International comparison of policy instruments for energy efficiency in residential space heating

Hubertus VOSS-UHLENBROCK, Christoph WEBER, Ulrich FAHL
Institute for Energy Economics and the Rational use of Energy, University of Stuttgart

1 - SYNOPSIS

The paper compares policy instruments for energy efficiency in residential space heating between five European countries in view of European environmental objectives and possibilities for more harmonization.

2 - ABSTRACT

The presentation deals with an international comparison of current policy instruments for energy efficiency in residential space heating in European countries. Thereby the different policy instruments including standards, subsidies, taxes and other instruments like information campaigns are analysed and compared for selected countries, namely Denmark, France, Germany, The Netherlands and Sweden.

Instruments are found to be related closely to environmental objectives. Due to the reduction goal of the European Community concerning greenhouse gases and the considerable share of residential space heating in final energy consumption in all countries special objectives and a broad set of policy instruments in the residential sector can be observed. Despite a missing of a harmonised European policy in the field of energy consumption for residential space heating some convergence from „bottom up“ in the national use of standards is found. However every country chooses its own key value of the building system to establish national requirement levels in standards. Given their considerable economic impact taxes are probably the main guiding structural force beside standards. A step by step widening and deepening of the tax base and rates took place in the 90ties, especially in Sweden, Denmark and the Netherlands the taxes being used to induce allocative effects.

However for activating the remaining, still considerable, potentials of energy saving in the residential sectors far more optimised instruments are necessary and their interplay has to be understood. The analyses carried out provide an excellent framework for empirical investigations and enable the national actors to learn from good practices for their own problems.

3 - INTRODUCTION

In northern and moderate climates energy consumption for space heating accounts for the major share of residential energy consumption. Large potentials for energy saving and emission abatement have been identified in the past for this end use. Consequently the member states of the European Union have implemented a broad variety of instruments - standards, taxes, subsidies - aiming at the realisation of these potentials. Without doubt, these resulted in decreasing energy consumption and emissions per square meter dwelling size. However, further tightening of the measures is required to meet new environmental objectives such as the emission reduction goals proposed by the European Union for the Kyoto conference.

This paper deals with an international comparison of current policy instruments (standards, subsidies, taxes and other instruments like information campaigns) for energy efficiency in residential space heating in selected European countries (namely Denmark, France, Germany, The Netherlands and Sweden). This comparison is of particular interest in view of European environmental objectives and the tendencies for more

harmonization between the European countries. Furthermore it allows to analyze the situation of individual countries in a broader context and to learn from practices of other countries. Some remarks are necessary regarding the cross-country comparison:

1. For the information on the different national situations, the following papers, have been used as basic source: Denmark (Leth-Petersen, Togeby 1998), France (Angioletti 1998), Germany (Schuler et al. 1998), Netherlands (Oosterhuis, Nieuwlaar 1998) and Sweden (Kjellsson 1998).
2. As common ground for the comparison, the situation of 1995 is taken. Although the national papers mentioned include a broader period (mostly 1975-1995), the focus of this paper is to compare the current state of regulation.
3. The papers' methodology is based on a comparison of the national regulation systems. Aspects for comparison are identified at the beginning of each chapter and worked out through the examined countries. Thus similarities and differences are laid out systematically.
4. Additionally, one has to differentiate between comparisons with and without evaluation. Within this paper different policy instruments in the examined countries are taken into consideration without evaluation. So far this paper is a preliminary step for evaluation and recommendations concerning future instruments which would require a deeper empirical investigation of the effects of different policy instruments.

The comparison is structured as follows. The current level of energy consumption for residential space heating of the examined countries as well as relevant context factors are presented in chapter 4. Similarities and differences between the national statutory regulations concerning space heating, e. g., the building codes and guidelines are listed in chapter 5. Then an overview of the current subsidy schemes is given and these schemes are compared in chapter 6. The inclusion of energy taxation for residential space heating into the national tax systems is analyzed in chapter 7 and other instruments used in the countries are presented in chapter 8. Finally, in chapter 9 the results are summed up and an outlook is given on future research tasks.

4 - CONTEXT

This chapter presents the background of regulation in the examined countries. It outlines the current situation with respect to the energy consumption for residential space heating and tries to clarify the importance of this sector and objectives for its development. The chapter is divided into two parts. The specific issue of residential space heating consumption is illustrated in the first part (chapter 4.1). In the second part political priorities and objectives are discussed (chapter 4.2).

4.1. Energy consumption in residential space heating

In all countries examined, the energy consumption for space heating plays an important role (cf. Table 4-1).

Table 4-1 : Key figures for residential space heating consumption in the countries examined in 1995

	DK	F	D	NL	S
(1) Energy consumption residential sector (TWh)	52.8	485.7	716.1	129.1	94
(2) Energy for residential space heating (TWh)	36.7	372.5	548.2	87.5	74 (incl. domestic hot water)
Energy for residential space heating per capita MWh/capita	7.1	6.4	6.7	5.7	8.4
Energy for residential space heating per capita and per degree day kWh/(K*day*capita)	2.43	2.60	2.22	1.77	2.18
Energy for residential space heating per m^2 kWh/m^2	139	189	186	151	160/174*
Energy for residential space heating per m^2 and per degree day Wh/(m^2K*day)	48	77	61	46	42/45*
Share (2)/(1)	69.5 %	76.7 %	76.6 %	67.8 %	78.2 %
Share (2)/total final energy consumption	21.1 %	22.6 %	21.4 %	15.4 %	n.a.
*one-two family houses/multi-family houses					

Energy for residential space heating accounts for a share of total final energy consumption ranging from 15.4 % in the Netherlands up to 22.6 % in France. The numbers vary considerably between the Netherlands and the other countries which are approximately around 20 %. Space heating accounts in most countries for about 70 % of total residential energy consumption.

An important indicator for heating energy use is the unit consumption, i. e. the consumption of energy for space heating per m^2. Denmark and Sweden show the lowest unit consumption when comparing the five countries, France show the highest number per m^2 in 1995. Also, per capita numbers are calculated for further comparison of the consumption figures concerning residential space heating. Due to the lowest average dwelling space per capita in the Netherlands, only 5.7 MWh per capita are consumed, whereas in Sweden 8.4 MWh per capita are used. However, if one takes climatic conditions into consideration, i. e., dividing the per capita consumption by the number of degree days (1), the Swedish and Dutch consumption figures are the lowest when comparing the five countries. In France, during the heating season per capita and per degree day 0.83 kWh more are used compared to the Netherlands, i. e. 47 %, but per m^2 and per degree day 31 Wh/m^2K more, i. e. 67 %.

Looking at the development of the final consumption for residential space heating reveals also important points for policy making (cf. Table 4-2). First of all the tendencies differ between the countries. Denmark and the Netherlands report declining figures, the consumption level in Sweden remains unchanged, whereas Germany and France present a slightly increase in absolute energy consumption for residential space heating (cf. Table 4-2). For a further understanding of these figures the development of the final energy consumption for space heating can be put down to the following drivers:

- the quantity effect (number of dwellings, increase of dwelling space) and
- the unit consumption effect (average consumption per dwelling).

The latter effect is influenced by

- the building efficiency;
- the fuel mix and the technology efficiency;
- the level of comfort inside the dwelling (central heating equipment rate) and the behaviour of households, depending mainly on their income;

- and the ratio between single-family dwellings and multi-family dwellings (cf. (Bosseboeuf et al. 1997)).

Table 4-2 : Development of final energy consumption for residential space heating decomposed in components - total energy consumption, dwelling space, unit consumption

Variation	1975	1980	1985	1990	1995
Energy consumption					
DK	100	89	80	74	76
F	100	95	93	98	102
D	100	99	105	102	117
NL	*100	121	113	106	100
S	100	93	85	88	89
Dwelling Space					
DK		*100	106	111	115
F	100	104	107	111	111
D	100	115	126	137	148
NL	*100	119	133	141	154
S	100	110	122	124	134
Unit consumption					
DK		*100	84	74	73
F	100	88	77	75	73
D	100	83	77	75	70
NL	*100	102	85	75	65
S	100	83	69	71	*67*

The German index is calculated for the former FRG; * NL 1973: 100 and DK 1980: 100 because basis data for 1975 are not available from the national statistics

All over the five countries a trend towards increasing dwelling space is reported (cf. dwelling space in Table 4-2) (2). If this tendency cannot be offset by the reduction of energy consumption per square meter an absolute increase will be observed like in France and Germany. However, all countries report a strong decrease in unit consumption (3). Sweden reports a strong effect due to changes in fuel mix, especially the replacement of oil heating by electric or district heating, which is more efficient at the final energy level (Kjellsson 1998). However in general, for the future development it is crucial to consider both, the increase in dwelling space and the rate of technical development concerning the building and heating system.

4.2. Energy priorities and policy targets

For all examined countries the traditional national objectives of energy policy (safety, security of supply) are supplemented by environmental goals motivated mostly by the threat of global warming (cf. Table 4-3).

Table 4-3 : Current policy targets and instruments in the countries examined

	DK	F	D	NL	S
Environmental goals	Major targets are - 20 % reduction of emission in 2005 compared with 1988 - 60 % reduction of SO_2 over the same period The energy action plan 1996 stated that - in 2005 the energy intensity will be improved by 20 % on the 1994 level, - renewable energy will be expanded to 12-14 % of the estimated energy consumption of 2005	- Since 1990 energy issues have less priority and French government reduced DSM policies (caused by price reductions) - However, preoccupation with environmental matters is strengthening - New energy policies have been announced for 1999 by the Government	- The major target is to reduce CO_2 emissions until 2005 by 25 % compared to 1990 - Under the new government phasing out of nuclear power has become a major policy goal	- Reduction of energy consumption compared with previous stage in residential sector: 25 % over the period 1989/90-2000, since 1993 reduced by 23 % - Actually general objective from 1998 is an efficiency improvement of 2% per year	Reduce environmental impact from the energy system, reduce NO_x, CO_2, SO_2 emissions. In 1997 started the phasing out of nuclear power
	Burden Sharing EU greenhouse gases reduction in the period 2008 -12 compared to 1990: whole EU - 8 % -				
	DK - 21.5 %	F - 0 %	D - 21.0 %	NL - 6.0 %	S + 4.0 %
Residential heating energy efficiency goals and instruments	- Support for installation of central heating systems based on renewable energy and for energy-conservation measures in the existing housing stock - In areas with natural gas or district heating it is not allowed to install electric heating	- Support DSM measures (i. e. information campaigns, definition of standards, decision making and financial incentives for existing buildings) - To elaborate new standards there are R&D actions for innovative technologies, calculation tools and methodologies	Different policy actions to influence space heating demand (amendment of decrees, information campaigns, programs to modernize dwellings)	Target figures for the energy efficiency improvements in the residential sector are now above the average of 2 %	Energy policy concerning space heating mainly focuses on reducing the use of oil and electricity. In order to decrease the use of electricity for heating new subsidies are proposed as well as subsidies for alternative production of electricity
Fuel substitution goals and instruments	- Tax rates are still differentiated to turn consumption of energy away from oil. - However, tax rates are harmonised for the main energy carriers toward year 2002		Phasing out of nuclear power is a political goal, but timing and substitution goals have not been decided yet	Price policy for gas to make the prices better reflect the scarcity of natural gas and to stimulate gas conservation	As there is a de-cision on phasing out of the nuclear power a conversion from the use of electricity to other fuels (except oil) or district heating is supported

Now, most of the countries examined are referring directly to a reduction of CO_2. Previous objectives concerning the substitution of finite resources like oil are renewed under the vision of sustainable development. Given the mentioned large share of residential space heating in total energy consumption in all countries (cf. section 4.1), also particular policy statements and concerning residential space heating exist (cf. Table 4-3).

For Denmark concrete targets are mentioned in the energy action plan from 1996. Reduction targets for CO_2 and SO_2 are fixed as well as targets for energy efficiency improvements and the use of renewable energy sources. Goals for residential space heating are strongly influenced by the further strengthening of district heating. An overall energy efficiency goal is of most importance in the Netherlands, too. Energy efficiency should be improved by 2 % per year. Target figures for the residential sectors exceed this average value. In Germany the situation is characterized by the reduction goal for CO_2 defined in the early nineties. Consequently amendments of the decrees influencing residential space heating is announced. In France environmental concerns became stronger during the 90ties caused by an on-going ecological debate whereas demand side policies of the 80ties and early 90ties were phased out and not renewed. In Sweden during 1997 a decision on phasing out of nuclear power was taken. Therefore in this country the whole energy policy and the special efficiency goals for residential space heating are aiming at a conversion from the use of electricity for heating to using other fuels (except oil), or especially district heating.

Regulatory policy has to keep in mind binding restrictions for measures which would be undertaken within a medium time range (up to ten years). These restrictions may stem from the existing energy system, the dwelling structure, techniques used or external market conditions. However, there are potentials, too (4). The following restrictions respectively potentials are remarkable:

- Energy system: For energy carrier substitution the case of the Netherlands shows a strong restriction because of the strong dependency on gas. Potentials are often seen in a larger share of district heating in Germany and France. France will also have to manage a high increase of electricity consumption and renewal of old nuclear plants which is predicted for 2010. This preoccupation could introduce larger DSM measures on electricity use which may also induce some further substitution from electric heating to other fuels.
- Dwelling structure: With a very small new construction market the Swedish possibilities to improve energy efficiency are mostly restricted to retrofitting activities. Potentials to use in the midterm are connected with the possible implementation of low-energy standards for new construction of buildings.
- Techniques: The speed and scope of efficiency improvements e. g., in the case of boiler technologies is slowing down as mentioned for the Netherlands in (Oosterhuis, Nieuwlaar 1998). Like in Denmark, the use of alternative sources of energy in the energy conversion sector is seen as a potential.
- Market signals: Low energy prices for oil on the world market make particular efforts necessary if fuel substitution goals are to be defined. Energy taxes give some potentials for structural guidance as discussed in France and Germany for 1999.

The policy instruments for energy efficiency in residential space heating which will be described in the following were highly influenced by these restrictions, potentials and policy targets.

5 - STANDARDS

This section presents similarities and differences concerning the mode of operation of building standards within the administrative frameworks of the countries examined. Thus first it presents the different administrative structures and then compares in detail the calculation methods for coefficients measuring the energy performance of the building system. Basically terms and modes of regulation are rather similar between the countries. In the following mostly methodological differences are presented.

It is quite surprising that despite of few common European regulations in the policy field of building regulations there are so many similarities in building decrees. The periods in which the regulations were introduced and later renewed are also quite similar in the countries examined. Table 5-1 shows that in the seventies most of the standards were set off for the first time. After this they were tightened several times.

There are some reasons why thermal insulation development converges from „bottom up“ in such a „rhythm of regulation“ (Eichhammer, Schlomann 1997), e. g.

- External events such as the two oil price shocks and the threat of global warming, which were the driving forces behind political campaigning for tighter standards, influenced all countries;

- Technical developments have been available in all countries;
- Research and development has been used to realize a more efficient use of energy.

Table 5-1 : Administrative structures for setting up standards on building energy efficiency in the countries examined

	DK	F	D	NL	S
Laws, Codes, Decrees	Building code BR 95 and for small buildings BR-S 85 (e. g. single family houses, BR-S 98 will be in force from 1.12.98)	Building Energy Codes Building Thermal codes	Decree on Space Heating Demand Decree on Heating Systems Decree on Heating Costs based on Law on Energy Conservation	Building decree supplemented by Energy Performance Standard	Building regulations for energy efficiency BBR 94 Design regulations BKR 94 based on Building Code of Statues
Period	Danish building codes have been revised in 1972, 1977,1982, 1985, 1995, 1998	1974 first decree on insulation standards. Two further steps in 1982 and 1989. The next step is planned for 1999-2000	1977 first decree on space heating demand. Two further decrees in 1982 and 1995. Next decree expected in 2000	Standards are in work since 1964. Since 1995 they are supplemented by standards for the overall energy performance	Standards are in work since 1975. Existing building regulations are from 1994
Applicability	Construction of new houses differentiated between small and large buildings	Construction of new houses	Construction of new houses new extensions of old buildings	Construction of new houses Applicability to houses built before 1985 is planned. Transition should be finished by the year 2004	Construction of new houses new extensions of old buildings

Finally in all countries standards are the main instrument for reaching an efficient use of energy in the residential sector. After a twenty year long stepwise tightening of standards all examined countries have reached a considerable reduction in energy consumption since the beginning of the regulation. Thus e. g. for France in 1999 a 50 % reduction compared with 1975 of the energy performance requirement for new residential construction is reported (Angioletti 1998) and in Denmark the required maximum heat loss is reduced by 60 % when comparing the current building code with the one of 1972 (Leth-Petersen, Togeby 1998).

It is interesting that this development is neither accompanied by a further regulation on retrofitting of the old building stock, nor by an extended control of the fulfilment of regulation requirements. So far the building codes are applicable in all European countries mainly to the construction of new buildings as shown in Table 5-1. Major renovations of old buildings are covered, but still no forcing of the retrofitting of old buildings is undertaken, differently from to the case of boilers (e. g. in the German decree on small boilers (5)). (Eichhammer, Schlomann 1997) mention as possible reasons for this, first that additional costs cannot always totally be covered through energy savings, and second that social factors might play an additional role.

For further analysis of standards a short methodological remark is necessary. (Eichhammer, Schlomann 1997) have classified standards into four groups „which were distinguished by the different degree of integration of the building as a system. The more integrative an approach is, the greater the flexibility permitted in details and the simpler the coefficients provided for a building which could be directly converted into a

certificate which clearly and understandably shows the energetic value of a building“ (Eichhammer, Schlomann 1997, p. 2). The four groups are:

- The *unit approach* which considers only the heat transmission through individual units/components of the building shell.
- The *average transmission through the building shell* gives a single value for the building shell and therefore allows the compensation of heat losses of different building components.
- The *maximum values of the heating demand of a building* includes alongside the heat transmission through building components, ventilation losses, heat increases due to solar heat recovery and internal heat sources in the house.
- The *fully integrated approach* also includes the heating supply system of the building in the calculation. This approach results in the integration of the thermal insulation and the heating system regulation.

Traditionally the thermal insulation ordinances started from a unit approach to regulate heat losses. Using the MURE (6) database it was concluded that considerable differences exist among the European countries concerning the integration level of regulation. The French situation was indicated as fully integrative, whereas e. g., the Swedish regulation standard was mentioned as less integrated, i. e. calculated on the building shell level (cp. (Eichhammer, Schlomann 1997)). From the results presented in Table 5-2 a slightly different picture has to be given.

All of the countries mentioned in this paper have reached a quite similar level of calculation of the building system, i. e., at minimum the calculation of the heating demand of the entire building structure is required (cf. the fat line running through Table 5-2 which indicates the most advanced level reached). More than one “yes” in the column for one country means that various alternatives exist to calculate the heating energy demand for a building.

Table 5-2 : Classification of building standards

Classification	DK	F	D	NL	S
Unit approach building shell	Yes	No	No	Yes	No
Average transmission building shell	Yes	Yes	No	Yes	No
Heating demand of buildings	Yes	Yes	Yes	Yes	Yes
Fully integrative approach	No	Yes	No	Yes	No

At the stage of calculation every country has its own denomination of the calculated coefficients. The German regulation is taken as an example for examination, the central coefficient is calculated as follows:

1. Basically the heat losses of the building components are summed up.
2. Thereafter internal energy gains and solar yields are added.
3. Based on the results values for annual consumption are calculated.
4. Then the annual heating energy consumption is related to the heated volume or to the heated surface.
5. Finally the values obtained are compared to the maximum annual heating energy consumption allowed per individual dwelling. If the counted values exceed the maximum one has to modify e. g. building components or the relation between walls and windows.

The first three steps bring to the calculation of the coefficient for heating energy demand whereas steps four and five are the assessment i. e., the comparison of the calculated value with the target set by authorities. A European standard EN 832 for the calculation of the thermal performance of buildings exists for the first three steps which could also be used as an example for calculation (7), but it does not deal with the assessment of the calculated values. Therefore EN 832 does not allow comparison of the point at which the main differences are to be expected.

Comparing the calculation procedures of the countries examined it can be shown that the main differences which hinder a direct comparability of regulations are located at the assessment step. Countries choose dif-

ferent values as basis for regulation and they relate these national coefficients to different aspects of the building system (total volume vs. surface building shell vs. heated floor).

Regarding these findings the comparison of maximum values must be viewed. Absolute standard values are not directly to be compared, which is not only true because of differences in climatic conditions. A broader simulation of the energy performance of reference buildings under the different regulations is still missing and would be useful but difficult to realize.

6 - TAXES

This chapter deals with the treatment of residential space heating in the national tax systems. Applied types of taxes are presented and analyzed with respect to their objectives (budget financing or allocative respectively guiding effect). Also tax rates for selected fuels are compared.

Basically it is possible to tax fuel consumption or emission production. Taxes on the income side are not described because aspects of distribution are disregarded. Four kinds of taxes are differentiated within the tax systems (cp. Table 6-1). There are a few general similarities between the countries concerning these taxes:

- Normally taxes are implemented on a national level. So all households are affected and taxes are collected for the federal budget. This can be different for taxes having special fiscal objectives.
- In all countries value added taxes are also applied to the consumption of fuels. However, the percentage rates vary slightly over the different countries (8).

Table 6-1 : Taxes on fuels or emissions in the countries examined in 1995

	DK	F	D	NL	S
Type/Short description	VAT Taxes on fuels Taxes on emissions	VAT Taxes on fuels Local taxes on electricity consumption	VAT Taxes on fuels	VAT Taxes on fuels Special tax and levy on final use	VAT Taxes on fuels Taxes on emissions Special levy
Energy carriers affected by taxes except VAT	Oil Electricity Gas (from 1996 on (9)) Coal	Oil and LPG Natural gas Coal Electricity	Oil Gas	Oil Gas, Electricity Coal	Oil Gas Electricity Other fuels
Main Objective	Allocative effects (Environmental) Budget financing effects	Budget financing effects Local investment on electricity networks	Budget financing effects	Allocative effects (special tax) Budget financing effects (others)	Allocative effects (Environmental)

An overview on the tax rates is given in Table 6-2. Particularly interesting is a short view on the induced price increases in the three countries examined which yet have levied taxes for environmental objectives, i.e. The Netherlands, Denmark and Sweden.

In The Netherlands the tax rate for natural gas is 0.043 ECU per m^3 in 1998 whereas this rate was only 0.014 ECU per m^3 in 1996. Through this tax and further tax increases for electricity and oil The Netherlands are expected to reach their CO_2 reduction goal of 2.7 Mt until the year 2002 (10). However, despite the burden of taxes, natural gas prices for households in the Netherlands are still among the lowest in the EU.

Table 6-2 : Taxes applied to energy carriers in the countries examined in 1995

Tax rates ECU/MWh	DK	F	D	NL	S
VAT Fuels	25 %	20.6 %	15 %	17.5 %	25 %
Coal	19.3	VAT + TIC**	not taxed	1.29	20
Light Oil	23.5	VAT +TIPP**	4.12	6.55	18 (gas oil)
Natural gas	0*	VAT + TIGN**	1.82	1.12	9.7
Electricity	52.5	VAT + local taxes	not taxed	2.47	10

VAT = Value added tax, *For Denmark: Tax introduced from 1996 on with an increasing value until year 2002; **For France: TIC = tax on imported coal, TIPP = tax on imported fossil fuels, TIGN = tax on imported natural gas

In Denmark the already mentioned tax rate on natural gas will be around 6.7 ECU per GJ or 0.019 ECU per m^3 in the year 2000. In Sweden the total tax is 11 ECU/MWh (0,011 ECU/kWh) in 1997 including 23.5 % for the general energy tax and 76.5 % for the CO_2 tax. However, few data are available which could assess the quantitative effect of these taxes and the other fuel taxes on the specific energy use for residential space heating.

For Germany, where so far no further energy taxes are applied beside those implemented by the mineral oil law, (Ebel et al. 1996) estimates that a new energy tax at a level of 25 - 30 ECU/MWh for residential space heating consumption would open up an energy saving potential of 50 %. The current level of the German tax on e. g., natural gas is 1.8 ECU/MWh if the gas is used for heating purposes. Note that the new German government has actually introduced ecological taxes for heating oil (2 cent/l), gas (0.16 cent/kWh) and electricity for heating purposes (0.5 cent/kWh).

Considering these price and volume effects taxes are found to be an important policy measure in all countries. Regarding structural effects, e. g., the reduction goals of about 2 Mt CO_2 emission in the Netherlands or the total amount of Swedish emission taxes, it could be shown that taxes are important for reaching allocative goals of energy policies. For budget financing the high rates of value added taxes play a considerable role, too.

7 - SUBSIDIES

This chapter compares subsidy schemes supporting a more efficient use of energy for residential space heating in the countries in question. For this comparison information on number, type and objectives of the subsidy schemes and the actors concerned as well as budgets spent have been collected.

First of all it can be stated that the share of government expenditures for subsidies aiming at energy conservation and the use of renewable energy has been 23.5 % of the total direct subsidies for energy purposes in the EU and its member states between 1990 and 1995. During this time around 2450 million ECU have been spent for conservation purposes out of the public budgets (Ruijgrok, Oosterhuis 1997).

In the following special initiatives and programs concerning the residential energy sector are outlined. However, the total number of subsidies seems to decline. Many of the appointed programs which started in the past are phased out or will be stopped in the near future. In general most of national governments meanwhile concentrate on a few programs, e. g., in the case of Denmark, with actually five subsidy schemes aiming directly at the housing sector, Sweden with three, France and the Netherlands with one or two main programs (cf. Table 7-1). The German situation differs as the programs are in the responsibility of different institutions such as federal, regional and local organizations, which have launched their own schemes.

Different types of subsidies can be found when comparing the countries: direct investment subsidies, fiscal tax reductions for households as well as interest reduced loans (cp. Table 7-1). Direct investment subsidies are used the most in all countries examined. Denmark and the Netherlands used them for all their schemes, in Sweden they are used for the promotion of new technologies under the program of the rational use of energy (started 1988) and the reduction of the use of electricity for heating. Three different objectives of subsidies can be found when comparing the countries (cf. Table 7-1):

- to improve the energy efficiency in residential space heating (often retrofitting of old buildings to overcome obstacles concerning investment decisions);
- to promote investment in renewable energy sources;
- to shift the demand from one energy carrier to another (e. g., electricity to district heating).

One interesting example for overcoming obstacles concerning investment decisions can be found in Denmark. In this country there is a scheme which especially promotes energy savings in dwellings which are owned by retired people. „The background for the scheme was an investigation showing that old age pensioners had higher expenses for heating than typical for households. The building must be built before February 1979. (...) The subsidy covers up to 50 % of the investment“ (Leth-Petersen, Togeby 1998).

Concerning actors and budgets an ongoing structural change has to be noted. Beside the mentioned activities of the public sector energy suppliers launch commercial subsidies. This is especially the case in France where investment grants are given to households choosing electric heating with high requirements for insulation in new construction. In the Netherlands „by the end of 1993, the government has terminated its financial support for thermal insulation and energy efficient heating equipment. As from 1994, these subsidies were provided entirely by the distribution companies, within the framework of their Environmental Action Plan“ (Oosterhuis, Nieuwlaar 1998). Therefore these subsidies are no longer budget relevant and public spending has been reduced to zero (apart from investment grants within the framework of general renovations). For Germany the budget effect is quite similar because of the concentration on interest reduced loans (cf. Table 5-1) and the repeal of former deduction possibilities.

Table 7-1 : Type of on-going subsidies in work in the countries examined in 1995

	DK	F	D	NL	S
Short description	Five subsidy schemes are aiming directly at the housing sector	One program for energy conservation	A couple of programs	Included in general retro-fitting program	A few special schemes
Type					
• **investment subsidies**	Investment subsidies			Investment subsidy	Partly investment subsidy
• **fiscal tax reductions**		Fiscal tax credits for households			
• **interest reduced loans**			Mainly based on interest reduced loans		System of low-interest loans
Actors	Public	Public	Public	Private, i. e. Energy suppliers	Public
Subjects	- Exploitation of renewable energy sources - Conversion of heating system in old houses into district heating - Subsidy for energy savings in dwellings owned by old-age pensioners - Installation of central heating in houses with electricity based heating systems	- Energy retro-fitting works	- Use of renewable energy carriers - Investment in energy conservation technologies - KfW program to support modernization measures in dwellings in the new Länder - KfW Program to reduce CO_2 emissions of the building stock - Subsidies for low-energy houses	- Insulation subsidies for existing buildings - Insulation subsidies for rented houses within the framework of general renovations - Subsidies for energy efficient central heating boilers - Other subsidies, e. g., for district heating and CHP	- Subsidies for bio-fueled power plants - Subsidies for solar collectors (ended 1997) - Subsidies for local wood fired stoves and storage tanks together with a maximum electrical power reducer - Subsidies for connecting to the district heating grid (only for cases with direct electricity heating, started 1998)

8 - OTHER INSTRUMENTS

This chapter deals with different additional instruments in the countries examined. As there is such a broad range of other policy instruments to influence residential space heating consumption, only some examples are presented. Basically the following types of instruments may be distinguished:

- information policies which try to overcome information problems of different actors like households or investors;
- information and training of architects and craftsmen for optimizing planning and minimizing building failures;
- audit and consultant schemes, which should work as further incentives for energy efficiency improvements by households as well as investors.

In Table 8-1 as an example the main information policies in the countries under study are listed. Major points to retain concerning information policies are:

- The total number of information campaigns seems to decline.
- Many of the appointed programs which started in the past are phased out.

Table 8-1 : Information policies in the countries examined

	DK	F	D	NL	S
Type/Short description	Little efforts on information campaigns Ongoing initiative is a leaflet supplied by the Ministry of Environment and Energy and supplemented by a public information telephone line An Internet service with advice for all energy users has been started (1998) by the Ministry	Between 1974 and 1992 information campaigns have been launched constantly Since 1993 no information campaigns were started except by energy suppliers	Various information programs and campaigns-for households, architects, engineers, technicians and craftsmen Books and brochures have been published recently	Various information and counseling campaigns, projects and actions have been initiated by the government. These activities are now carried out mainly by the distribution companies	Energy consultants within the municipalities. Information departments within the Swedish Council of Building Research and NUTEK
Main objectives	Households can use it to acquire information on how to save energy	Stimulate energy conservation and behaviour improvement Give objective information for decision	Stimulate rational use of energy	Stimulate energy conservation	Provision of information on energy conservation to different target groups

Measures for the information and training of architects and craftsmen are seldomly found in the countries examined. In Sweden demonstration projects embedded in the program for rational use of energy can be mentioned. The German parliament tried to improve the incentives for architects and engineers to reduce CO_2 emissions through an amendment to the code on fees for architects and engineers (HOAI). The payments for the architects' work should be better in the case of planning an increased use of renewable energy carriers.

Consultant and audits schemes vary broadly across Europe. Among the countries under study the most stringent strategy concerning the use of audits is found in Denmark where not only several consultant schemes are active but from 1997 on all buildings with an area less than 1,500 m^2 must have an energy label when they are sold (11). Despite of being mandatory no control is made on the existing label. Therefore the rate of houses really checked is only around 50 %. For buildings that are larger than 1,500 m^2 an energy audit must be carried out by an approved consultant. A standardized format exists for the energy plan worked out within this audit. This includes an overview of the building, its installations and relevant projects for saving energy and water.

9 - CONCLUSION

Energy consumption for space heating plays an important role in Europe. The figures presented for 1995 are the result of deep structural changes concerning the residential consumption of energy for space heating. Due to the still active quantitative effect of an increase of total dwelling space in all countries examined, on the one hand the total energy consumption for space heating is under steady pressure to climb up more. On the other hand in all countries examined a strong reduction of unit consumption of energy per square meter is reported, which has now reached the lowest values of the countries examined in Denmark, the Netherlands and Sweden (around 46 Wh/m^2K*day). Depending on the national strength of these diverging forces different actual trends result. Whereas in France and Germany the total energy consumption for space heating increases, this number declines for Denmark and the Netherlands.

In all countries examined a further decline of the unit consumption of energy for space heating is politically wanted. A variety of measures are used to reach this reduction in unit consumption (and partly in overall consumption): standards, subsidies, taxes, information campaigns and other kinds of instruments are found. Similarities and differences can be summarized as follows:

- *Standards:* Despite the lack of a harmonized European policy some convergence in the national use of standards is found concerning the strength of requirements for heating energy conservation as well as their scope. Every country takes a different key value of the building system to establish national limit values. Therefore difficulties for a direct comparison of the strength of regulation result.
- *Taxes:* Regarding their considerable revenues, taxes are probably the main instrument beside the standards because a step by step widening and deepening of the tax base and rates happened in the nineties. Most of all, in Sweden, Denmark and the Netherlands taxes are used to induce effects on allocation.
- *Subsidies:* In comparison to the step by step tightening of standards and taxes, subsidy schemes are launched for specific goals and only for a limited period. All over the countries examined they are mainly used to strengthen retrofitting activities in the old building stock and to promote renewable energies.
- *Other instruments:* Screening the national information activities it can be seen that there is no regular institutionalized information policy for energy efficiency in residential space heating. Consultancy and audits concerning energy consumption for space heating have become important in some countries, e. g., in Denmark the mandatory energy label for buildings which are to be sold.

The crucial question about the further development of these measures is relevant for all of the countries examined. To activate the remaining and still considerable potentials of energy saving in the residential sectors, far more improved instruments are necessary. This means that on the one hand the effectiveness of the specific measure regarded should be further analysed, and on the other hand the diverse instruments must be seen closely together. Important questions occur especially regarding the relationship between the fulfilment of standards and the further need for consultancy or control and concerning the relationship between subsidies and the investment in building retrofitting.

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11 - ENDNOTES

(1) This is only a rough calculation because of the differences in calculation methods of degree days.
(2) Note that the increase in the dwelling space is partly caused by an increase in the population during this period, e. g. in Sweden from 8.081 mil. in 1970 to 8.837 mil. in 1995, and partly by an increase in dwelling space per capita.
(3) The further analysis of policy instruments has also to differentiate between the new construction of buildings and the existing building stock.
(4) Cf. the discussion of restrictions and potentials as found in urban planning theory, e. g. (Friedmann 1987).
(5) In The Netherlands a mandatory retrofitting of buildings built before 1985 is announced for the near future. Additionally, the missing of standards for thermal insulation of old buildings can not be used directly as an indicator for low retrofitting insulation levels in the other countries, because other policy measures may be used for retrofitting. For the countries examined they are found frequently in the bundle of subsidies, where they have a more voluntary character and where they are connected with investment incentives to overcome the financial obstacles mentioned above.

(6) Under the European Commission´s SAVE Programme the MURE (Mésures d'Utilisation Rationelle de l'Energie) database is developed.
(7) Broadly compared with the German calculation beside considerable similarities there exist following differences:

- EN 832 is a fully integrative approach using the classification mentioned above. The final heating energy demand for buildings is calculated in addition to the annual heating demand for building in the German regulation;
- The approach in EN 832 starts with the definition of heated zones, which is not made explicit in the German method;
- The demand of heating for hot water is added in EN 832.

(8) Note that the situation of 1995 is reported. In the future further harmonization of VAT within the European Community can be expected.
(9) Before 1996 the system in Denmark was complicated - with a shadow tax on natural gas. The gas utilities were allowed to sell the gas to the same price as oil including tax. The revenue was used to finance the natural gas grid.
(10) Total emissions from combustion of fossil fuels stationary sources in 1995 were around 130 megatons.
(11) Similar rules can be found in the United Kingdom (cp. (Eichhammer, Schlomann 1997))

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