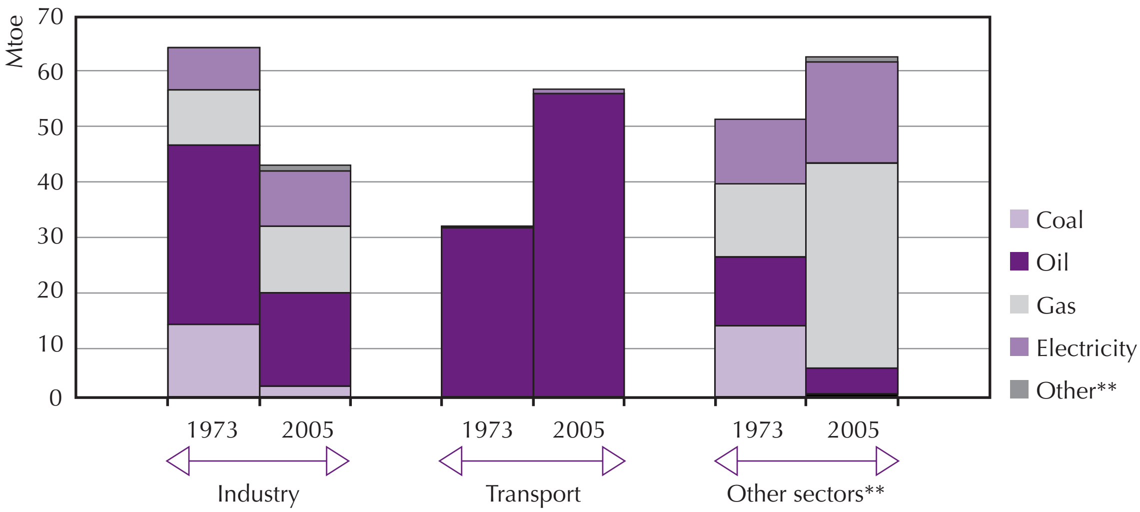
Energy profile

Both total primary energy supply (TPES) and total final consumption (TFC) have risen considerably less in the UK than in the OECD countries as a whole. The UK TPES in 2004 was 234 Mtoe, only 6% higher than 1973. The OECD countries as a whole saw an increase in TPES of 46% over the same period.[97] The modest UK TPES growth is largely the result of decreased coal use and its replacement by more efficient energy sources. In 2004, the UK TFC was 164 Mtoe, an increase of 11% since 1973. TFC grew 35% for the OECD countries as a whole over the same period. These trends have continued in recent years. From 2000 to 2004, UK TPES grew a total

97. This and all averages in this section represent a weighted average of countries' data.

of 0.3% (compared to 3.4% for the OECD as a whole) and TFC grew 1.6% (compared to 4.0% for the OCED) (see figure below).

Figure 60 • *Breakdown of sectorial final consumption by source in 1973 and 2004*



Source: IEA (2007c), *Energy Balances of OECD Countries*, IEA/OECD, Paris. The "other sectors" category includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

The following graph shows that energy consumption per person has increased by 18% since 1970. By 2000 energy consumption per household was 6% below 1970 levels and energy consumption per unit of household disposable income fell by 44% between 1970 and 2000.

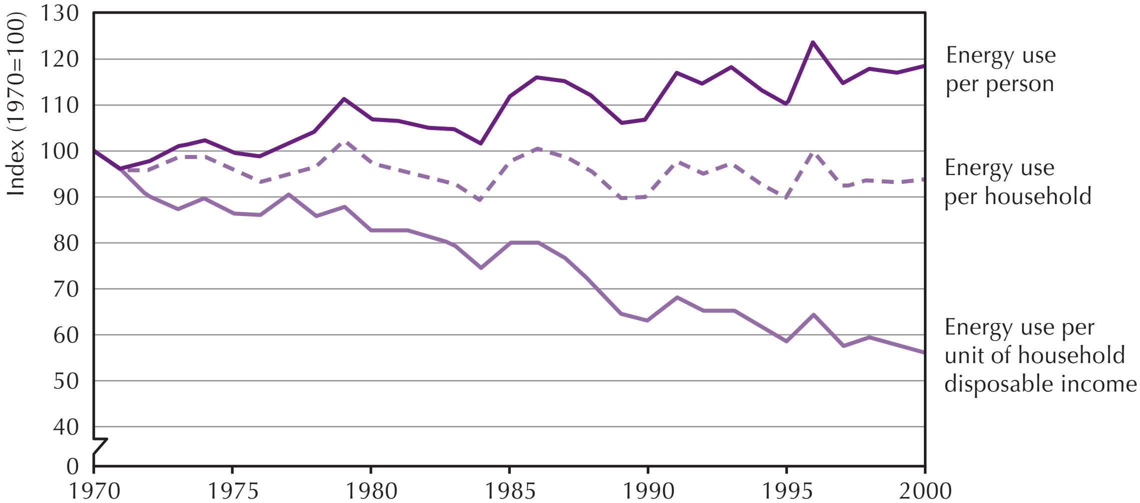
In 2004, UK aggregate energy intensity, as measured by a ratio of the country's TPES in tonnes of oil equivalent (toe) over its national gross domestic product (GDP, in thousands of 2000 USD), was 0.147 toe per USD 1 000. This was the fifth lowest energy intensity in the IEA (behind Japan, Switzerland, Denmark and Ireland) and 26% below the OECD average (See Tables 37 and 38).

Figure 62 and Table 36 below compare UK national energy intensity to the IEA average as well as to selected countries.[98]

The UK was the first country to deregulate its electricity market. The legal framework enabling the effective launch of liberalisation took shape in 1989 with the Electricity Act. A series of reforms then followed which culminated with the Utilities Bill in 2000. Today there are 17 electricity distributors, seven of which are national; all are free to set their prices and organise their development as they want. Since competition was introduced in 1990, real electricity bills for individual consumers have declined by 30% on average (IEA, 2002). However, the UK's household electricity prices remain higher than in other countries where prices are regulated (*e.g.* France).

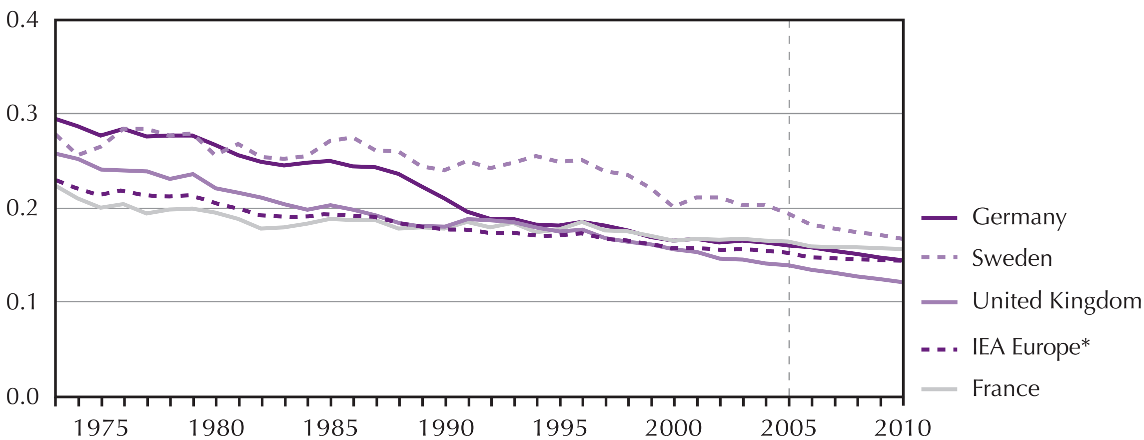
98. Caution should be placed however on the validity of these numbers to the extent that GDP measures can vary, and is to some extent subjective.

***Figure 61* • Domestic energy consumption (per person, per household and per unit of household income)**



Source: BERR (2007), *Energy Consumption in the UK,* UK Department for Business, Enterprise and Regulatory Reform, London.

***Figure 62* • Energy intensity in the UK and in other selected IEA countries, 1973 to 2010** *(Toe per thousand USD/2000 and purchasing power parities)*



Sources: IEA (2007c), *Energy Balances of OECD Countries*, IEA/OECD, Paris; IEA (2007d), *National Accounts of OECD Countries*, OECD/IEA, Paris, and country submissions.

Table 36 • *Decrease in energy intensity measured as TPES/GDP (toe per thousand 2000 USD)*

Country/Region	1973 to 2004	1983 to 2004	1993 to 2004
UK	**-46%**	**-31%**	**-24%**
France	-26%	-8%	-11%
Germany	-44%	-34%	-14%
Australia	-24%	-21%	-17%
United States	-46%	-31%	-20%
Japan	-26%	-4%	1%
OECD Total [1]	**-36%**	**-21%**	**-12%**

[1] *Weighted average of all countries.*

Source: IEA (2005), *Energy Balances of OECD Countries,* IEA/OECD, Paris.

Disaggregated measures of efficiency and/or intensity can help identify areas in an economy where a country may be more or less energy efficient compared to other countries. At the same time, such measures can be misleading because the relevant country characteristics can vary so much. Important differences could be the size and type of a country's industry, climate and geographic size and distances to be travelled. A series of data from IEA analyses is provided in Table 38 which compares UK energy use to other countries by sector. Such data can be very instructive but due to the many extraneous factors, should be considered indicative rather than providing a direct measure of each country's efficiency in each sector.

Table 37 • *Measurements of energy use by sector for UK and other IEA countries*

	UK	US	France	Germany	Japan
Energy use per unit of manufacturing added value, MJ/USD (1999)	**6.99**	~ 9.40	7.1	6.37	7.3
Energy use per unit of service sector added value, MJ/USD	**1.1**	1.36	1.11	1.07	0.85
Car fleet average fuel intensity, L/100 km	**8.96**	10.89	7.41	8.49	7.69
Residential energy use, GJ/capita (1998)[1]	**31.48**	41.25	34.05	30.05	19.28

[1]*Residential energy use is normalised for climate at 2 700 degree days. It includes space heating, water heating, cooking, lighting and appliances.*

Source: IEA (2004), *30 Years of Energy Use in IEA Countries,* IEA/OECD, Paris.

Table 38 • Measurements of energy intensity by sector for UK and other OECD countries

	UK	France	Australia	*Average*[1]
Industry	**0.025**	0.027	0.04	0.039
Residential	**0.027**	0.031	0.016	0.025
Commerce and public services	**0.01**	0.009	0.01	0.015
Transport	**0.033**	0.032	0.05	0.044

[1]*Weighted average of all the OECD countries.*

Source: IEA (2006), *Energy Balances of OECD Countries*, IEA/OECD, Paris.

Notes: Figures show final consumption in each sector per national GDP, toe per thousand 2000 USD.

Climate indicators

The climate in the UK is quite irregular but generally cool and mild with frequent clouds and rain. Though the amount of rainfall varies greatly according to region (from 5 000 mm in the western highlands of Scotland to 500 mm in parts of East Anglia), and the number of rain days ranges from 150 to 200 days in drier areas, to just over 250 days in the wettest areas. In general, the South of the UK is warmer than the North, and the West wetter than the East. Mountainous regions experience more extreme weather, where it is often wet, cloudy and windy.

On average, January is the coldest month in the UK, and July the warmest. During the cold months, inland temperatures are lower than those near the coast, particularly the west coast. In the summer the opposite takes place, with coastal areas having lower temperatures than inland ones. The mean temperature in January ranges from 3 °C to 9 °C in the South, and between -4 °C and 2 °C in the North. In July, this ranges from 14 °C to 19 °C in the South and from 6 °C to 13 °C in the North. Over the year, the sunniest parts of the UK are flat areas along the coast. Some sites along the south coast receive 40% of the maximum sunshine possible per year (1 800 out of 4 000 hours). The mountainous areas receive the least amount of sunlight, with an average of less than 1 000 hours of sun per year (Met Office, 2007). The winter months also have less sunshine because of frequent fog and low clouds due to wind from the Atlantic that brings in humidity.

Energy use for space heating demand rose between 1990 and 2004, the main factor driving the 13% increase in household fuel consumption during this period (IEA, 2007b; Mure, 2006). However, overall household efficiency improved by 11% during the same period, with most improvement occurring in the early 1990s (Mure, 2006).

The following section will examine the UK's energy policy goals and the main bodies which develop policies and manage their implementation.

Policy and institutional framework

Policy goals and strategies

The UK is active in trying to reduce greenhouse gas emissions. It signed the Kyoto Protocol in 2002 with other members of the European Union. Under the EU burden sharing agreement, the UK has a target of reducing greenhouse gas emissions by 12.5% below 1990 levels in the first commitment period (2008-2012). In its 2003 Energy White Paper the government adopted an ambitious goal of reducing greenhouse gas emissions by 60% by 2050. This remains one of the UK's four energy policy goals, along with: i) maintaining the reliability of energy supplies; ii) promoting competitive markets at home and beyond, helping to increase sustainable economic growth; iii) ensuring that every home in the UK is adequately and affordably heated. The UK has already surpassed its Kyoto target, having reduced emissions by 15% between 1990 and 2004 alone. Energy efficiency is at the heart of the UK strategy to reduce emissions. Improved energy efficiency is estimated to represent 35% of the emissions reductions achieved so far, the single most important factor identified (Defra, 2006a).

In the UK then, the prioritisation of energy efficiency is rooted in environmental targets and obligations. In recent years, energy efficiency has emerged as one of the government's primary tools in meeting its energy policy objectives. The Energy White Paper of 2003 made a strong case for improved efficiency stating that "the cheapest, cleanest and safest way of addressing our energy policy objectives is to use less energy." The White Paper elaborated a vision whereby half the expected emissions reductions through 2020 would come from improved efficiency. Subsequent annual reports on the implementation of the Energy White Paper track the progress made in this area.

In April 2004, the government released *Energy Efficiency: the Government's Plan for Action*. This report further examines the potential savings identified in the White Paper and lays out plans to deliver over 12 million tonnes (Mt[99]) of additional CO_2 savings through energy efficiency by 2010. In the household sector, the plan aims to deliver savings of approximately 3.5 million tonnes of CO_2 from homes by 2010.

In December 2005, the government published the *Energy Efficiency Innovation Review: Summary Report*. This report summarises the conclusions of the Energy Efficiency Innovation Review (EEIR) launched jointly by the Department for Environment, Food, and Rural Affairs (Defra) and HM Treasury in the Pre-Budget Report 2004. The document offers a detailed analysis of the scope, costs and benefits of enhanced action on energy efficiency. It states that while the UK has made good progress in reducing emissions, substantial new action would be needed to meet the goal of reducing CO_2 emissions 20% below 1990 levels by 2010. The report analyses existing programmes in the household and business sectors and various ways to effectively expand them. It also considers new demand-side efficiency technologies.

The Climate Change Programme (CCP), published on 28 March 2006, provides further details on government plans for improving efficiency. This programme lays out the full range of existing

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99. With 1MtC = 3.67 $MtCO_2$.

and proposed measures to curb carbon emissions. Efficiency and other demand-side efforts feature prominently in all sectors. Defra estimates that over half the savings in the CCP are derived from energy efficiency policy. According to Defra, residential building regulations alone could result in potential annual emissions savings of 1.4 MtC by 2010, while Energy Efficiency Commitment (EEC)[100] can be expected to result in about 1.8 MtC of annual savings in the same time frame (Defra, 2007a).

The May 2007 White Paper on Energy reiterates the UK's commitment to tackle climate change by reducing carbon dioxide emissions, and ensuring clean, secure and affordable energy. The starting point for meeting these goals is to save energy, and the Paper asserts that action must be taken domestically and internationally. The Paper announces the enhancement of several existing programmes targeting energy efficiency in households, with the aim that by the end of the next decade all homes will have achieved their cost-effective energy-efficient potential (DTI, 2007). It also commits to publish annual performance targets and standards for a range of products for the period to 2020, in order to signal long-term ambition and priorities to the supply chain and encourage innovation. Defra's *Energy Efficiency Action Plan* of June 2007 elaborates on the manner in which the White Paper goals will be put into practice. The Plan outlines programmes which target what it sees as the primary barriers hindering energy efficiency measures in buildings and for the individual, namely lack of information and motivation along with split incentives (Defra, 2007a).

Actors

Department for Business, Enterprise and Regulatory Reform (BERR)

The Department of Trade and Industry (DTI), now known as the Department for Business, Enterprise and Regulatory Reform (BERR), has the primary responsibility for the development and implementation of UK energy policies on the supply side. BERR role is to set out a fair and effective framework in which competition can flourish for the benefit of customers, industry and suppliers, which will contribute to the country's environmental and social objectives.

Department for Environment, Food and Rural Affairs (Defra)

The Department for Environment, Food and Rural Affairs (Defra) is the government department in the UK in charge of environmental protection, working for the essentials of life including water, food, air, land, people, animals and plants. Defra is responsible for developing and implementing the UK's policy on climate change and its policy on energy efficiency. In promoting sustainable development, Defra's five strategic priorities are: i) climate change and energy; ii) sustainable consumption and production; iii) protecting the countryside and; iv) natural resource protection, sustainable rural communities and a sustainable farming and food sector, including animal health and welfare.

100. This policy will be discussed in detail further in the chapter.

Office of Gas and Electricity Markets (Ofgem)

The Office of Gas and Electricity Markets (Ofgem) is the government regulator of gas and electricity markets in England. Its two primary goals are promoting effective competition where necessary and regulating the monopolistic companies which run the market. Funding is obtained from the energy companies who are licensed to run the gas and electricity infrastructure (Ofgem, website).

Community and Local Government (CLG)

Community and Local Government (CLG), formerly the Office of the Deputy Prime Minister (ODPM), sets UK policy on local government, housing, urban regeneration, planning and fire and rescue. It is responsible for building regulations and some housing issues in England and Wales, though most of its work applies only to England. Energy efficiency programmes relating to buildings in England are largely administered by CLG.

Energy Saving Trust (EST) and Carbon Trust (CT)

The Energy Saving Trust (EST) and the Carbon Trust (CT) are independent bodies funded by the government which promote energy savings and the reduction of carbon emissions. The EST is geared at delivering energy efficiency solutions to households and the general public through 52 Energy Efficiency Advice Centres (EEACs) and the Energy Efficiency Campaign. The EST is upgrading their existing national network of EEACs into 16 holistic regional centres. These will provide advice not only on energy efficiency, but also water, waste, microgeneration and low-carbon transport. The CT is responsible for helping business and industry reduce their carbon emissions and meet CO_2 emissions reduction targets by providing information and impartial advice on energy savings and carbon management.

The activities of the above actors often complement each other, and some of their programmes target the same barriers or segments of the population. They are often required to co-ordinate their activities to manage the policy measures described below.

Policy measures

This section will give an overview of policies implemented in the residential sector in the UK, drawing on the classification developed in the introduction.

Regulatory measures

The Energy Efficiency Commitment (EEC)/Carbon Emissions Reduction Target (CERT)

The EEC is the principal policy mechanism driving improved efficiency in existing homes. The GB-wide EEC (excluding Northern Ireland) sets energy savings targets to electricity and gas suppliers in the residential sector in order to improve the energy efficiency of households. The EEC allows some flexibility in the means to implement the targets. Suppliers can thus fulfil their obligations by carrying out any combination of approved measures, including installing insulation or supplying and promoting low-energy light bulbs and high efficiency appliances. Suppliers under the current EEC must achieve all their savings in the household sector and at least half of their savings obligation must come from households which receive income-related benefits and/or tax credits, the so-called "priority sector." During the 2008-11 period, 40% of savings obligations must come from the priority sector. The purpose of the "priority sector" is to achieve a proportion of the annual energy savings in low-income households for reasons of equity. This instrument specifically addresses the household sector, which is not subject to a Climate Change Levy or the EU ETS directly.

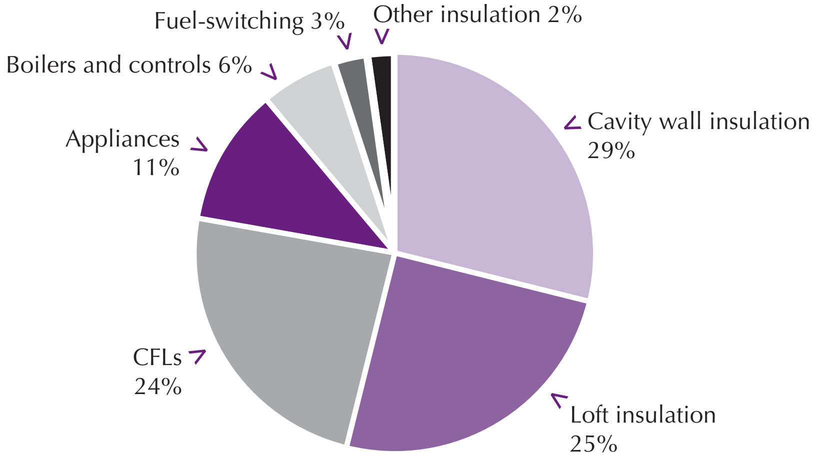
The EEC targets and policies are set by Defra but operated and administered by the Office of Gas and Electricity Markets. Ofgem sets the suppliers' targets, assesses proposals for saving schemes, monitors activity, approves compliance schemes and enforces compliance when necessary. For any specific measure implemented by any supplier, annual energy savings are determined by calculating the difference between business-as-usual energy use and energy use with the measure put in place. The annual energy use is then discounted over the expected lifetime of the measure and is fuel-standardised.

While the EEC/CERT does not provide tradable certificates based on the energy savings obtained, like in France and Italy, flexibility is assured by allowing for energy savings and individual obligations to be traded between suppliers. Suppliers can buy or sell energy savings that are already verified and approved by Ofgem to other suppliers. They can also trade their obligation, or a part of it, to other suppliers. The supplier paid to meet the extra obligation will thus be required to meet both its own energy saving target and the additional obligation. This is done through a written agreement certified by Ofgem, after which obligations are re-allocated (Oikonomou and Patel, 2004). However in practice thus far, little of this trading has taken place among suppliers (IEA, 2007a).

The first phase of EEC ran from April 2002 to March 2005 for 12 supplier groups. All energy suppliers, except two, successfully met their targets and were able to bank additional activity into the next phase of the scheme. EEC 2002-05 is expected to save 0.3 MtC annually by 2010. The current phase EEC2, running from April 2005 to March 2008 will deliver roughly double the level of activity of EEC1 and is expected to achieve annual carbon savings of around 0.5 MtC by 2010. The CCP of March 2006 allowed the government to expand the EEC further, targeting around 1.1 of annual MtC savings for EEC3, known as the Carbon Emission Reduction Target (CERT), covering the period 2008-11. CERT has the same framework and purpose as EEC, with an expanded range of measures including microgeneration and behavioural measures. Legislation for CERT was completed in early 2008, allowing Ofgem and energy suppliers to prepare for its start in April 2008 (DTI, 2007).

The results of the EEC have so far been positive. Suppliers have met – and very often exceeded – their targets, and the costs for doing so have been less than expected by Defra. During the three year period of EEC1 (2002-2005), measures put in place resulted in 86.8 TWh of savings. This is nearly 40% higher than the target of 62 MtC of savings from that time period (Eoin Lees Energy, 2006). The "extra" savings can be carried over to the EEC2 (2005-2008). Savings in the priority sector were around 42 TWh, while those in the non-priority sectors were around 42 TWh (Ofgem, 2005a). The figure below shows how much each set of measures contributed to the total savings for all obligated suppliers.

Figure 63* • *Energy savings by measure type as a percentage of total savings for EEC1



Source: Ofgem (2005b), Energy Efficiency Commitment Update Issue 13, August 2005.

In its February 2006 report to Defra on the EEC1, Eoin Lees Energy calculates that the EEC1 measures have been realised at a total cost of GBP 1.3 pence (p)/kWh for electricity and GBP 0.5/kWh for gas. These figures include all costs from both the obligated supplier and the consumer who may contribute to some of the cost of the measures implemented. The cost of savings for both electricity and gas are less than the consumer prices for these fuels, which the report cites as GBP 6.7 p/kWh for electricity and GBP 1.7 p/kWh for gas in 2004 (These consumer prices have risen significantly, with electricity prices having increased by 50% and gas prices by 90% since 2003).

As for the effect on customers' bills, Eoin Lees Energy in the same report calculates that the average customer's bill has risen to GBP 3.18 per year per fuel. This is around 20% less than the expected customer bill increase estimated by Defra given the energy price increase. Ofgem estimated in April 2006 that for EEC2, the likely increase to each customer's bill will be GBP 9 per fuel per year. To put this indicative figure in context, energy bills in the UK currently average GBP 380 and GBP 630 per year for electricity and gas respectively (EnergyWatch, 2007). Of course, the activity of the suppliers and the degree to which they must financially incite consumers to implement energy savings measures is inversely related to energy prices. High energy prices – and public and press attention to these prices – will motivate consumers to be more energy efficient even if there were no supplier activities through the EEC. It is therefore possible that the amount suppliers' need to spend to achieve their savings obligations will be less than anticipated for EEC2.

Defra (2006b) has estimated that the measures implemented in EEC1 resulted in a negative cost of around GBP 300 per tonne of carbon emissions reduced. In other words, the measures were cost-effective without taking the benefits of reduced emissions into account.

Results thus far for EEC2 (2005-2008) show that savings are being achieved at rates well above the obligation levels. The carry-overs from EEC1 equal 27% of the suppliers' EEC2 obligations for the whole three-year period. By the end of the programme's first year, 60% of target energy savings were achieved and 93% have been achieved by the end of the second year, with two suppliers having already met their targets (Ofgem, 2007). In addition, anecdotal evidence suggests that, the high UK energy prices seen in the winter of 2005 have fostered increased natural energy savings' activity. Thus, it is likely that suppliers will meet their EEC2 obligations without undue difficulty and are likely to again carry-over substantial savings to the subsequent period (IEA, 2007a).

The target level for CERT is broadly double of that under EEC2. The programme will provide new and more flexible routes for innovation and offer a broader range of options for business models. CERT may represent a first step towards transforming the energy marketplace, towards a position where suppliers' businesses are more about selling energy services rather than units of energy. This is meant to make customers' energy usage become an integral part of suppliers' business (DTI, 2007).

Regulations such as the EEC are relevant to overcome financial barriers in that they help to introduce increased certainty and impose minimum thresholds of performance. Although the EEC does not contain direct financial provisions, it fixes the context wherein suppliers are forced to promote energy efficiency thereby contributing to create a market by increasing demand from consumers and increasing certainty on the amount of energy saved. Moreover, regulations tend to be clearly understood by the different actors since they send a simple message and target a specific need. The latest programme, CERT, may start to transform the energy provision market itself to make energy efficiency and customer energy usage part of suppliers' businesses. This momentum will also be sustained, since the government's 2006 Energy Review announced that some form of supplier obligation would be in place until at least 2020 (Defra, 2007a).

Northern Ireland Energy Efficiency Levy

The Northern Ireland Energy Efficiency Levy (EEL) Programme has been running since 1997, when it was introduced by the Office for the Regulation of Electricity and Gas (Ofreg). The EEL is not a legal obligation on suppliers; a levy is charged per customer and is available to all suppliers wishing to promote energy conservation projects. It runs parallel to the EEC and CERT programmes. The size of the levy has increased over the years, with customer contribution for 2007-09 set at approximately GBP 7, resulting in funds of GBP 5.6 million.

The initial aim of the EEL was to reduce carbon emissions through the implementation of energy efficiency schemes for domestic supplier customers. With alleviating fuel poverty becoming a rising concern, 80% of the levy funding is targeting at improving poorly heated and inadequately insulated properties. A portion of these funds can support the Warm Homes programme. The remaining 20% is available for non-priority domestic and non domestic customers.

Ofreg sets yearly energy savings targets for suppliers. Not meeting the target does not incur penalties, while an incentive is provided should the target be overachieved. For 2007-08 the target is 374 GWh with an incentive of GBP 4 995 per GWh over achieved. The levy has been in operation for over ten years, and been considered successful. Targets have been consistently over achieved, customer savings over ten years have added up to over GBP 11.5 million, with lifetime carbon emissions savings of over 454 000 tonnes (NIAER, 2006; EST, 2007).

Building regulations and energy performance certificates (EPCs)

The building regulations, implemented under the Buildings Act 1984, set standards for the design and construction of buildings in England and Wales. The regulations define types of building, appropriate procedures and what is expected in terms of performance. Any building work must comply with a set of requirements covering among others individual aspects of buildings, the design and construction, insulation, fire safety, access to and use of the building. A mandatory Building Control Service must be carried out by anyone undertaking significant building work to verify that building regulations are complied with. This control is only compulsory for work that qualifies as "Building Work". Building work is defined as the erection or extension of a building, the installation of a fitting, an alteration project involving work which will temporarily or permanently affect the compliance of the building with the requirements, the insertion of insulation or the underpinning of the foundation of a building (ODPM, 2005).

These regulations are steadily driving up the energy standards of new and refurbished buildings. Since 1990, the energy efficiency of new buildings has increased by 70%. For example, a house built to the 2002 standards uses about half the energy consumed in the average existing house built before 2002. The 2002 Building Regulations (England & Wales) are expected to deliver reductions in carbon dioxide emissions in 2010 of 0.6 MtC in the household sector (Defra, 2007a).

The same building regulations do not apply UK-wide: those in England and Wales are shared, while Northern Ireland and Scotland have separate regulations. The Scottish Building Standards Agency (SBSA) was established in 2004, with the authority to make building regulations further achieve fuel and power conservation and sustainable development objectives. In 2007 building regulations were updated and made more energy efficient in Scotland, which Defra estimates will result in an annual carbon dioxide emissions reduction of 0.1 MtC in 2010, increasing to 0.4 MtC in 2020 (Defra, 2007a). The new regulations have highly demanding standards for the thermal performance and insulation of new buildings, extensions to old buildings and the addition of conservatories. They also require that replaced windows be double glazed and that replacement boilers meet stricter energy efficiency standards. The new standards deliver 18%-25% increased carbon savings as compared with the previous 2002 building regulations (Defra, 2007a). Northern Ireland updated building regulations in 2006 to establish energy efficiency standards for new residential constructions.

In September 2005, the government announced further changes to the building regulations to make buildings more energy efficient. From April 2006, these new measures have delivered increased energy standards for new buildings of around 27% in non-domestic buildings, 22% in houses and 18% in flats. On average, the energy efficiency improvement in dwellings will be 20% which reflects in part the growing proportion of flats being built with more people now living alone (CLG, 2007a). Once again reflecting the environmental concern which underpins energy efficiency policy, the new minimum energy efficiency standards are framed in terms of a target carbon dioxide emission rate (in kg/year per m^2 of floor area) as a result of the provision of heating, hot water, ventilation and fixed internal lighting (CLG, 2007a). The Building Regulations were amended in 2006/2007 in the three UK territories to implement the technical parts of the EPBD. At the same time the three sets of regulations substantially raised EE standards that apply when building work is carried out – either construction or alterations and extensions of all types of new and existing buildings.

Between August 2007 and January 2009, the government will be phasing in a requirement for all homes on the market to produce an energy rating similar to those on domestic appliances. The new energy performance certificates (EPCs) will be required whenever a building is constructed or sold, and includes existing buildings. The measure is part of the UK's commitments as part of the EU Energy Performance of Buildings Directive (EPBD). The purpose of an EPC is to provide buyers and renters with transparent and accurate information on the energy costs of their homes, as well as practical advice on how to cut energy bills and carbon emissions. The government is currently working with the Energy Saving Trust to provide support to households making the changes recommended within EPCs through information on available grants and complementary programmes (DTI, 2007).

Buildings for rent, both new and existing, will also require EPCs starting on 1 October 2008 in England and Wales. As of 10 September 2007, EPCs are required in England and Wales for every home put on the market with three or more bedrooms, as part of a Home Information Pack (HIP) that must be provided when selling a home (CLG, 2007b, 2007c). In Scotland they will be required for the sale of new and existing homes in Autumn 2008 as part of a similar Single Survey Property Information Pack, and for rented buildings in January 2009 (SBSA, 2007). In Northern Ireland the Department of Finance and Personnel is currently establishing regulations for the introduction of EPCs.

As for new dwellings, the UK government has announced the intention to raise standards by a further 25% in 2010, 44% in 2013, and require net zero carbon emissions from new homes by 2016. It has published a paper on how these improvements could be delivered in practice. In tandem with amendments covering new dwellings, the government will be introducing improvements of a similar scale for non-residential buildings, and raising the standards applying to work carried out on all types of existing buildings.

Decent Homes

More directly targeted at overcoming financial barriers is the July 2000 Decent Homes programme implemented in England. Through this programme, the government established a minimum standard below which homes should not fall to ensure that all social housing is made decent by 2010. A decent home must be warm, weatherproof and have reasonably modern facilities. The Decent Homes programme allows local governments to deal with inequalities, tackle fuel poverty and make homes more energy efficient. The energy performance of homes is improved through efficient insulation and heating.

By the end of 2004, the number of non-decent homes was reduced by 1 million for an investment of GBP 18 billion in existing council and housing association homes. Over the period 2004-2006 an additional investment of GBP 7 billion is to be made in existing homes (CLG, 2007d). Since 2001 there has been a 31% reduction in the number of social sector homes failing the standard on the thermal comfort criterion. Also since 2001, over 470 000 dwellings have received work to improve their energy efficiency under the Decent Homes programme or as part of wider local authority work to update the stock (Defra, 2006c). It is expected that 95% of all social housing will be made decent by 2010 (CLG, 2007e).

The government is very active and heavily involved with local authorities to achieve the Decent Homes target by 2010. To assist those in need of funding to meet the required standards the government introduced three options: the Arm's Length Management Organisation (ALMO), the Private Finance Initiative (PFI) and the Registered Social Landlords (RSL).

ALMO started in 2001 and is a company set up by a local authority to manage and improve its housing stock. It operates under the terms of a management agreement between the authority and the ALMO. The ALMO is managed by a board of directors composed of tenants, local authority nominees and independent members. By the end of 2006-2007, ALMO investment in Decent Homes is expected to total GBP 2.6 billion (CLG, 2007f). PFI provides financial support to partnerships between the public and private sector. This initiative offers an alternative to direct procurement, stock transfer or social housing grant for providing investment in social housing. PFI contracts last 30 years and provide maintenance and services in the contracted homes (CLG, 2007g). RSLs are housing associations registered with the Housing Corporation whose regulatory code requires them to meet the Decent Homes standard. These organisations can borrow money from banks and building societies to make their homes decent. It is run by a committee or board made up of volunteers, and in the case of new housing associations a minimum of one-third of the board is made up of tenant representatives (CLG, 2007h). Furthermore landlords can also seek funding from EEC or the Warm Front Programme.

To evaluate the standard of a home and determine if it is decent, the Housing Health and Safety Rating System (HHSRS) is used. This legislation implemented in 2006 assesses hazards in a home and provides guidance on how to tackle these risks. The average Standard Assessment Procedure (SAP) rating of the social sector stock rose from 47 in 1996 to 57 by 2005 and is likely to rise further over the coming years (DITI, 2007). The SAP rates buildings on a scale of 0 to 120, with a higher score indicating higher energy efficiency levels. Homes built according to the most recent England & Wales building regulations, for example, would have a SAP rating of approximately 80 (eaga, 2007a). The Decent Homes standard is a "trigger point" for action to improve energy efficiency, not a level that work should be completed to. As social landlords undertake works beyond the standard, energy efficiency improvements are accelerating which in turn reduces carbon emissions. The CLG's Housing Research Summary (2007i) found that most local authorities and RSLs were undertaking work in excess of the thermal comfort standard, with 96% of them using EEC to carry out the work.

The same report found that some local authorities had problems with the reliability of information about stock attributes and conditions, which are required in adopting the Decent Homes standard. In addition, there remain a number of local authorities and RSLs with limited amount of knowledge about HHSRS and how they impact decent homes. They are concerned with how to collect and model such information, in order to incorporate it into their databases and programmes. Greater clarity and assistance in overcoming informational barriers to implementation would therefore increase the programme's impact.

Complementary programmes: Scotland, Wales and Northern Ireland

In Scotland and Wales, governments have announced Housing Quality Standards (HQS) for properties owned by local authorities and registered social landlords. Both HQS include provisions for minimum standards of energy efficiency. In Wales social landlords are expected to adopt these standards and devise programmes for their properties to meet them by the end of 2012. In Scotland the HQS announced in 2004 are to be attained by 2015. Loft and cavity wall insulation (where technically feasible and appropriate), insulation of hot water pipes and tanks, and that full central heating systems be energy efficient are explicit requirements of the Scottish HQS (Defra, 2007a).

In Northern Ireland, Housing Associations have higher SAP ratings compared to the Northern Ireland average due to their more recent construction dates. The Housing Executive (NIHE) has implemented a variety of measures to improve the energy efficiency of its own building stock. These include conversions of old heating systems to natural gas ones, or oil heating systems where natural gas is not available. Such works are undertaken during planned improvement programmes, though tenants can apply for grants earlier than the planned date for heating system replacement. Building insulation rates have also risen since 2004. Replacement of windows with double glazing has led 43% of the Housing Executive stock to be double glazed, a 27% improvement since 2001 (NIHE, 2005).

Voluntary agreements and partnerships

Market Transformation Programme

Key to the smoothing of refurbishment financing is the creation of a market. As soon as appropriate demand for energy efficiency is created, supply will follow. As such, the government's Market Transformation Programme (MTP) aims to drive and underpin sustainable products through improvements in their energy efficiency and environmental impacts. From a highly regarded evidence base, MTP uses policy tools to assess and rank the performance of energy-using products; establish performance information, including labels; encourage innovation and competition; and identify appropriate levels for minimum, average, or best practice standards. The MTP encourages more effective standards for products and the creation of a competitive market for products based on their environmental performance. It also seeks to accelerate the deployment of innovative technologies and services to support sustainable product development (MTP, 2005).

The EU Eco-design of the Energy Using Products (EuP) framework Directive now provides a powerful formal mechanism for establishing product standards. EuP permits EU member states and the EU itself to signal to industry its product innovation priorities, to negotiate and, if necessary, to set mandatory energy and other eco-design requirements for energy-using products which are placed on the EU market. The Commission estimates that this measure alone could reduce EU energy consumption by around 10%, while a recent IEA study on energy savings in California attributes 30% of all energy saved to product standards of the type envisaged in EuP (*op. cit.* IEA, 2007a). The UK government has already committed to proactively follow this policy approach and, supported by the Market Transformation Programme, is actively determining UK priorities to negotiate with the Commission and other member States. The Commission has identified 14 priority product sectors including consumer electronics, lighting, heating, white goods and electric motors.

In 2006 the government announced a new initiative to promote energy-efficient choices to consumers. In September 2007 the UK government announced a voluntary initiative led by retailers and UK energy suppliers to phase out inefficient light bulbs by 2011, in advance of measures under EuP. In parallel, Defra, along with its MTP, has been working with major electronics retailers to phase out energy-inefficient products. The central suggestion is for retailers, with manufacturers' support, to adopt a policy that ensures certain standards in the consumer electronics products they procure and sell, with the aim of significantly reducing GHG emissions by 2010.

Financial and incentive-based measures

Fiscal measures

Landlord's Energy Saving Allowance

Introduced in 2004 by HM Revenue & Customs, the Landlord's Energy Saving Allowance (LESA) provides tax deductions to landlords who make investments in certain energy saving measures. This measure, as a part of 2004 Budget, allows private landlords who let residential property to claim a deduction against profits of up to GBP 1 500 per property for energy efficiency installations (HM Treasury, 2007).

When introduced in 2004, LESA covered investments in cavity wall and loft insulation. Since its implementation the allowance has been extended to include solid wall insulation in 2005, draught proofing and hot water system insulation in 2006, and floor insulation in 2007. Following the Finance Act 2007, the allowance has been extended to 2015. The government is awaiting state aids clearance to extend LESA to corporate landlords, making the allowance available to an additional 25% of properties within the sector. Further, LESA will now be applied per property rather than per building, to ensure access to the allowance for smaller properties. These extensions could, depending on how extensively they are used by landlords, result in CO_2 savings of 0.15 to 0.67 MtC by 2010/11 (HM Treasury, 2007).

Reduced VAT for energy-efficient appliances

In 1998 the Government introduced a reduced VAT rate of 5% (down from 17.5%) for the grant-funded installation of certain energy-saving materials (ESMs) in the homes of elderly, less well off and vulnerable households. This reduced VAT rate applied to all insulation, draught stripping, hot water, and central heating controls. In Budget 2000, the Government extended this scheme to all households, even if the service is not grant funded. Budget 2000 and 2002 also introduced further reduced VAT rates for ESMs when they are part of grant-funded installations into vulnerable households — including central heating systems, heating appliances, and factory-insulated hot water tanks. The 2004 Budget announced reduced VAT for ground source heat pumps, and the 2005 Budget extended this to air source heat pumps.

The 2005 and 2006 Budgets also announced reduced VAT to encourage microgeneration technologies for use by individual households. These include small wind turbines, solar panels and microcombined heat and power (CHP) units. The government is also envisaging regulatory measures to ensure microgenerators are rewarded for the energy they produce by being able to sell extra energy back to suppliers. The 2007 Budget has further confirmed this commitment to maintaining reduced VAT for microgeneration technology, and the government recommended to European Finance Ministers and the European Commission the introduction of a reduced VAT for the sale of energy-efficient products and ESMs.

Fuel Poverty Programmes

Addressing and reducing fuel poverty is one of the four major objectives of UK energy policy. This objective remains a priority in light of rising energy prices, as well as the possible increase in energy prices resulting from energy efficiency policies (such as energy supplier obligations and the EU ETS), which disproportionately affect low-income households (DTI, 2007). The carbon emission reductions are a secondary effect of the energy efficiency measures resulting from the programmes.

A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including housing benefit or income support for mortgage interest) on household fuel use. Fuel poverty is caused by a combination of poorly insulated, energy inefficient housing and low incomes. There were approximately 2 million households in fuel poverty in the UK in 2004 (Defra, 2006c). Various programmes addressing fuel poverty are in place in the devolved administrations.

Warm Front Scheme

The Warm Front Scheme was launched to tackle fuel poverty in the private sector in England in 2000, and is the UK's largest fuel poverty reduction programmes. It is a typical illustration of public grant, funded by Defra and managed by eaga. The programme is designed to provide grants to private sector households with dependent children, the elderly, the long-term sick and the disabled, who are in receipt of certain benefits. Warm Front now offers central heating to all eligible households and gives them the option to receive the full range of appropriate measures over a period of time, subject to the maximum amount of grant that can be paid. Eligible households generally are those which receive some form of social benefit, and the scheme continues to target households with members over 60 and under 16 years old.

Since the scheme's introduction in June 2000, over 1.46 million households have received assistance. From April 2006 to March 2007, over 250 000 households were assisted, an increase of over 100 000 households from the previous year. The reduction in CO_2 emissions in the average household per year was more moderate, from 6.97 to 6.16 tonnes, as opposed to a reduction from 7.43 to 5.98 tonnes per year during 2004-05. The average grant investment increased from GBP 839 in 2004-05 to GBP 1 436 in 2006-07, and the investment payback time also increased by from five to seven years. Given the number of homes benefiting from the Warm Front Scheme and the reduction in average running costs per property, the potential energy savings amount to almost 10 GJ per household every year for the next 20 years (eaga, 2005, 2007).

The government has provided over GBP 850 million to tackle fuel poverty for the 2005-08 period, with GBP 350 million for the Warm Front Scheme in 2007-08. Warm Front and other programmes addressing fuel poverty are expected to result in annual emissions savings of 0.4 MtC by 2010 (Defra, 2007a). The Warm Front Scheme could increase annual emissions savings by 0.04 MtC in 2010 and 0.08 Mtc in 2020, and also produce positive ancillary impacts on air quality and energy security (Defra, 2007d).

Warm Homes Scheme

The Warm Homes Scheme was launched in Northern Ireland in 2001; it is funded by the Department for Social Development (DSDNI) and managed by eaga. Like Warm Front, it is the main instrument aimed at tackling fuel poverty in private sector housing, targeting tenants and owner-occupiers. It offers grants of up to GBP 850 for the installation of insulation measures (including boiler jackets and window and door draught insulation) and energy advice. Eligible households are those receiving social or disability benefits, and households with young children and householders over 60 are specifically targeted. The latter group is also eligible for Warm Homes Plus, involving heating system replacement and/or upgrade grants on top of insulation measures.

Fuel poverty has substantially decreased in Northern Ireland, with 24% of all households considered to be in fuel poverty in 2004, compared with 33% of all households in 2001. Funding for the scheme has increased from approximately GBP 3 million in 2001 to just over GBP 20 million in 2006-07 and 2007-08, allowing an increase in the number of homes that can be targeted from 8 250 to 10 000 (DTI, 2007; DSDNI, 2007).

Fuel poverty schemes in Northern Ireland face the challenges of higher energy prices and low income, and see tackling the low levels of energy efficiency in Northern Ireland homes as a primary target for reducing fuel poverty. The widening of eligible households and rising costs of parts and labour have put strain on the programme. The lack of adequate data on housing conditions poses a large problem to the scheme, and DSDNI is exploring the development of a fuel poverty indicator tool to map and identify those at risk of fuel poverty by location (DSDNI, 2007).

Home Energy Efficiency Scheme (HEES) Wales

The HEES Wales scheme was launched in 2000; it is funded by the Welsh Assembly Government (WAG) and managed by eaga. HEES provides grants for heating and insulation improvements not only for owner-occupiers, but also to tenants. There are two levels of the scheme for those receiving social benefits, the first targeting households with young children or pregnant householders. A grant of up to GBP 2 000 can be received for home improvement measures. The second level awards grants of up to GBP 3 600 to those over 60, single parents with young children, disabled or chronically ill householders, and those with a disabled young child. Homeowners not receiving any social benefits can still be eligible for grants of up to GBP 500 for home energy efficiency improvements. Since 2004, all households applying for the scheme receive advice on the benefits they are entitled to and the assistance available to them under HEES.

Since the scheme's inception, 75 000 households have been assisted. The number of households in fuel poverty in 2004 represented 11% of Welsh households, and it is estimated that there are 30 000 additional fuel poor households since then. Funding has been increased by GBP 5 million for the 2007-08 programme year, as it was in 2006-07. This has allowed for extension of the scheme, higher grants for the replacement of central heating systems, and special assistance to rural areas. SAP ratings following HEES interventions increased an average of 20 points, and average SAP ratings following works in 2006-07 increased to 65 from 60 for the 2004-05 programme year (eaga, 2007a).

Scottish Government Central Heating and Warm Deal Programmes

The Central Heating Programme was introduced in 2001 to tackle fuel poverty. It is funded by Communities Scotland and managed by Scottish Gas, as is the Warm Deal Programme. The latter scheme was introduced in 1999 to replace the previous fuel poverty reduction schemes in place since 1991.

The Central Heating Programme offers central heating, insulation and advice to private sector homeowners and landlords. The scheme targets homeowners aged 60 and over without central heating. The scheme has been extended to both householders over 60 receiving pension benefits, and those over 80 who have inefficient or partial central heating systems. To date the programme has installed central heating and insulation in 81 000 homes. Average yearly savings per household are of GBP 400 (eaga, 2006).

The Warm Deal Programme provides insulation measures (mainly loft and cavity wall insulation) and energy efficiency advice to low-income households. Grants of up to GBP 500 are offered to households receiving income-related benefits. Householders aged 60 and over can receive grants of up to GBP 125 even without receiving benefits. Since 2007 households with young children receiving a disability living allowance can receive free insulation measures up to GBP 500. The Warm Deal Programme has brought the number of insulated homes in Scotland to 319 000, representing around 14% of the building stock. Given that 18% of the Scottish households were considered to be in fuel poverty in 2004-05, these programmes have contributed to reducing the cost of heating homes and increasing their energy efficiency (DTI, 2007).

Community Energy

Community Energy was a GBP 50 million UK-wide capital grant programme funded from the Treasury's Capital Modernisation Fund to increase the development and installation of community heating schemes. The first bidding round under the programme was held in January 2002. Its aim was to address the key barriers of a lack of investment capital and a lack of knowledge on how to deliver the benefits of community heating. The programme intended to deliver carbon savings and help alleviate fuel poverty through lower energy bills. Schemes mainly based on combined heat and power (CHP) with innovative approaches, such as energy from waste, were also encouraged.

Defra announced an additional GBP 10 million in December 2004 to extend the programme. This decision was based on strong demand for funding in early bidding rounds, including a number of larger schemes with significant outputs. However, experience has shown that, largely because of the limited time span of the programme with a spend deadline of 31 March 2007, many of these larger schemes did not go ahead. By contrast, the smaller schemes that can complete within the programme's timeframe tend to be expensive in relation to the outputs they deliver. The following table summarises how the programme has delivered against the targets originally set for it.

Table 39 • Comparison of outputs against targets for phase I of the Community Energy programme

	Programme targets	Estimate of total outputs from programme
Funding	GBP 50m	GBP 22.3m (45%)
Carbon savings (tC/yr)	150 000	19 481 (13%)
Leverage of other funding	GBP 200m	GBP 50m (25%)
CHP capacity (MWe)	130	28.9 (22%)
People on low incomes helped	100 000	18 453 (18%)

Source: IEA (2007a), *Energy Policies of IEA Countries: The United Kingdom 2006 Review,* IEA/OECD, Paris.

The high drop-out rate for larger schemes was reflected in the limited estimate of expenditure. This was despite the government's expectation of some drop-out of schemes by over allocating funds against the budget of GBP 50 m. After a wide appraisal of existing climate change policies Defra decided not to extend the Community energy programme, which closed as planned on 31 March 2007.

Information and capacity building programmes

Energy Saving Trust (EST)

The Energy Saving Trust (EST) does not provide grants or financing per se, however it provides centralised information on all the available grants at the government, utilities, and local level (*i.e.* UK government funds can provide up to GBP 2 500 for households receiving certain benefits to impose heating and energy efficiency through the Warm Front Scheme). The EST provides direct information and support through local information centres in the devolved administrations. The Welsh Assembly Government provides complementary information, advice and support through its Energy Saving Wales portal (www.energysavingwales.org.uk).

The Energy Saving Trust is a private company funded by the government to promote energy savings and emissions reductions in the household sector. Its energy efficiency activity is grant-funded by Defra. The Trust also receives funding from the Scottish Executive, from the Department of Transport to run transport programmes and from BERR to run renewable energy programmes. EST's activities are designed to underpin and complement the work of other actors in energy efficiency markets. In particular it seeks to work with the key government policy drivers for household energy efficiency, such as EEC, fuel poverty programmes, Decent Homes and building regulations. Its principal activities are aimed at increasing demand for energy efficiency by raising awareness, providing advice and support for action. It also supports the supply of energy efficiency products and services to meet this demand by developing partnerships, stimulating innovation, supporting training and providing accreditation. In 2010 carbon savings under this programme are expected to be 0.31 MtC.

The Energy Saving Trust is also responsible for managing the BERR's Low Carbon Building Programme. The programme was launched in March 2006 and seeks to enhance the use of microgeneration technologies combined with energy efficiency improvements, through a combination of information and capacity-building measures (for example undertaking demonstration activities) and financial incentives. Householders can apply for grants through the programme for the purchase and installation of microgeneration technologies, such as solar photovoltaics, small hydro, wind turbines and wood fuelled boiler systems. Grant amounts range from GBP 400 to a maximum of GBP 2 500, with 3 to 12 months provided for installation depending on the technology. Prior to being eligible for a grant householders must undertake a number of energy efficiency measures, such as insulation meeting current building code standards, low energy light bulbs on all fixtures, and controls on heating systems (Low Carbon Buildings Programme, 2007).

Climate Change Communications Initiative (CCCI)

The Climate Change Communications Initiative (CCCI) was launched in December 2005, with a budget of GBP 12 million over three years, to help people understand that climate change was an immediate issue that affects them directly, and emphasise the use of "trusted intermediaries" to change attitudes. Part of the initiative involves funding various projects across the UK to encourage positive attitudes, providing freely available communication resources such as films, DVDs and a website. A new short film aimed at helping people link their actions, climate change and CO_2 emissions was launched in mid-April 2007. The initiative has also launched a web-based CO_2 calculator, for individuals and households to calculate their carbon footprint. The calculator is tailored to the individual, brings together domestic heating, electrical appliance use and personal travel, and also provides recommendations on reducing energy use (Defra, 2007a). The calculator is part of a cross-government, multi-media communication and marketing campaign to raise awareness of the contribution individuals make to CO_2 emissions, and the simple ways in which they can act to help tackle climate change.

The campaign carries simple call-to-action branding: Act on CO_2, which will unfold in two phases. The aim is to improve the public's CO_2 literacy in the first phase, moving on in the second phase to encourage and show individuals how to adopt more pro-environmental and energy-efficient behaviours, such as not leaving appliances on stand-by.

Microgeneration Strategy / Combined Heat and Power (CHP)

In March 2006 the Department of Trade and Industry published its Microgeneration Strategy. Microgeneration is defined as the small-scale production of heat and/or electricity from a low carbon source. The strategy aims to address barriers to the wide-scale deployment of microgeneration, following a report by the EST suggesting that by 2050 microgeneration could provide 30%-40% of the UK's electricity needs and reduce per household carbon emissions by 15% per year. These are technologies which can be installed in individual existing residential homes and community housing projects. Following on from the UK strategy, the Welsh Assembly Government launched a Microgeneration Action Plan in March 2007, which includes installing 20 000 micro-heat systems by 2012 (Defra, 2007a).

Direct grants are awarded to address the upfront financial barriers in installing microgeneration technologies, for example the Low Carbon Buildings Programme managed by the EST and the Clear Skies programme which supports renewable energies. The BERR strategy identifies combined heat and power (CHP) as leading the potential in carbon emissions reduction and electricity production of microgeneration technologies, followed by micro-wind and solar photovoltaics.

Besides cost constraints, the adoption of microgeneration strategies also face regulatory barriers, such as planning constraints on installing microgeneration units in existing buildings. Communities and Local Government is to review local plans to tackle this issue. The BERR is also trying to address the issue of household access to electricity and gas grids, and their ability to "export" any additional electricity produced back to utility suppliers. This will involve collaboration with utility suppliers, Ofgem and distribution network operators. There are also technological constraints, particularly regarding domestic micro-CHP which is a new technology with as yet unproven economic benefits and energy saving potential. Research into micro-CHPs and other microgeneration technologies are being funded by the Carbon Trust, an independent company funded by the government which provides similar services as the EST but for businesses and the public sector.

The growth in CHP electricity since 2004 has been slow despite supportive national schemes. This is accepted as being due to a number of barriers - the most significant being the relative prices of gas (the fuel used most abundantly in CHP in the UK) and electricity (Defra, 2007a). If domestic micro-CHP follows a similar build up pattern to that of condensing boilers, it is likely to make a very small contribution to installed CHP capacity by 2010 (around 5 MWe by 2010), particularly as early trials in the UK have been unsuccessful. However, government intervention, for example through the building regulations, to require that micro-CHP be installed as a direct replacement for existing and new boilers would cause the installed capacity to increase at a much faster rate (Defra, 2007b).

Impact analysis and evaluation

General policy analysis

Unlike many other IEA countries where both supply and demand side of energy are handled by the energy ministries, energy efficiency policy in the UK is largely the responsibility of Defra.

Owing to this organisational arrangement, energy efficiency policies are largely driven by climate change mitigation. For example, efficiency targets are almost always stated in MtC of emission reduction rather than in units of energy (*e.g.* kWh, tonnes of coal, or therms of gas). Another major actor in determining and enacting energy efficiency policy is the BERR, which also explains both the regulation-driven policies and the emphasis on finding market-based solutions to enacting energy efficiency measures in the residential building sector. Given the multi-faceted role of energy efficiency as described above, close communication and co-ordination between Defra, BERR and other relevant bodies is essential so that energy efficiency policy can be pursued from broader energy and environment policy perspectives. This is particularly crucial in evaluating cost-effectiveness of policies and measures across energy demand and supply side (*e.g.* energy efficiency and renewables). Enhanced energy security is one obvious benefit of efficiency beyond emissions reduction. At a time when energy security is receiving increased attention in the UK, greater appreciation of efficiency's contribution in this area could be helpful in shaping future policy, and is explicitly mentioned in the 2007 Energy White Paper.

Defra has implemented a wide range of energy efficiency policies and measures in the household, business and public sectors based on *Energy Efficiency: the Government's Plan for Action* in April 2004 and the *UK Energy Efficiency Action Plan 2007*. While such a wide range of measures and programmes may lead to complications, dispersion of resources and occasional bureaucratic infighting, it also allows each programme to specialise in a particular area and to operate more independently and, ideally, more effectively. The UK government manages this inherent tension well. The wide range of measures also makes comparing the cost-effectiveness of each measure more difficult although the government has taken steps to address this problem through Defra policy evaluation studies released in April 2006 and January 2007. The Defra studies conclude that efficiency and demand reduction measures tend to be more effective than supply-side measures. The 2007 *Energy Efficiency Action Plan* also attributes the largest part of carbon emissions reductions by 2020 in the household sector to EEC/CERT, similar supplier obligations post-2011 and improved building regulations. The analysis below will focus on these two policies, along with several other policies presented in this chapter.

Energy Efficiency Commitment (EEC) / Carbon Emission Reduction Commitment (CERT)

As mentioned, a major and impactful policy pillar in the household sector is the Energy Efficiency Commitment (EEC). It directly addresses the informational and financial barriers to improving energy efficiency in existing homes. In the first phase (2002-2005), energy suppliers surpassed their targets with net benefits and are set to do the same in the current and second phase. The programme's success can be attributed to various factors. First, putting obligations on a limited number of energy suppliers instead of numerous end-users has made the system management relatively simple. Second, the calculation of energy saving has been relatively easy because the measures have focused on insulation, heating, appliances and lighting. Ofgem published a list of measures the suppliers may implement and how much energy savings each measure will be worth. This substantially lightens the administrative load for everyone involved. The policy has therefore been clear and flexible, as it allows individual utilities lee way in how they intend to achieve targets. The programme is also reviewed before implementation of a new phase, allowing changing circumstances to be taken into account. Third, there have been plenty of "low hanging fruit" for achieving the targets. The majority of the targets have been achieved through insulation, an area where UK housing has traditionally been poor. Fourth, there have been various initiatives by the Energy Saving Trust involving consumers and manufacturers/retailers of energy-efficient equipment to supplement the EEC. Fifth, the EEC has been active in the social housing sector, where it has been a primary source of funding for energy improvement measures undertaken by social landlords and worked hand-in-hand with the Decent Homes programme objectives.

Up to now, EEC has been very successful in addressing some critical gaps in energy efficiency's access. The uplifting success of the programme thus far explains the government's ambition to set the targets higher in the coming phase. However, numerous challenges will need to be faced. First, "low hanging fruit", or low-cost, well-understood and easily undertaken efficiency measures will be gradually exploited. As regards fuel poverty, Warm Front remains relevant since fuel poverty programmes do lead to increased efficiency and specifically target households for whom the financial barriers to energy efficiency measures are high. The fuel poverty programmes operates where the Decent Homes and complementary programmes don't, targeting private households, and their expansion may lead to more flexibility within the EEC/CERT regarding priority group obligations.

Given the increasing exploitation of "low hanging fruit", broader measures such as behavioural changes, microgeneration, smart metering and real-time displays will need to be incorporated. In order to improve the support given to consumers, the UK has developed a framework for pro-environmental behaviours with the help and advice of a wide range of experts. This summarises the government's understanding of the evidence on consumer behaviour, and is designed to support policy development and implementation across the UK government and externally. The 2007 Energy White Paper directly addresses the latter two issues, seeking to phase in better metering as of 2008 and to utilise EEC to encourage innovative low-carbon technologies. The expectation is that all domestic energy customers will have smart meters with visual displays of real-time information that allow communication between the meter, the energy supplier and the customer over the next decade. Both are essential in achieving the government's long-term target of 60% emissions reduction in 2050. Programmes operating directly within households, such as EEC/CERT, Decent Homes and Warm Front, can contribute as implementing tools for the broader microgeneration and CHP market transformation programmes. The EST has provided a good structure for launching these initiatives as well, as seen by its management role for the Low-Carbon Buildings Programme. Second, the government and Ofgem should ensure that such a wider scope will not result in unduly complicated and cumbersome administrative procedures. This is pertinent given that encouraging microgeneration usage will involve changes in energy distribution networks. Energy suppliers already must devote administrative efforts to comply with their obligations with the current limited range of measures. It is a challenging task to broaden the scope while minimising administrative burdens. For this purpose, developing standardised and simple methodology for calculating energy savings from any newly introduced measures is essential.

Given that "low hanging fruits" of cost-effective demand-side measures will be increasingly exploited as the EEC/CERT targets are expanded, the government may consider additional measures for changing the behaviour of the household sector together with incorporating broader measures in the EEC/CERT. Certain UK actors have suggested that there could be a tax incentive (*e.g.* reduction in community tax) in addition to the appliances VAT reduction, and the Landlord's Energy Saving Allowance (LESA), for a reduction in energy consumption. While ensuring that policies targeted to end-users and those targeted to energy suppliers would not hamper their overall efficiency and effectiveness, such options would merit consideration. Existing fiscal policies have had an unknown impact. Any new combination of tax deductions or reductions would need to be clear and simple to be utilised. Since they tend to modify behaviour temporarily, they would either need to remain in place long enough to be sustainable, or be part of a broader initiative and aimed at kick-starting behavioural changes.

Third, the efficacy of incorporating social policy objectives in EEC should be carefully evaluated. Currently, energy suppliers must realise at least half of their energy savings in the priority sector (*i.e.*, low-income households). Under CERT suppliers will be required to direct at least 40% of carbon savings to a priority group of low-income and elderly customers. However, imposing such constraints likely reduces the overall cost-effectiveness of the system. In fact, it is likely that suppliers could realise savings at a lower cost in wealthier households since such end-users would be able to pay for a greater share of the measures put in place. Putting consumer contributions aside, any type of restrictions put on the suppliers will raise the cost of the entire system. There is, of course, an equity issue to be considered. Since all consumers contribute equally to the cost of the EEC (through higher energy rates), supplier activity heavily weighted towards upper income customers would result in an implicit subsidy from the less well-off to the more well-off. In addition, lifting the 50% obligation for the priority sector would diminish the EEC's effectiveness as a tool for combating fuel poverty. EEC was launched as an energy efficiency programme and the 50% requirement could hamper its ability to achieve its goals. While equity and fuel poverty are important policy issues, they can be pursued more effectively through more direct and targeted policies that are not incorporated in the EEC programme itself.

The EEC is also a sustainable policy. It has been in place long enough to instil behavioural changes, and the CERT seeks to truly transform the energy market in changing the way utility companies do business. It aims to make them energy service suppliers rather than providers of units of energy, making energy efficiency an integral part of their business. This has also been initiated by prolonging the policy's time-frame, ensuring that some form of utility supplier obligation will be in place post-CERT, until 2020. The changes made to EEC are firstly possible due to a policy of regularly reviewing programmes, in this case every three years. This allows for important changes to be made, or for ineffective programmes to be terminated, such as in the case of the Community Energy Programme, or improved, such as LESA. Secondly this revision has allowed the programme to be incorporated into a broader policy aim of achieving market transformation in the energy efficiency sector, which should enable all existing homes to reach their maximum energy efficiency potential. The Market Transformation Programme targeting appliances, the microgeneration strategy, as well as the Low Carbon Buildings Programme, all aim to create a sustainable shift towards increased energy efficiency in existing buildings.

Building regulations and standards

Building regulations are another strong measure in the household sector. It is encouraging that the new and stronger building codes, which will enhance energy efficiency for new buildings by 18%-27%, have been put in place from 2006 in England and Wales, and 2007 in Scotland.

In Denmark, where building codes have been highly successful in promoting energy efficiency, the government regularly announces how the building codes will be strengthened in the coming years. This gives certainty to the building and housing industries and enables them to prepare for any changes. The government is developing the Code for Sustainable Homes for the construction of new residential buildings (level 1-5). Such codes should have indicative time frame, as the Code for Sustainable Homes does, as to when each level will be put in place as a mandatory code. It is a cause of concern that the compliance level of the building code is low. Experience with the previous code shows that one-third to one-half of all new buildings did not meet the relevant regulations. Stronger leadership by the government is required, including simplifying the guidance accompanying the regulations, since frequent changes in regulations (in 2002, 2005, 2006 and 2007) are difficult for builders to keep track of. This could include enhancing awareness and capacity building (more staffing and training) at the local authorities enforcing building regulations. While reviewing building codes is important to keep this measure relatively flexible, it must not be done at the expense of clarity. In addition, there can be difficulties in obtaining adequate, transparent data on energy efficiency in the household sector. This appears to result at least in part from the division of responsibilities among Defra, BERR and CLG. Greater co-ordination in gathering and disseminating data could help both policy makers and industry. The Energy Review report recognised the need for enforcing building codes and amendments were made in 2006 to simplify procedures, while training and dissemination programmes were delivered. The 2007 Energy White Paper announces that implementation of the 2006 regulations will be reviewed within three years.

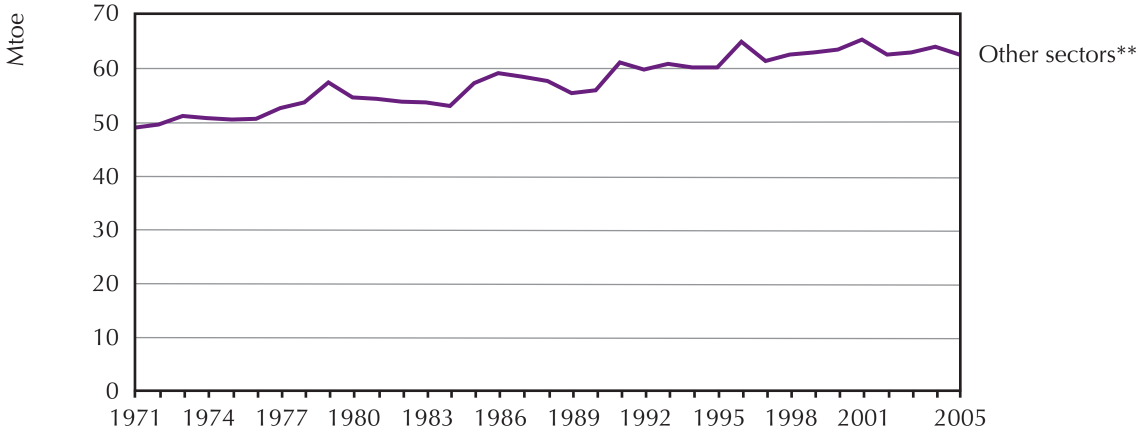
Building regulations in the UK have been relevant and had impact, in directly improving energy efficiency in buildings and limiting the choice that builders and planners have to the most energy-efficient one. These also impact existing buildings as they are required for renovation work and are a pre-requisite for grants like the Low Carbon Buildings Programme. Other building standards such as energy performance certificates (EPCs) also support energy efficiency in existing buildings firstly by providing transparent information and secondly by providing energy efficiency improvement recommendations. EPCs have the advantage of strong clarity and eventually sustainability: their increased implementation should also help make energy efficiency an integral part of the real-estate market. Consumer surveys thus far have shown a high level of satisfaction with EPCs, which are rated as being either easy or very easy to understand, as are their accompanying energy efficiency recommendations (Shorrock and Coword, 2007). Other standards, such as the Decent Homes and Housing Quality Standards, also ensure energy efficiency improvements are undertaken in social housing even where renovations are not underway. As with building regulations, government reports indicate that more effort must be made to improve the clarity of the Decent Homes programme.

The evolution of total energy consumption in the building sector is quite illustrative of the UK's success in applying demand-side management programmes.

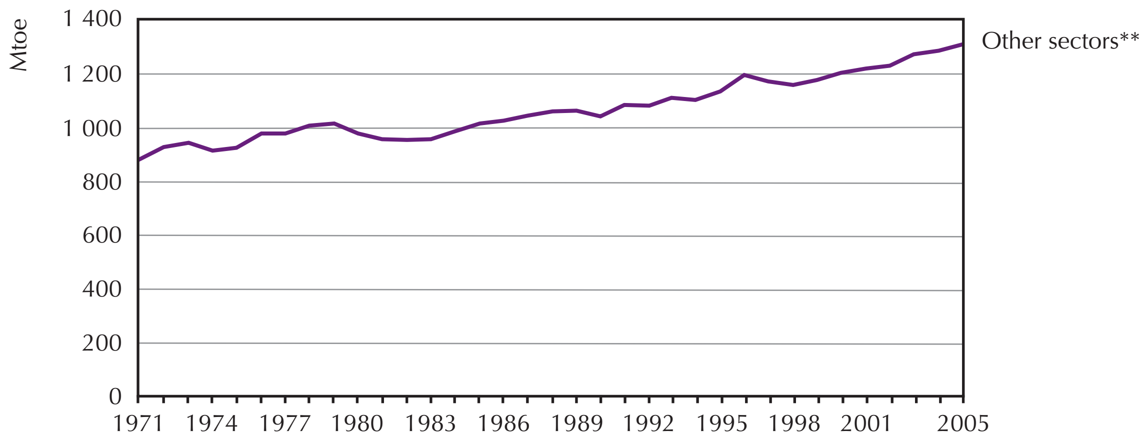
As shown by the graphs, although on average OECD total energy consumption has risen through the last decade, the UK has managed to stabilise its total energy consumption in the same period. This consistency in comparison to other industrialised countries shows the major success of the UK's energy efficiency programmes and policies.

Figure 64 • Comparison figures of energy consumption evolution in the UK and OECD countries

United Kingdom



OECD total



Source: IEA (2007c), *Energy Balances of OECD Countries,* IEA/OECD, Paris. "Other sectors" category includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

Conclusion

The 2007 *UK Energy Efficiency Action Plan* emphasises the need for combined policy measures to lower energy consumption. Building regulation standards are used as a prerequisite for financial incentive measures, in the case of the Low Carbon Buildings Programme and the Decent Homes standard. Engaging in partnerships with the private sector in the Market Transformation Programme also increases standards for appliances, whose purchase can then be financed through fiscal measures or grant programmes. Information sharing between programmes also reduces their operational costs, for example data about homes in fuel poverty can be shared between Warm Front, Decent Homes and the EEC/CERT. The government recognises the strength in tight cooperation between programmes to mutually enhance their impacts; an investment of GBP 7.5 million to improve coordination between Warm Front and the Energy Efficiency Commitment was announced in 2006 (DTI, 2007).

The combination of the Market Transformation Programme for appliances, mandatory energy performance certificates (EPCs), EEC and public grants through the fuel poverty and Decent Homes programme, has led to effective transformation of the UK's housing market. Though official government policy has largely been driven by environmental concerns, high energy prices and a tough winter in 2005 have also motivated utility customers and stimulated enhancement of fuel poverty reduction programmes. The case of the UK is good example of what environmentally driven energy efficiency measures can accomplish. Policy objectives have focused on building the most conducive framework to enhance energy efficiency. Strengthening of building codes, the reinforcement of energy commitments, and the climate change agreement have all been adopted to reach the same goal: reducing energy consumption as a means of reducing greenhouse gas emissions.

The UK government puts very high emphasis on energy efficiency, noting in the 2007 Energy White Paper that it is "the starting point of [UK] energy policy". This approach has been reiterated in numerous other policy documents and statements by policy makers. The government's policies in this field are always viewed on three levels, with simultaneous measures taken on the national, European and international level. The UK's energy efficiency policies form part of the overall target of saving 20% of the EU's primary energy consumption by 2020. The UK plans to work actively within the EU and internationally for increasing the energy efficiency standards of internationally traded energy-using products. Improving energy efficiency necessitates market transformation and therefore taking action outside the borders of the UK, given its place in the EU and its globalised economy.

A variety of policies have been implemented to improve energy efficiency in the household sector in the UK, from regulations, grants and fiscal incentives to information campaigns. Energy efficiency has also been incorporated in the government's goal of improving social housing through the Decent Homes standard. The homes of vulnerable groups are continuously being improved through fuel poverty reduction programmes and the establishment of social housing standards. Achieving targets includes improving insulation and heating; tackling fuel poverty therefore also leads to improvements in energy efficiency. Thus through a variety of policies, the government is able to deal with inequalities, well-being, housing standards and energy efficiency.

An overview of the UK Energy Efficiency Action Plan 2007 shows that most of the current energy efficiency policies in the household sector are being reviewed, and that new policies and programmes are being implemented. Review of the policies put in place indicates that buildings built in 2007 are 40% more efficient than buildings built in 2002. Compliance with the building regulations has even been reinforced. The Energy Efficiency Commitment is still being improved and strengthened to deliver its energy savings by 2011. The government is also ensuring that the energy efficiency of products used in homes is improved by trying to implement minimum performance standards and encourage industries to deliver sustainable products. Furthermore several information campaigns to promote energy efficiency and encourage action by individuals have been put in place.

By 2016, the UK would like all new homes to be zero-carbon, with interim targets and potential carbon savings between 1.1 MtC and 1.2 MtC per year by 2020. As can be seen in the table below, energy efficiency in the household sector is expected to improve substantially. Total energy and carbon savings will increase from 4.7 MtC in 2010 to 13.1 MtC in 2020.

Table 40 • Summary of energy savings resulting from various policy measures

Policy	Expected energy and carbon savings in 2010		Expected energy and carbon savings in 2016		Expected energy and carbon savings in 2020	
	TWh	MtC	TWh	MtC	TWh	MtC
Energy Efficiency Commitment Phase 1 (EEC 1)	3.1	0.3	3.1	0.3	3.1	0.3
Energy Efficiency Commitment Phase 2 (EEC 2)	7.8	0.5	7.8	0.5	7.8	0.5
Carbon Emission Reduction Commitment (CERT)	14.2	1	15.5	1.1	15.5	1.1
Supplier Obligation	0	0	31.2	2.2	50.2	3.5
Northern Ireland Energy Efficiency Levy	0.4	0	0.4	0	0.4	0
Fuel Poverty Schemes	2.7	0.4	2.8	0.4	2.8	0.4
Energy Performance of Buildings Directive (EPBD)(1)	3.5	0.2	7.6	0.4	10.1	0.6
Building Regulations England & Wales 2002	11.4	0.6	12.5	0.7	12.5	0.7
Building Regulations E & W 2005/6	13.2	0.7	33.8	1.8	49.4	2.6
Building Regulations Scotland 2007	1.8	0.1	4.7	0.2	6.8	0.4
Building a Greener Future - Towards zero-carbon homes	0	0	4.2	0.2	22.6	1.2
Billing and Metering	2.6	0.2	5.8	0.4	5.8	0.4
Product Policy	6.6	0.6	11.2	1	14.2	1.3
Package of Measures (2)	1.4	0.1	1.5	0.1	1.5	0.1
TOTAL HOUSEHOLD SECTOR	**68.7**	**4.7**	**142.1**	**9.3**	**202.7**	**13.1**

(1) EPBD savings in the Energy White Paper (EWP) do not include 0.2MtC/y in the Household sector for 2010 and subsequent years which arise from advice on heating systems, including early replacement of inefficient boilers. These savings had already been identified in the Climate Change Programme 2006 and included in the EWP baseline. The full savings are included here.

(2) Package of Measures includes the Green Landlord Scheme, improved enforcement of Building Regulations, reduced VAT for wood fuelled plants and the Low Carbon Building Programme

Source: Defra (2007a), *UK Energy Efficiency Action Plan.*

Savings in the household sector have been quite important thus far but barriers still exist and there are still significant potentials to be achieved. A wide range of policies, from regulations, to grants and information campaigns are necessary to engage the various actors who make decisions on energy efficiency in the household sector. Lack of information and motivation, as well as the cost of obtaining information, the greater cost of energy-efficient appliances and the investment needed to make energy-efficient improvements have all been identified as barriers. Only a multi-policy package can address these barriers, through offering information, setting standards, and providing financial assistance and incentives to meet those standards (DTI, 2007). Engaging with a variety of actors and crafting policies that aim to transform markets to be inherently energy efficient also demonstrate a concern that policies enacted must be sustainable. As mentioned in the Government Action Plan "the challenge comes down to how we can successfully mobilise millions of individuals, households and organisations to change their behaviour and make more energy-efficient choices and purchasing decisions".

Section III • CONCLUSIONS

CONCLUSION

Annex I • SUMMARY TABLE OF US POLICIES

Annex II • FRANCE

Annex III • GERMANY

BIBLIOGRAPHY AND DATA SOURCES

CONCLUSION

The six cases addressed in this book underscore the real potential for energy savings in existing residential buildings. They also highlight that policies do exist to help overcome financial barriers and to take advantage of these untapped potentials.

This chapter first seeks to draw general findings across the six case studies, by summarising the key findings in relation to each category of policy type based on the five evaluation criteria set out in the introduction. Based on this evaluation, the second part of the chapter then identifies five key policy lessons. The chapter concludes with several observations as to next steps for policy makers.

Summary of evaluations

Regulatory measures

As mentioned in the first section of the study, market failures in the existing residential sector exist and are a significant impediment to the delivery of a welfare maximising level of EE (IEA, 2007). Case studies have shown that in this situation regulations can be effective at improving EE levels. In the examples under analysis, regulatory measures addressed specific gaps in the market and imposed minimum performance thresholds and behaviours. As such they provided clear messages to consumers and helped trigger market transformation. One such example was the high market penetration rate of more energy-efficient boilers in the UK and Germany following changes to thermal regulation standards. The EPBD requirement to quantify energy savings and diffuse information on the energy performance of buildings will help increase both customers' awareness of the issues, and actors' training in energy efficiency. Such training and certification programmes have already commenced in France and the UK.

This being said, regulatory measures do have some limitations. First, they need to be kept in place for a long time for a genuine market transformation to happen, since they do not call for an important implication from actors. However, keeping them in place for a long time can make them become obsolete. The constant need to readjust regulatory measures and the need to check whether actors are complying with them, can lead to these measures being costly to implement.

Regulatory measures have to be narrow in scope to be effective. Yet this narrowing can reduce their overall effectiveness. The EPBD typically has been criticised since its inception for being too restrained. It only covers refurbishments for surfaces of more than 1 000 m^2. In nearly all the cases studied building regulations are updated approximately every three years, with the consultation process beginning over a year before the new regulation is ready. Changing regulations too often has the affect of reducing their clarity, as seen in the variety of changes in UK building codes (England, Wales and Scotland) between 2002 and 2007, which resulted in inefficient application. Balancing clarity and flexibility can be achieved through a combination of set targets, while allowing freedom in the means to achieve them, as is the case with the white certificate scheme in France, and to some extent the supplier obligation scheme in the UK.

Despite the observed effectiveness of regulatory measures in the six cases studied, their costs relative to other measures, as well as their inflexibility and tendency to become obsolete very quickly, are major drawbacks.

Financial and incentive-based measures

Grants and subsidies present the advantage of filling an immediate financial gap, thereby allowing for a temporary shift in the market, at a minimum. By targeting very specific measures or appliances, they also send clear messages to customers. Most of the grant programmes observed in the case studies had a very wide scope. Although they were not always targeted at energy efficiency directly, they contributed to reduce the energy consumption of low-income houses, and to spread information on EE.

The major drawback of the use of grants is their low sustainability. In most instances, once a grant programme is finished, there is no sustained change in the market. Customers revert to previous behaviours. Longer implementation of grant programmes on the other hand can make these costly, and do not result in more market transformation. However, training and information programmes operating alongside grants programmes can make up for this limitation. Such a combination was successful in weatherisation programmes in the US, for example, in which EE training, certification and best practices were developed and then became standardised.

Fiscal measures in the cases studied did not appear to have had particularly large impacts. They are relevant in targeting a financial liquidity barrier, since they can reduce the cost of EE improvement measures, for example through reductions in VAT rates for energy efficient installations offered in France. They can also offer incentives that create demand for energy-efficient goods, such as tax credits for the purchase of designated energy-efficient appliances in the US and France. However they often lack clarity and are not well known by or explained to the public; the US government launched its tax incentives awareness programme based on this recognition. Being tied to large administrative bodies for changes, they also tend to be inflexible. As it is, updates to tax credits accounting for new and improved EE measures and equipment tended to occur very slowly in the countries studied. These still do not meet the standards offered by the latest technology available in both France and the US. Moreover, fiscal measures tend to be unsustainable as they depend on political support that is tied to a short- and/or medium-term electoral cycle. While preferential loans in the cases studied were mostly offered by way of public-private partnerships, this is theoretically not the only option. Zero interest loans could be provided directly by public bodies in the same way that grants are.

Voluntary agreements, public-private partnerships and ESCOs

Preferential loans were the most common form of public-private partnerships (PPPs) in the cases studied. Loans that account for EE in their provision directly target the financial barriers to initiating EE improvements. Examples include the JHF in Japan, EEMs in the US and the KfW loans in Germany. Preferential loans have been used by a large number of applicants in both Japan and Germany for improvement work that increase building EE. The conditions for these loans are clear to those applying, and clear sets of rules are established within the public-private partnerships. As a result, PPPs can potentially incite a sustainable shift in the housing loan market that favours EE refurbishments. In France and Japan for example, an increasing number of loan products include EE in their provision conditions. In Germany this has been the case since the mid-1990s, and has impacted tens of thousands loan applications yearly.

In all cases studied preferential loans were implemented through PPPs. Being administered by private actors they appeared more flexible and able to adapt rapidly to changes in the market. For example, EEM provision in the US is often based on Energy Star energy performance ratings that are regularly updated in response to new technologies available on the market. The combined forces of the public and private sectors appeared to deliver the most cost-effective policy instruments.

While the case studies indicated that ESCOs are not very active in the residential buildings sector, publicly owned residential buildings could be good candidates for ESCO contracts. This is because ESCOs are more likely to work with the public sector, due to both the larger contract size and the decreased risk factor as compared with private sector housing.

Information and capacity-building programmes

In the cases studied, the success of regulatory and voluntary measures often relied on the concurrent implementation of information programmes which increased their clarity. The Energy Savings Trust in the UK, DENA in Germany and ADEME information centres in France are meant to inform people on measures and policies to improve EE. Such programmes are relevant since they provide information and advice on EE measures that should be taken. As such they help create demand for EE services such as home energy audits. They also guide people on obtaining the financing necessary for undertaking improvements, whether through fiscal incentives, grants or preferential loans.

Capacity-building programmes can also be pivotal in the successful implementation of regulation. For example, producing energy performance certificates means implementing programmes to train and certify energy performance raters. As seen in the UK example, poor implementation of building codes was also actively targeted through widespread government-initiated training and information programmes for professionals. Capacity-building can also reduce costs associated with improving EE, such as developing building codes. The US federal government model building code and support programmes provide a tool for states to develop more energy efficient codes with fewer monetary, informational and time costs, for example. Further, demand-side management programmes, such as those enacted in California, have had an impact on EE improvements in residential buildings due to their relevance and flexibility.

If policies and measures are not understood by the relevant actors, they are unlikely to be effectively used and implemented. This reduces their overall relevance and potential impact. Publicly funded agencies which make policies clearer, and offer tools to better implement them, play an important role.

Overall then, the evaluation of different policy types leads to conclusions set out in the following table:

Table 41 • Summary table of policy evaluation

	Relevance	Flexibility	Clarity	Impact	Sustainability
Regulatory measures	✓	X	✓	✓✓	X
Financial and incentives					
Fiscal Measures	✓	X	X	✓	X
Grants	✓	X	✓	✓	X
Voluntary agreements and PPPs	✓	✓	✓	✓	✓
Information and CBP*	✓	X	✓	✓✓	✓

** CBP: Capacity Building Programmes.*

Five main policy lessons can be drawn from the cases studied.

Policy lessons

Multi-policy packages

First, no single policy can serve as a silver bullet: policies or programmes solely targeting financial barriers — or one facet of the financial barriers — will not be sustainable. Although they might, as examples of isolated grants have demonstrated, have a direct and temporary beneficial impact on the market, they will not work upstream by helping to create an autonomous energy efficient market for buildings.

Only policy packages that address multiple financial barriers simultaneously will have flexibility, impact, and sustainability. One such example is the case of France, where information services and energy audits helped individuals to decide which EE improvement measures to undertake, after which subsidies, preferential loans or tax deductions could be obtained depending on the individual's situation. Should the EPBD be effectively implemented, improved EE standards will also require more trained professionals and audit capacities. These combined with the above financial mechanisms will increase the EE improvements that can be undertaken. In the German case, preferential loans and building regulations — which stand amongst the most successful measures — had most sustainable impact when combined with fiscal policies, subsidies, and information programme by the DENA.

These cases do not stand alone. The UK case also illustrates that policy packages — aimed simultaneously at the lack of training, the nature of the financier and the awareness of the customer — have met more sustainable successes than isolated measures.

The variety of EE measures initiated and the concrete energy savings resulting from white certificate schemes in the cases studied show the potential of combining a minimum regulation with the flexibility of market actors.

Public-private partnerships

In all cases studied, public-private partnerships (PPPs) fostered the best results. The case studies reveal that PPPs offer the best opportunity to meet a combination of all five evaluation criteria. Public-private partnerships allow measures to address different facets of the financial barriers concurrently, and provide for joined forces from the public and private sector to increase the policy's impact level in terms of market transformation.

Public-private partnerships such as the preferential loans offered by French banks, the KfW in Germany and the JHF have proven more successful than isolated grants, from either government or private organisations, to foster sustainable change. The case of EEMs in the US underwritten by Fannie Mae, a federal charter company operating in the secondary mortgage market, provides an example of the creation of demand through a small adjustment to classical loans. This is due to a better understanding of how improved energy efficiency can affect customers' credit capacity.

Creating a market

The overall increase of efficiency in residential buildings will require the expansion of a market for energy efficiency. Such markets today are very weak, meaning there is little demand and therefore few providers. Markets need strengthening through demand increase, and through improving actors' competence in energy efficiency (Urovas, 2006). This circular dynamic, whereby actors required to develop the market will not enter it because of its current weakness, underlines the importance of public policies' intervention to trigger and strengthen the market. The UK and Japanese examples are clear illustrations of this. Soft instruments, such as private sector voluntary agreements, voluntary labelling, training, and information provision are pivotal to filling this gap in the market. This will enable the demand for energy efficiency to rise, and in turn will allow the range of financing tools for EE in the housing sector to grow in scope and creativity.

The creativity and resources of private actors is needed to bring about wide scale impacts and long lasting market transformation. However, evidence suggests they will not enter the market in the present context (de T'Serclaes, 2007). The uncertainties characterising energy savings' evaluation and the appropriate discount rate to be used makes it too risky for private investors to mainstream energy-efficient loans. In the cases studied public policy has played an important role in reducing the risk to investors. The diffusion of housing loan provision accounting for EE has in all the cases studied been induced by public-private partnerships, and supported by quantification methods for energy savings most often developed by regulations. Even voluntary labelling schemes that can impact on loan provision, such as home energy labels in Japan and France, have been government-led initiatives.

The policies seen in the six case studies play important roles in creating conditions necessary for such a market transformation. One such example is the establishment of harmonised evaluation tools for measures, equipment and appliances that improve EE. These can then be used by a variety of actors, including financiers, to make loan and investment decisions. Such activity is seen in the European Union, which self-consciously sees its role as one of creating the conditions to stimulate a shift in the market toward energy efficiency.

The systematic imposition of efficiency benchmarks, or MEPS, represents another means of creating more favourable grounds for energy efficiency investments. MEPS have significantly increased the average efficiency of residential equipment and appliances in Japan, the EU and the US. MEPS offer the advantage of leaving flexibility in the application method, thereby calling on the innovative skills and ingenuity of market actors. By setting benchmarks, while leaving flexibility as to the means for reaching them, MEPS push the market in a certain direction, and entice it to find the solutions to match the standards on its own.

Strong political will

The case studies also reveal that private sector involvement will not come about without strong political will to establish more favourable grounds for energy-efficient investments. This could notably imply an international plan of action to establish a common international evaluation framework. Although fear of hidden costs in energy-efficient policies have consistently been proven wrong, the absence of a set international framework for evaluation, which would settle issues such as the discount rate, or the proper method of energy savings evaluation, could certainly improve the confidence of investors.

The importance of national context

Finally, a crucial finding of this study is the role of national context in determining the success or failure of any given policy. National context here refers to the energy profile of a country or region, its political structure, as well as the nature of its building sector. Typically, countries or jurisdictions where most residential units are owner-occupied (for example Japan) will be less affected by principal-agent problems. In jurisdictions with a high proportion of social housing, the government will retain greater flexibility with regard to the type of policy measures available. For example, it may be able to more easily impose regulatory measures or introduce more innovative efficient energy sources such as cogeneration. Further, the political structure of a country is relevant to the way in which policies are implemented. A large federalised system such as the US may not be able to initiate specific policies on the same scale as a highly centralised state like France. Any lessons learned based on the above findings must be observed through this jurisdiction-specific bias.

Next steps

The need for more systematic data gathering

The study findings also underline the need to increase the availability of relevant quantitative *ex-post* evaluation data. Such increased evaluations would enrich future policy analysis.

A sound and comprehensive cost-benefit analysis quantifying the overall existing building market could also assist in bringing in the financial sector. Although financiers presently know little about energy efficiency and are for the most part unwilling to rethink their formulas and ratios, they also express interest in the sector, should it prove to be cost-effective with acceptable risks and returns, and manageable transaction costs. Once financial institutions are convinced that a market exists, they will devote resources to understanding and framing specific financial structures to accommodate it.

Neither the public, nor the private sector alone will overcome current market failures to optimal energy efficiency in the residential building sector. Strong political will is therefore needed to create more favourable grounds for the development of energy efficiency investments. Most financial tools to assist specific obstacles — such as the initial cost barrier — exist. What is still crucially lacking is a common framework that would allow the mainstreaming of energy efficiency investments, which in turn would lower the transaction cost and the general disinclination of financiers.

Should the uncertainty concerning energy efficiency evaluation and benefits be properly addressed through adequate public intervention, the private sector could bring a significant capital input in the sector.

Annex I • SUMMARY TABLE OF US POLICIES

Years of operation	Funds, programmes and tools	Goals	Target area/Addressed sector	Impact
		Regulatory measures		
2006 (last updated)-present	International Energy Conservation Code (IECC)	To develop codes to address energy efficiency in homes and buildings on a voluntary basis	New commercial and residential buildings and additions to existing buildings	Reduces emissions, saves energy costs; 26 states have adopted codes at 2003 or 2006 IECC standards
1987 (legislation), amendments 1988, 1991 (effective for most appliances: 1990) - present	National Appliance Energy Conservation Act (NAECA)	Establish national energy efficiency standards for appliances and HVAC equipment	15 appliances in the residential sector: refrigerators, freezers, kitchen ranges, kitchen ovens, room air conditioners, direct heating equipment, water heaters, pool heaters, central air conditioners, central heat pumps, furnaces, boilers. Effective 1991: fluorescent light ballasts. Effective 1994: clothes washers, clothes dryers, dishwashers	0.77 quads savings up to 2000, *i.e.* about 7% of residential energy demand (without electricity system losses), favourable benefit/cost-ratio. Drawbacks: Slow or missing update process to follow technical development, state appliance efficiency requirements pre-empted by NAECA
1992, 2005	Energy Policy Act	Update existing standards and establish new standards for other appliances in the law	EPAct 2005 includes among others furnaces and boilers (effective only 2015)	Only moderate EE requirements, slow introduction
2007 – present	Energy Independence and Security Act	To reduce dependence on oil by increasing the supply of alternative fuel sources, setting a national fuel economy standard, and increasing appliance and equipment standards	Cross-sectoral: Transport, fuel production, manufacturers, federal buildings. Appliance and equipment standards will affect the residential building sector. Residential white goods, boilers, and lighting standards are to be improved, along with labeling for consumer electronic goods. The Act sets a goal to phase out incandescent light bulbs in ten years	Unknown as yet; the Act has been criticised for removing tax credit provisions, subsidies for renewable energy and a renewable electricity standard (requiring that a certain share of electric power be produced using renewable energy sources)

Years of operation	Funds, programmes and tools	Goals	Target area/Addressed sector	Impact
		Financial and incentive-based measures		
1976 - present	Weatherization Assistance Program (WAP)	To provide low-cost residential weatherisation and other cost-effective energy-related home repair. To enable low-income families to reduce their energy bills by increasing the energy efficiency of their homes	Low-income households	5.6 million households served in 2006; on average, weatherisation reduces overall energy bills by USD 358 per year at current prices; benefit-to-cost ratio of about six to one
1974 - present	Low-Income Housing Energy Assistance Program (LIHEAP)	To enable low-income households to meet their energy needs through direct financial assistance. To provide low-cost residential weatherisation and other cost-effective energy-related home repair	Low-income households	Approximately 4.8 million households served in 2003, with average household benefit for heating costs of USD 312
1978, 2005 – December 2007	Energy Tax Act	To introduce tax incentives such as tax credits for highly efficient new homes and for improvement of existing homes	Commercial and residential building upgrades/renovations; new residential houses. Tax credit and deduction (limited to USD 500 for residential building envelope upgrades)	Between 1978 and 1983, 24 million households claimed tax credits; negligible impact on the rental and low-income sector. Modelled provisions of 2005 Act show limited impact
1974-present	State Energy Conservation Programs (SECP), Institutional Conservation Program (ICP), State Energy Program (SEP)	To provide federal sources of funding for states to implement energy conservation programmes	Cross-sectoral	Several programmes affecting EE improvements at the state level, such as weatherisation programmes, are funded through the SEP

Years of operation	Funds, programmes and tools	Goals	Target area/Addressed sector	Impact
		Information and capacity building programmes		
1992-present	Federal Housing Administration (FHA) Energy Efficient Mortgage (EEM) Program. FHA is part of the US Department of Housing and Urban Development's (HUD) Office of Housing	The goal of the FHA is to increase the country's home ownership rate. Part of this involves insuring mortgages to allow for housing loans requiring lower down payments and interest rates. FHA recognised that reduced utility costs allow a homeowner to pay a higher mortgage that covers the cost of energy improvements on top of the approved mortgage. The programme aims to incorporate the financial impact of EE improvements into mortgage loan provision. Mortgage loans are funded by lending institutions, not FHA. The programme seeks to meet national energy efficiency goals while providing better housing for those otherwise unable to afford it	One- to four-unit existing and new residential buildings undertaking cost-effective energy efficiency improvements. The total cost of the improvements must be less than the total present value of the energy saved over the useful life of the energy improvement. A home energy rating system (HERS) must be undertaken to apply for an EEM	EEMs are offered by a large number of lenders, and largely for existing homes. Fannie Mae and Freddie Mac, federal charter companies in the secondary mortgage market, also changed underwriting guidelines to support EEMs. Fannie Mae guidelines permit approved lenders to increase debt-to-income ratio requirements by 2% for EEMs, while Freddie Mac also allows lenders to stretch this ratio to their discretion. The US department of Veteran Affairs also provides EEMs to qualified military personnel. Lenders estimate that EEMs can result in annual energy savings of 30% to 50%
		Information and capacity building programmes		
1979 – 1986 and 1980 – 1986	The Energy Extension Service (EES) and the Residential Conservation Service (RCS) (Federal programmes implemented at the state level)	To provide information and demonstrate energy conservation opportunities, techniques and products. Includes conducting on-site home audits	Cross-sectoral (implemented by states); also targeted households and small businesses	Limited impact on homeowners
2005-2007	Tax Incentive Assistance Project (TIAP)	To provide information necessary for people to make use of federal income tax incentives	Consumers and businesses	

Years of operation	Funds, programmes and tools	Goals	Target area/Addressed sector	Impact
1992 - present	Home Energy Rating Service (HERS)	To establish a standardised system for rating the energy efficiency of buildings	New and existing residential buildings	In some states used by builders, real estate agents and mortgage lenders; makes EE a feature of the housing market
1992 - present	Energy Star Program	To label product categories (office equipment, residential heating and cooling, lighting, etc.); to provide building assessment tools; to provide auditing and technical services	Commercial and industrial buildings, new homes and appliances	In 2006: USD14 billion energy cost savings; 170 billion kilowatt hours (kW/h) saved
		NEW YORK		
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Regulatory measures		
1978 – present (mandatory since 2002)	State Energy Conservation Construction Code Act	To increase EE in the residential sector through the establishment of codes. Amendments to the original Act mean that this law now also covers substantial renovation of existing buildings	New residential buildings and large renovation projects in existing buildings	
1980 – (up to the introduction of federal standards for some appliances in 1988 and 1995)	State Energy Law	To set standards for appliances	Appliances, including water heaters, room and central air conditioners, heat pumps	
1977 - 1980	New York State Energy Conservation Plan	To encourage energy conservation in all sectors through a combination of regulatory and voluntary measures; to achieve a quantitative energy saving goal of 5% up to 1980. Included 21 conservation programmes, some of them mandated by the federal Energy Policy and Conservation Act of 1975	Cross-sectoral	Established certification of houses, furnace maintenance, home audits, weatherisation, and thermal and lighting standards in the residential sector

NEW YORK				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Financial and incentive-based measures		
1998 - present	Energy $mart Loan Fund (funded through the System Benefits Charge)	To encourage EE improvement measures by providing preferential loans through a network of participating lenders	Owners of one- to four-family homes; owners of multi-family buildings; new construction multi-family buildings. During the first two terms of the programme (1998-01, 2001-06), about 30% of the budget was allocated to residential programmes. In the current term (2006-11), the budget share is increased to 36%, in addition to indirect funding through R&D and general costs. Residential programmes include lighting, appliances, new homes and whole building assessments and improvements; some of these programmes specifically address low-income households	2 500 GWh of annual electricity demand and 12 00 GWh of annual non-transportation fuel demand saved in 2006. 16% of electricity savings and 40% of the fuel savings originate from the residential sector
1998 - present	Energy $mart Assisted Home Performance with Energy Star (HPwES)	To reduce energy costs of low- and moderate-income households by providing affordable energy efficiency improvements; the programme covers up to 50% of the costs associated with EE improvements	Low-income homeowners, renters and one- to four-family building owners	In 2006 these accounted for 37% of all HPwES participants, or 1 499 projects
1998 - present	Energy $mart Home Performance with Energy Star (HPwES) Financing	To provide preferential loans for those wising to undertake EE improvements as part of the Home Performance with Energy Star programme	Homeowners participating in the Home Performance with Energy Star programme, who do not qualify for the Assisted Home Performance programme reserved for low-income homeowners	In 2006, 4 235 projects were completed (up from 3 400 the previous year) with participants saving more than USD 700 a year on utility bills

NEW YORK				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
1998 – present	EmPower New York	To encourage cost-effective reductions in electricity and gas use through providing free weatherisation services	Customers of participating electric utilities (contributing a systems benefit charge) living in a building with 100 units or less, or with a household income of 60% below median state income. Current National Grid natural gas customers residing in one- to four-family homes with household income below 60% of state median	Provided electricity demand reduction and home energy performance improvements to more than 9 800 low-income households. The estimated annual energy cost savings is USD 256 per household, with an average investment of USD 1 200 per household
1988 – about 1994	Oil Heat Rebate Program and NY$AVE Program	The Oil Heat Rebate Porgram provided incentives for heating systems, and the NY$SAVE Program for electric household appliances	Residential sector	
2000-present	Green Building Tax Credit	To encourage the construction of Green Buildings by providing tax credits to owners and tenants of buildings meeting "green" standards	Commercial and residential multi-family buildings; includes new and rehabilitated buildings	
1977 - present	Property Tax Exemption	To encourage EE improvements in the residential sector by exempting qualifying energy conservation improvements from property taxes (to the extent the improvement would increase the value of the home)	Owners of one- to four-family dwellings	

NEW YORK				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
1996 (took effect 1998) – present	System Benefits Charge (Funds New York Energy $mart programmes)	To reduce energy use; designed to fund energy efficiency and renewable energy programmes that might not immediately develop in the competitive market place; money raised through the SBC goes to energy efficiency, research and development, and low-income programmes; the energy efficiency aspect focuses on market transformation, energy services industry programmes, and technical assistance and outreach programmes	Cross-sectoral, including low-income households	In 2006, USD 436.3 million for energy efficiency offerings, including USD 16.5 million for special consumer education and outreach activities; USD 113.7 million for low-income energy affordability programmes; and nearly USD 200 million for R&D projects, including programmes fostering distributed electric generation and CHP installations
2000 – present	Long Island Power Authority (LIPA)- Residential Energy Efficiency Rebate Program	To reduce electric energy consumption through a rebate programme for energy-efficient appliances	Residential customers of LIPA wishing to purchase or replace old appliances with energy-efficient ones (air conditioners, air-source heat pumps, geothermal heat pumps and clothes washers)	
Information and capacity building programmes				
1998 – present	Energy $mart Home Performance with Energy Star	To provide a comprehensive and standardised assessment of homes by certified contractors to determine the existing EE of the home and a diagnosis of improvements to be made; prerequisite for obtaining Energy $mart financing measures for EE improvements	Residential homeowners	In 2006, 4 235 projects were completed (up from 3 400 the previous year) with participants saving more than USD 700 a year on utility bills

MAINE				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Regulatory measures		
1977 (voluntary), 1980 (law), 2005 - present	Energy Efficiency Building Performance Standards (EEBPS) / Maine Model Building Energy Code	State-wide minimum energy efficiency requirements for buildings. For residential buildings the Maine Model Building Energy Code is based on the 2003 IECC. Not mandatory; can be adopted in part and not required if a town already adopted a building energy code before July 2005	Commercial and residential, new and existing (in the case of additions). In the residential sector applies to buildings with two or more dwelling units only	Presumably limited impact; not mandatory for single-family homes which represent a large majority of Maine's residential buildings, general lack of enforcement
		Financial and incentive-based measures		
1976-present	Weatherization Assistance Program (WAP) and Low-Income Housing Energy Assistance Program (LIHEAP): Federal programmes administered by state/local entities, complemented by state (*e.g.* REACH) or utility programmes (*e.g.* Northern utilities)	To enable low-income households to meet their energy needs through direct financial assistance (pay part of their energy bills). To provide low-cost residential weatherisation and other cost-effective energy-related home repair	Low-income households	
1998 - 2000	FIX ME, a federal programme of HUD in which Maine participated	To complement the weatherisation programme. Encourage needed home repairs and replacement by providing low-interest loans with an interest rate of 2% and 4%. Repair loans up to USD 15 000 for 15 years, replacement loans up to USD 25 000 for 20 years	Low-income sector. Replacement windows, heating system upgrades, insulation and septic system upgrades	Maine State Housing Authority has purchased in excess of 2 400 loans totalling approximate USD 20 million in two years. The average loan amount was USD 8 300

MAINE				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
2006 - present	Home Energy Loan Program (HELP) through several lending institutions	Encourage energy efficiency improvements such as insulation, air sealing and weather-stripping, heating system repair or replacement. Using Energy Star rated windows and appliances, storm doors and storm windows, ventilation and moisture controls	Owner-occupied two- to four-unit dwellings in the low-income sector. Special incentives for borrowers who follow the recommendations of a home energy audit (1% interest rate instead of 3%)	Since 2006, this programme has provided more than USD 500 000 in low-cost energy loans to help 40 families
Information and capacity building programmes				
1985- present (since 2003 part of Efficiency Maine)	Maine Energy Education Program (MEEP)	Teach students about energy efficiency and conservation topics	Education sector	
2002	Bundle Me Up	Help households manage their energy costs in response to the oil price shock in the 2000/2001 heating season through energy saving tips and information about additional financial help	Residential sector	
Combined programmes				
1970s	Low Cost / No Cost (LC/NC)	Providing incentives and information in combination. Pilot programme by DOE and six New England states	Residential sector, supporting energy-efficient choices (for example efficient use of hot water using shower control devices)	Combined approach was effective; residents took significantly more LC/NC actions than control group
2002 (legislative), 2003 (creation) - present	Efficiency Maine, public benefit programme. Funds collected from utilities that include the state assessed charge in their rates. Programmes developed and implemented by the Maine Public Utilities Commission	Increase consumer awareness of cost-effective options for conserving energy. Create more favourable market conditions for the increased use of efficient products and services. Reduce the price of electricity over time for all consumers by achieving reductions in demand for electricity during peak use periods	All sectors (residential, commercial, industrial, tertiary, public, agricultural) where electricity is used. Residential sector is targeted by two programmes: Residential Lighting and Low-Income	23.2 GWh saving through the Business Program between January 2005–June 2006. In 2007 the Residential Lighting and Low-Income programmes resulted in annual savings of 48.0 GWh, lifetime savings of 363.5 GWh and lifetime economic benefits of USD 101 million

VERMONT				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Regulatory measures				
1998 – present (revised version effective 2005)	Vermont Residential Building Energy Standard (RBES)	Constrain energy use of new floor area and create a standard for rating systems and minimal requirements for financial instruments	New homes and additions over 500 square feet (46.4 m^2). City of Burlington: also in all types of renovation	Indirect impact on existing buildings through market transformation of building elements such as windows, heating systems, etc.; financial incentive programmes use the Standard
2006 (enacted), effective date to be determined (*)	Minimum energy efficiency standards for residential furnaces and boilers	Save costs, energy, reduce pollution and other environmental impacts, make the electricity system more reliable, reduce or delay the need for upgrade investments in the electricity system. A complement to federal efficiency standards	All residential furnaces and boilers sold, including those replacing existing ones	Potentially high if implemented (10% efficiency gain or more for all buildings)
(*) the Commissioner of the Department of Public Service must determine if standards for residential furnaces and boilers require a waiver from federal pre-emption and if so, must apply for a waiver.				
Financial and incentive-based measures				
1978 – present	Vermont Weatherization Program	Improve both comfort of living and energy efficiency	Low-income residential sector	Between 1980-2006, 40 000 homes weatherised. Average saving per weatherised home about 20% (1996-2000). Benefit-to-cost ratio increased from 1.3 (1993), 1.8 (1955, 1997) to 2.4 (1999). Back to 1.8 in 2001. Benefit-to-cost ratio including non-energy benefits improved from 3.3 (1999) to 4.1 (2001)
1986 – about 2000	Vermont's Home Energy Loan programme	Provide preferential loans to improve the EE of existing homes	Existing single-family homes	Low in quantity (180 homes up to 1998), 20% savings in average
1993 – about 2000	Energy efficient mortgage (EEM), Energy improvement mortgage (EIM)	Provide preferential loans to purchase energy-efficient homes (EEM) or to improve EE (EIM)	Existing single-family homes	Low (0.1% of total residential mortgage market in 1999)

VERMONT				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
2003 - present	Existing Homes Programme of Efficiency Vermont (EVT)	Capture energy efficiency opportunities in existing homes	Retrofit of building envelope, heating, and cooling systems (also provides training and incentives to contractors for adopting energy-efficient practices)	Not evaluated in 2005, evaluation ongoing during 2007
1993 - present	Vermont Gas HomeBase Retrofit Program and Equipment Replacement Program (Residential Energy Efficiency Rebate Program and Residential Energy Efficiency Loan Program)	Improve efficiency of homes with larger-than-average gas usage by retrofit and equipment replacement	Single-family homes and multi-family buildings that use more than 39 600 kWh of natural gas	Through to 2002, 1 900 audits, 1 000 customers with installations (22% of those eligible for the programme), 18.8 GWh of annualised savings
Information, demonstration and capacity building programmes				
1987 - present	Energy Rated Homes of Vermont (ERH-VT), Home Energy Rating System (HERS)	Increase market transparency and create differentiation regarding EE by providing easy understandable information about homes' energy efficiency. HERS is also used to check building code compliance	New and existing homes	0.8% of all homes rated by 1998, 1.6% up to 2002
2005 - 2007	Tax Incentive Assistance Project (TIAP): Federal measure supported by Efficiency Vermont (EVT)	Provide information to make use of federal income tax incentives	Consumers (including home owners) and businesses	

VERMONT				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Combined programmes		
1996 - 2000	Low-Income Multi-family Program (1996 and early 1997) of Green Mountain Power Corporation (GMP), statewide Residential Energy Efficiency Partnership (REEP) after April 1997	The GMP programme is a DSM programme. REEP provides retrofit services in low-income multi-family housing sector	Property developers, owners, and managers of low-income multifamily housing	1.4 GWh in 1997
1999 (creation) 2000 (operation) - present	Efficiency Vermont (EVT), an energy efficiency utility, run by an independent co-operative (VEIC), funded by an energy efficiency charge (EEC)	Several programmes provide technical advice, financial assistance (*e.g.* for chillers, furnaces, boilers, heat pumps, air conditioners through the HVAC Equipment Rebate Program), and design guidance to become more energy efficient and reduce energy costs. Goal 2006 to 2008: 1% of incremental saving	Cross-sectoral (equipment, new and existing homes, farms and businesses)	2000 to 2006: met or exceeded all performance requirements; 2002: 38.3 GWh savings; 2003: 46.7 GWh savings; Electricity savings up to 2004: 3%; 2006 to 2008: 270 GWh savings projected

FLORIDA				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Regulatory measures		
1980 - present	Florida Energy Efficiency and Conservation Act (FEECA)	Reducing the growth rates of weather-sensitive peak demand, reducing and controlling the growth rates of electricity consumption, and reducing the consumption of expensive resources such as fossil fuels	FEECA requires electric utilities to implement cost-effective demand-side management programmes	From 1980 to 2005 state-wide summer peak demand reduced by 4 950 MW, winter peak demand by 5 510 MW (corresponding to 11% of total demand), annual energy consumption by 5 490 GWh (corresponding to 2.5% of electricity energy demand)

FLORIDA				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Early and mid-1980s - 1988	Standards, first on central and room air conditioners (regulated by federal law as from 1988), further appliances in 1987	See FEECA	Central and room air conditioners and other appliances (up to 1988)	See FEECA
Late 1970s (early action) -1982; moderate reinforcement between 1982 and 1997 / 1998 (re-activation) – present (revised 2004 and 2007)	Florida Thermal Efficiency Code and Florida Lighting Efficiency Code; combined in 1980 as the FEECBC / Florida Energy Code (Chapter 13 of the Florida Building Code)	See FEECA. Establishing a model code more stringent than the IECC 2000 and IECC 2006. Improving EE requirements for exterior envelopes, lighting, electrical distribution, and selection of heating, lighting, ventilating, air conditioning and service water heating systems	State-wide uniform. New and existing buildings. In the case of addition or renovation, new portions and components must comply with energy efficiency requirements for the building envelope, space conditioning equipment (cooling, ventilation, heating) and for hot water systems	For new buildings the 2007 version is 55% more stringent (per m^2) than 1979 Code version (73 kWh/m^2 instead of 161 kWh/m^2). The 2007 version is 4% more stringent than the 2006 IECC, and will increase to 15% by Jan 2009. Overall savings as compared to 1979 version are 34 300 GWh/yr (*i.e.* annual demand of residential sector would be 27% higher without the Code). Impact on existing buildings presumably through market transformation (*e.g.* window U-factor decrease from 1.3 (1979) to 0.75 (2007) (efficiency gain of 42%), SEER (Seasonal energy efficiency ratio) from 6.1 (1979) to 13.0 (2007) (efficiency gain of 53%)
Financial and incentive-based measures				
1980 – present	Various demand-side management (DSM) and "Good Cent" programmes of large utilities regulated by the FEECA	Meet requirements of FEECA to implement cost-effective DSM measures	Large utilities subject to FEECA regulation. Programmes target various sectors, including existing residential buildings	See FEECA

FLORIDA				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Information, demonstration and capacity building programmes				
1993 - present	Building Energy Efficiency Rating System (BERS) based on the Florida State Energy Code	Increase market transparency and create differentiation regarding EE by providing easily understandable information about homes' energy efficiency. Serve as a basis for incentive and DSM programmes	New and existing homes. Purchaser of single- or multi-family dwellings (should receive written notification that the buildings energy efficiency may be determined prior or at the time of real estate transaction)	
Combined programmes				
Florida Energy Efficiency and Conservation Act (FEECA) and the DSM programmes of the utilities under FEECA regulation can be considered as combined programmes.				

CALIFORNIA				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Regulatory measures				
1978 – present (three-year code change cycle)	California Energy Efficiency Standards for Residential and Non-residential buildings, mandatory state-wide	To increase EE in the building sector through the establishment of codes that are updated every three years	New buildings and other projects requiring a building permit (*e.g.* additions and renovations)	Building efficiency standards (along with those for energy-efficient appliances) have saved more than USD 56 billion in electricity and natural gas costs since 1978. It is estimated the standards will save an additional USD 23 billion by 2013
1976 - present	Appliance Efficiency Regulations	To reduce energy consumption by improving EE	Residential and commercial appliances	Reduced need for new power plants; reduced consumption and emissions; helped consumers save money on energy bills
Financial and incentive-based measures				
2001 - present	Tax Deduction for interest on loans for energy efficiency	To encourage the purchase of EE products or equipment, by allowing interest paid on loans taken for these purposes to be deducted from personal income taxes	Residential sector; targets those with loans from public utility companies for EE product and equipment purchases. Can also be used by those with home equity or home improvement loans	

FLORIDA				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
1996 – present	Systems Benefit Charge administered by the California Public Utilities Commission	To fund cost-effective EE measures, renewable technologies, public interest research and low-income assistance programmes	Largely devoted to funding utility demand-side management or demand response programmes, some of which are targeted to low-income households	USD 2 billion provided in funding for the state's utilities for 2006-08
Information and capacity building programmes				
1996 - present	Public utility demand-side management (DSM) or demand response (DR) programmes	To reduce energy use by providing incentives such as: rebates for EE products and equipment as well as renewable energy sources; loans and grants for EE improvements; weatherisation services	Mostly commercial and residential sectors (most utilities provide similar programmes for both sectors), can also extend to industrial and public buildings	Utility-sponsored incentives are considered to be one of the most influential policies in bringing about increased EE and limited electricity consumption in the state
1999 - present	California Home Energy Rating System Program	To provide reliable information to differentiate the energy efficiency levels among homes and to guide investment in cost-effective home energy efficiency measures	Residential buildings	

OREGON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Regulatory measures				
1974– present Code is updated every three years	Oregon Residential Energy Code. Mandatory state-wide, exceeds the 2003 IRC. State developed software, CodeComp can be used to show compliance	To reduce the energy costs of operating a home; the goal is to reduce heating bills up to 40% as compared with the 1988 residential building code	All new residential buildings three stories high or less must comply with the code; includes hotels, motels, apartments, dormitories and certain assisted living facilities. The code has a "Base Path" and eight other alternate Paths to ensure flexibility. Each path has its own thermal performance requirements for building envelope components (walls, floors, windows), making them applicable for renovation of building components	2003 amendments reduced energy use 5%-10% in new homes. It is estimated that in 2003 energy savings as a result of building codes amounted to 952 million kWh of electricity and 58 million therms of natural gas

OREGON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
2005-present	State Appliance/ Equipment Efficiency Standards	Increasing the energy efficiency and therefore lowering energy costs of 11 appliances not currently covered by federal legislation. Nine of these standards have been adopted, with some appliances used in residential buildings, such as compact audio products, DVD players and recorders, single voltage external power supplies and hot tubs	Manufacturing; the Oregon State Department of Energy establishes standards and appliance and equipment manufacturers certify to them that products meet these standards. Various sectors are affected, since the appliances covered are for commercial, residential and industrial use	
Financial and incentive-based measures				
1977- present (updated with new technologies)	Residential Energy Tax Credit	To encourage the purchase of highly efficient appliances, heating and cooling systems, duct systems, closed-loop geothermal space or water heating systems, solar water and space heating systems, photovoltaics, wind, fuel cells, alternative fuel vehicles and charging or fuelling systems. New rules adopted in December 2007 added an incentive for certified residential clean burning wood stoves, or high efficiency biomass combustion devices	Homeowners and renters who pay Oregon income tax. Tax credits are set at a maximum amount depending on the type of appliance or system purchased and installed, or sometimes a percentage of the total cost, whichever is less. The Oregon Department of Energy keeps a list of appliances qualifying for the tax credit	Since the programme began it has supported the installation of 22 080 renewable energy systems and the purchase of 134 029 energy-efficient appliances. In 2003 electricity savings amounted to 84 million kWh, natural gas savings to 108 million therms, and oil savings to 41.6 cubic metres

OREGON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
2002 - present	Energy Trust – Existing Home Energy Solutions Program. Energy Trust is funded by a "public purpose charge" collected by Oregon's two largest investor-owned utilities	Providing services, cash incentives and qualified contractors to increase the energy efficiency of existing homes	Existing residential dwellings. The programme is available to Oregon homeowners who are customers of Portland General Electric, Pacific Power, NW Natural or Cascade Natural Gas. Cash incentives are provided for both energy-efficient renovations and appliances, with a bonus offered if several measures are taken concurrently. A free home energy review is provided beforehand. Low-interest financing is provided to undertake measures recommended following a complete home energy performance rating. Assistance in obtaining residential energy tax credits is also provided	In 2006 residential programme energy savings resulted in electricity savings of 10 MW and gas savings of 1 million therms. Gas savings booked in 2007 were 167% of those booked in 2006, with overall incentives paid increasing by 122%
2002- present	Energy Trust Multi-family and Small Multi-family Home Energy Solutions Program	Providing cash incentives for owners of multi-family buildings to make energy-efficient choices when renovating or replacing equipment and appliances	Existing multi-family residential buildings of five units or more. Existing small multi-family residential buildings of two for four units	In 2006 residential programme energy savings resulted in electricity savings of 10 MW and gas savings of 1 million therms. In 2007 the multi-family programme commitments experienced a dramatic jump, with over USD 1 million in incentives being committed for projects. This jump was largely stimulated by a marketing and outreach campaign

OREGON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
1983-present	State Home Oil Weatherization (SHOW) Program	Improving the weatherisation and heating capacity of homes heated with fuel oil and wood. This represents approximately 100 000 homes, most of which were built before energy standards were included in the building code and are therefore in need of weatherisation. These homes also do not qualify for weatherisation programmes offered by electricity and gas utilities	Homeowners and renters of homes heated with fuel oil and wood. Rebates of up to USD 500 are provided for the installation of weatherisation and heating measures. Owners of rental accommodations heated with fuel oil or wood are also eligible to obtain a Oregon Business Energy Tax Credit on top of SHOW rebates	In 2003, SHOW measures resulted in 1.9 million gallons of oil savings, a monetary value of USD 2.5 million
Voluntary agreements and partnerships				
1981 - present	State Loan Program. Loans are funded through the sale of state general obligation bonds. Borrowers pay the programme administration costs	The programme offers low-interest, long-term loans for projects that: i) save energy; ii) produce energy from renewable resources such as water, wind, geothermal, solar, biomass, waste materials or waste heat; iii) use recycled materials to create products; iv) use alternative fuels	Residential, commercial and tertiary. Buildings are specifically targeted, individuals and municipal authorities can apply for loans. A wide variety of actors can apply for loans which usually range from USD 20 000 to USD 20 million. An energy audit is required as part of the loan application.	Between 1980 and 2006, 709 loans were disbursed, representing approximately USD 345 million. Residential loans represented 17.3% of the total loans disbursed, and 0.5% of the total loan amount. A portion of municipal loans could possibly used in residential buildings. In 2003 the entire loan programme accounted for savings of 444.8 million kWh of electricity and 17.2 million therms of natural gas. The impact of projects affecting residential buildings alone is unknown
Information and capacity building programmes				
2002-present	Energy Trust of Oregon	Providing home energy rating services to guide energy efficiency improvement decisions	Residential and commercial	Audits form a part of the incentive programmes offered by Energy Trust

WASHINGTON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
		Regulatory measures		
1977–present. Code is updated every three years; last update 2006 effective July 2007	Washington State Residential Energy Code. Mandatory state-wide, exceeds 2006 IECC standards for most homes	To provide minimum standards for new or altered buildings, and structures or portions of buildings, to achieve efficient use and conservation of energy	All new residential buildings; applies to existing buildings in the case of additions, change of occupancy or use, alterations and repairs	
2005-present	Appliance and equipment standards	To establish minimum efficiency standards for six appliances not covered by federal legislation. Two of these can also apply for residential use and have been enacted: state-regulated incandescent reflector lamps and single voltage external power supplies	Commercial, industrial, residential, tertiary	
		Financial and incentive-based measures		
2006- present	Solar water systems sales and use tax exemption	To encourage the installation of solar water heating systems with a view of improving energy conservation in houses. Sales tax is not charged for all certified solar water heating systems, including replacement parts and all installation and servicing on the equipment	All; for anyone buying certified solar water heating systems or having them serviced	

WASHINGTON				
Years of operation	**Funds, programmes and tools**	**Goals**	**Target area/Addressed sector**	**Impact**
Information and capacity building programmes				
1995-present	Utility Energy Conservation Programs. These are supported by the Washington Utilities and Transportation Commission (WUTC) which regulates the utilities' activities	To reduce energy demand by implementing cost-effective energy conservation programmes. Measures are developed by energy service providers, including information provision, rebates for purchase of energy-efficient appliances, and low-interest loans for energy efficiency improvements. All programmes are financed through varying surcharges imposed by the individual utilities	Residential and commercial customers of various electricity and gas utilities. Several gas and electricity utilities not regulated by the WUTC also provide energy conservation programmes to their customers	Expected energy savings vary between utility providers. Those with programmes in place since the 1990s vary between 40 and 170 million kWh of electricity savings and 240 000 to 2.9 million therms of gas savings. Those implementing programmes from the year 2000 onwards expected approximately 19 million kWh of electricity savings and 340 000 therms of gas savings

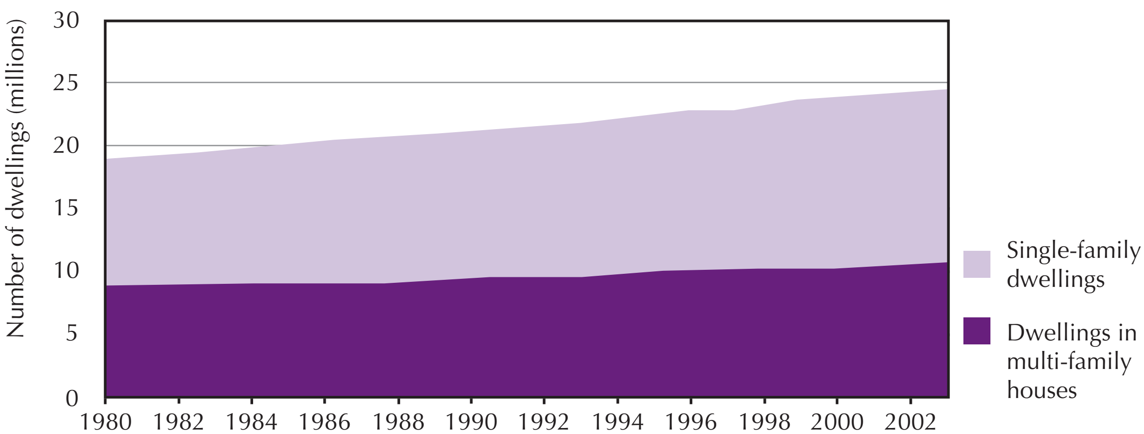
Annex II • FRANCE

General background information

Building types

The share of single-family houses (56% in 2003) is predominant and grows faster than the one of multi-family houses; accordingly, floor area of single-family houses dominate, all the more so as floor area is greater per dwelling (Figure 65).

Figure 65* • *Number of dwellings in single- and multi-family houses in the French building stock (permanently occupied dwellings)



Source: Authors' calculations based on Odyssee-Database (Version 4.1).

Age structure of the building stock

Referring to figures in Table 42, almost two-thirds of the French building stock was constructed before the mid-1970s, when building codes for new buildings were first introduced. In terms of energy consumption their share is slightly higher (69% for all dwelling types). 45% of social sector dwellings were constructed before 1970 and another 25.7% between 1970 and 1980.

Table 42 • Overview on the stock of residential buildings and its energy consumption in France

	Built before 1975		Built after 1975		New
	Stock (million dwellings)	Energy consumption (TWh)	Stock (million dwellings)	Energy consumption (TWh)	Million dwellings constructed in 2004
Single-family houses	8.5	187.7	5.5	94.8	0.2
Apartment buildings	7.4	118.3	3.6	45.2	0.12
Total	**15.9**	**306**	**9.1**	**140**	**0.32**

Source: Wellhoff and Tabet (2006).

The economics of housing and construction

Total housing expenditures in France amounted to about 19% of the GDP in 1984 and increased to 21.3% in 2004 (Table 43). The current expenditures for rents, energy and charges amounted to about 70% of total household expenditures during the last years and the investment expenditure (renovation, maintenance, new buildings) between 28% and 30%, with an increasing tendency. The "Comptes du Logement" report express concern about the increase in energy costs, in particular for oil heated dwellings.

Table 43 • Current and investment housing expenditures in France (billion EUR, current prices)

	1984	2002	2003	2004
Current housing expenditures	**84.8**	**219.9**	**231.8**	**243.9**
Rents (incl. mortgage pay off)	52.5	164.6	173.6	183.1
Energy	23.1	35.3	37.3	38.7
Charges	9.1	20	20.9	22.1
Investments (including land)	**48**	**89.2**	**93.7**	**104.7**
New dwellings	30.1	49.1	51.5	59.2
Large maintenance* renovation etc.	16.3	32.4	33.8	36.2
Acquisition minus cessions of old dwellings	1.6	7.6	8.4	9.3
Financial fluxes	**1.3**	**4.5**	**4.6**	**4.9**
Total national expenditures	**134.1**	**313.6**	**330.1**	**353.5**
Percentage of GDP	19.2%	20.2%	20.7%	21.3%

** include renovation and retrofit of the building shell and of the building technology (heating system).*

Source: *Compte du logement,* Edition 2006.

Structural change in the residential sector and CO_2 emissions

Carbon dioxide (CO_2) emissions of the total building sector increased by 22.3 % between 1990 and 2004 (Le Déaut et al. 2006; CITEPA, 2006a). The increase in the residential sector was less pronounced, namely 12% between 1990 and 2003 (using climate corrected average CO_2 emissions per dwelling and the number of occupied dwellings from the ODYSSEE database, Version 4.1). This has been caused by the increase of the total final demand and the decrease of CO_2 neutral wood that led to a net increase in the use of fossil fuels.

Building codes and components

Technical requirements to apply for tax credit, and the development of building codes, are shown in the following tables.

Table 44 • Technical energy efficiency requirements for tax credit in the case of existing buildings

Technology, type of work	Criteria	Value
Wood boilers	Thermal efficiency	≥ 65%
Heat pumps	Coefficient of performance	≥ 3.0
Insulation material for opaque elements (walls, roofs, terrace)	Thermal resistance	≥ 2.5 m^2K/W
Insulation material for attic floors	Thermal resistance	≥ 4.5 m^2K/W
Windows including glass doors	Thermal transmission Uw	≤ 2.0 W/m^2K
Glazing	Thermal transmission Ug	≤ 1.5 W/m^2K
Shutter (including air layer)	Thermal resistance	≥ 0.2 m^2K/W
Insulation of heating generation or distribution systems	Thermal resistance	≥ 1.0 m^2K/W

Source : Ministère de la cohésion sociale et du logement, 2006.

Table 45 • Development of building codes in France

Short description	Effective	
	From	To
Limit of heat loss through building shell and ventilation. The limit depends on the energy type of the heating system (*e.g.* 25.1 MWh for oil, 15 MWh for electricity).	1974	1982
Limit of heating requirement, taking into account heat loss through building shell and ventilation (coefficient G must be below 1.6W/°C/hour/m^3) as well as internal and external (solar) gains, entailing a reinforcement of 25% (*e.g.* 15.3 MWh for oil, 8.7 MWh for electricity)	1982	1989
As above, but additionally including hot water and the efficiency of the heating system (newly introduced coefficient B must be below target value), entailing a reinforcement of 25% (*e.g.* 10.6 MWh for oil, 6.1 MWh for electricity)	1989	2000

Short description	Effective From	To
Established 2000, updated and further specified in 2001, 2003 and especially in 2004 to comply with European EPBD, based on the following principles: · Energy use for heating, hot water, ventilation, air conditioning, and lighting (tertiary sector) must be below according value of the reference building (coefficient C), independent of the energy type. Thermal bridges are explicitly taken into account. · Additionally, despite the whole-building approach, building elements must comply with max. U-values. · RT 2000 also set standards for indoor conditions (including the summer case): the indoor temperature of non-cooled buildings must be below the temperature of the reference building (referring to four climate zones in France).	2001	2005
Reinforcement of about 15%. Energy use for cooling must be compensated for most building types and zones. Building elements and equipment must comply with reinforced max. U-values (*e.g.* wall: 0.45, roof 0.28 W/m²K).For residential buildings, the primary energy use is limited, depending on the climate zone and depending on the type of energy. All buildings must comply with summer comfort conditions (cooled ones must be satisfy requirements also without using the cooling system). Climate zones have been redefined.	2006	≃2010
Reinforcements announced 2010 (*e.g.* Plan Climat 2004, website ADEME June 2007), and every five years up to 2020	≃2010	(2015) (2020)

Source: Mure database (measure descriptions of household sector Fra8, Fra9, Fra15, Fra18, Fra24), CSTB (2000), website www.rt2000.net (June 2007), website www.ademe.fr (June 2007).

Preferential loans that may affect EE improvements

GIPEC loan, also called 1% Housing, including "Pass-Travaux"

It offers the possibility to undertake works on buildings financed with preferential loans currently at an annual interest rate of 1.5% with a payback period from 5 to 20 years (ADEME, 2006a), generally limited to EUR 8 000. Beneficiaries are employees of the industrial and the commercial sector with at least 20 employees, regardless of their time in the company and independent of the type of employment (full time, part time, type of contract). The loans are attributed among others for the purchase of old dwellings of more than 20 years, conditioned to subsequent improvement investments of at least 25% of the purchase price. The "Pass-Travaux" scheme attributes loans for the improvements of a main home, including EE measures such as thermal diagnostics, the improvement of boiler efficiency and thermal insulation, heating system control, and the use of renewable energies. It also covers a large variety of other housing and daily living improvement measures, and the enlargement of dwellings or the change of a non-residential location into a dwelling. The amount of loan depends on the economic resources and may be up to 100% of the costs up to EUR 9 600, with a ten year payback term. The loans are refunded by employer participation at a rate of 0.45% of the company's salary expenditures (earlier this rate was 1% from which the name of the loan was derived).

Loan P.A.H. of the *Caisse d'Allocation Familiale* (CAF, Family Allowances Fund)

Families receiving specific social subsidies may receive special loans, dedicated among others to improvement works and thermal insulation. It may cover 80% of the costs (up to EUR 1 067) with an interest rate of 1% and a payback term of three years (ADEME, 2006a).

PAS (*Prêt accession sociale*)

PAS may finance the purchase of an existing dwelling without conditions regarding the building's age and work that has to be done. Furthermore, enlargements of existing dwellings may be financed. Work to reduce energy expenditures may be financed. The loan may be up to 100% of the costs of improvement work and energy efficiency measures. The loan depends on the economic resources of the applicant, the region and the number of persons in the household (ADEME 2006a).

Prêt conventionné (PC)

It finances the purchase of new and existing houses or apartments. It includes general housing improvements, energy efficiency improvements, extensions, and adaptation to handicapped persons.

Annex III • GERMANY

Administrative framework and relevant actors at the regional level.

Table 46 • *Responsible ministries for the building sector in the German* Länder

Baden-Württemberg	*Innenministerium*	(Ministry of the Interior)
Bayern **(Bavaria)**	*Innenministerium*	(Ministry of the Interior)
Berlin	*Senatsverwaltung für Stadtentwicklung*	(Senate Department for Urban Development)
Brandenburg	*Ministerium für Infrastruktur und Raumordnung*	(Ministry for Infrastructure and Regional Planning)
Bremen	*Senator für Bau, Umwelt und Verkehr*	(Ministry for Construction, Environment and Transport)
Hamburg	*Behörde für Stadtentwicklung und Umwelt*	(Department of Civil Engineering and Environment)
Hessen **(Hesse)**	*Ministerium für Wirtschaft, Verkehr und Landesentwicklung*	(Ministry of Economics, Transport and Regional Development)
Mecklenburg-Vorpommern **(Mecklenburg-West Pomerania)**	*Minister für Arbeit, Bau und Landesentwicklung*	(Ministry for Labour, Building and Regional Development)
Niedersachsen **(Lower Saxony)**	*Ministerium für Soziales, Frauen, Familie und Gesundheit*	(Ministry for Social, Women's and Family Affairs and for Health)
Nordrhein-Westfalen **(North-Rhine Westphalia)**	*Ministerium für Bauen und Verkehr*	(Ministry of Building and Transport)
Rheinland-Pfalz **(Rhineland-Palatinate)**	*Ministerium des Innern und für Sport*	(Ministry of the Interior and Sport)
Saarland	*Ministerium für Umwelt*	(Ministry for the Environment)
Sachsen **(Saxony)**	*Sächsisches Staatsministerium des Innern*	(Saxon's Ministry of the Interior)
Sachsen-Anhalt **(Saxony-Anhalt)**	*Ministerium für Landesentwicklung und Verkehr*	(Ministry for Regional Development and Transport)
Schleswig-Holstein	*Innenministerium*	(Ministry of the Interior)
Thüringen **(Thuringia)**	*Ministerium für Bau und Verkehr*	(Ministry of Building and Transport)

Thermal insulation ordinance of 1977 and its amendments of 1982 and 1994.

Table 47 • Maximal U Values (W/m²K) for construction elements of existing residential buildings

Year	Outer walls	Windows and glazings	Ceilings, roof slopes and roofs	Walls adjacent to unheated rooms or soil
WSchVO 1978	(1.45-1.75)	double glazing (n.c.&i.g.)	0.45	0.8 – 0.9
WSchVO 1982	0.6	double glazing (n.c.&i.g.)	0.45	0.7
WSchVO 1994	0.4 – 0.5	1.8	0.3	0.5
EnEV 2002/2004	0.35 – 0.45	1.5 – 1.9	0.25 – 0.30	0.4 – 0.5

n.c.&i.g.: not coated and inert gas filled.

Source: MURE-database, WSchVO, EnEV.

Table 48 • Mean consumption of new residential buildings, constructed in compliance with the regulations

	Useful energy demand (*) below
WSchVO 1978	200 kWh/(m²a)
WSchVO 1982	150 kWh/(m²a)
WSchVO 1994	100 kWh/(m²a)
EnEV 2002/2004	About 25% to 30% below (not directly comparable because EnEV sets a limit to primary energy consumption)

(*) Final energy consumption is obtained by dividing the useful energy demand by the technical efficiency of the heating generation and distribution systems.

Source: MURE-database, WSchVO, EnEV.

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