Labelling domestic ovens (Save study 4.1031/D/97-047)

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Abstract

The European Union, through its SAVE II programme, aims at promoting the rational use of energy within the community. SAVE II is a non-technological programme with many elements, among others *labelling, standardisation and other actions in the area of energy-using equipment.* This report summarises the results of the Working Group on Efficient Domestic Ovens. The purpose of this study is to identify possible EU Commission actions to improve the efficiency of domestic electric and gas ovens and to develop a common basis for possible national actions. The study focuses on conventional domestic ovens only. Other ways of cooking, such as hobs, microwave ovens, grills and electric kettles are not taken into consideration. Possibilities for and impacts of fuel switching are also outside the scope of this study. However, a wide range of possibilities to improve energy efficiency, and related policy options, are discussed in a qualitative way, to give a more complete picture of ovens in the context of climate policies.

The study, financed by the SAVE II Programme (with supplementary financing from NOVEM for the Dutch partner) was carried out in 1998-1999 by research teams from eight countries. Representatives of NOVEM and CECED as well as those of the relevant working groups of CENELEC (CLC/TC 59X/WG3) and CEN (CEN/TC 49/WG2) have participated in the meetings. CECED has also provided data for a number of tasks.

The work was organised in six tasks. The aim of Task 1 was to establish the *real life energy consumption* of the ovens concerned, as opposed to the energy consumption according to the test standard. Task 2 was to *provide a statistical analysis of the European gas and electric ovens market*. The purpose of Task 3 was to *review, identify, and analyse energy-saving design options for domestic ovens*. Task 4 was to *assess the environmental impacts* of scenarios concerning the efficiency improvements of domestic ovens. A stock model methodology was used. Task 5 aimed at analysing the *different impacts of efficiency policies on manufacturers*.

The aim of Task 6 was to give the information necessary to develop an appropriate mix of policies. The focus is on actions at EU level. The following policy options were analysed:

- EU energy labels which are warranted for domestic ovens through directive no 92/75/EEC;
- mandatory minimum energy efficiency standards;
- as an alternative to the latter, the acceptance by the EU of a voluntary initiative of the European White Goods industry to phase out ovens with a consumption higher than a certain value and/or to reach a certain average energy consumption of the appliances sold;
- co-operative procurement (technology or market procurement);

- national policies which could supplement EU policy are also analysed qualitatively.

1. Introduction

The European Union, through its SAVE II programme, aims at promoting the rational use of energy within the community. SAVE II is a non-technological programme with many elements, among others labelling, standardisation and other actions in the area of energy-using equipment.

Domestic ovens, both gas and electric, are among the last appliances to labelled as part of the European framework labelling directive of 1992 (CEC, 1992). An implementing directive is expected, which will draw on the findings of the Working Group on Efficient Domestic Ovens summarised in this paper. The purpose of this 'ovens' study conducted by the Working Group was to identify possible EU Commission actions to improve the efficiency of domestic electric and gas ovens and to develop a common basis for possible national actions (Kasanen, 2000).

The study focuses on conventional domestic ovens during their use phase only; energy used by standing pilot lights and cleaning cycles were not considered. Other ways of cooking, such as hobs, microwave ovens, grills and electric kettles, are not taken into consideration by this study. Possibilities for, and the potential impact of fuel switching, are also beyond the scope of this study. However, a wide range of possibilities to improve energy efficiency, and related policy options, are discussed in a qualitative way, to give a more complete picture of ovens in the context of climate policies.

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2. Current situation

2.1 Ownership and usage of domestic ovens

Most households in the EU own an oven, of which approximately 61% are fuelled by electricity and 38% by gas. There are inter-country variations, with some countries like Finland predominantly using electricity and others like Spain favouring gas (Table 1).

Table 1: Input data for ovens stock model, 1998

	House (m)	Electric ownership (%)	Gas ownership (%)	Use (times pa)
AU	3.2	79.9	19.1	110
BE	3.8	50.3	62.1	157
DK	2.4	88.0	10.4	150
FI	2.3	99.0	1.0	200
FR	23.2	51.1	48.3	224
GE	37.7	79.9	19.1	87
IR	1.2	44.4	67.8	157
IT	21.8	60.9	38.5	124
NL	6.7	63.5	20.3	45
SP	15.1	12.0	85.0	124
SW	4.2	97.3	3.0	136
UK	24.3	56.7	41.2	157
EU	145.9	60.9	37.8	135

Household use of ovens also varies quite considerably across the EU – for instance, Dutch households will, on average, use their ovens only 45 times per year, while the average French household will use its oven more than four times as often. The data shown in Table 1 are best estimates and change through time.

2.2 Ovens on the market

The construction of a mass-produced oven’s cooking compartment is essentially a pressed-steel cavity wrapped in thermal insulation, a hinged and often glazed door, and a vent or a flue. The oven temperature is regulated by thermostatic control of the gas burner or electric supply. The heating elements are located in the upper and lower faces of the cavity for electric ovens and in the lower face for gas ovens. The lower heating element is usually concealed, whilst the upper one can be exposed in an electric oven and double as a grill.

Usually, ovens are sold either as free-standing cookers (where the oven is combined with a hob) or as separate ‘built-in’ appliances. An increasing share of the market consists of fan-assisted ovens, where air is forced around the oven, or air is distributed by natural convection. The market can be segmented further, distinguishing between those appliances possessing or not possessing additional features such as an in-built grill or microwave, or self-cleaning ability. The latter – based on catalytic, pyrolitic and hydrolytic cleaning processes – is increasingly found in modern, especially electric, ovens.

2.3 Efficiency of new ovens (and testing procedures)

If efficiency improvements are to be made for domestic ovens, the first step is to have a reproducible and representative test procedure. Until recently, the efficiency of ovens was compared with reference to consumption measured in the so-called 'empty' oven test. For electric ovens the test (CENLEC HD-376S2-1998) was based on measuring the energy needed to preheat the oven to 200°C (or 175°C for forced convection ovens) and maintain it at that temperature for one hour. This is now being replaced by the 'chilled wet brick' test, prEN 50304, which is considered more representative of actual oven usage. In this test procedure a saturated chilled wet brick is raised in temperature from 5°C to 60°C – the energy used to perform this task being the important measure. From a sample within the study there was little correlation between the energy values measured by the two different testing procedures. Therefore, future policy will have to aim at improving the test data under the new test.

The empty oven test (EN 30 2.1) for gas ovens is also being replaced by a wet brick test. The new procedure, very similar to the electric oven test, is still being developed. Round robin tests, where the same oven is tested in different laboratories, still need to be carried out for gas ovens.

CECED, the European manufacturers' association, provided a database on electric ovens which revealed the average natural convection oven to consume 1224Wh under the brick test, with values ranging from 710 to 1907 Wh). Data for the forced convection ovens had consumption values ranging from 736 to 1920 Wh with an average of 1269Wh.

Since the new test had not been completed for the gas oven, the detailed analysis could not be repeated for these types of ovens. However, 13 gas ovens were tested under the provisional test procedure to gain an insight into their performance. The average consumption of these ovens was 1.5 kWh (or 5.45 MJ), while the minimum was 1.14kWh (4.1 MJ).

None of the test cycles take into account the energy used by additional modes or facilities of the oven – eg clocks, grills, cleaning cycles – due to a lack of data. These may, however, consume significant amounts of energy, depending on use.

3. Potential for improvement

The potential for improvement will be different for each oven, and will depend on its current design. For both electric and gas ovens, the energy consumption could potentially be decreased by up to 55%, under test conditions, using known design improvements. In the ovens study, two electric ovens considered representative were used as 'reference' ovens, for which an estimation of the potential energy savings to be achieved through design improvements could be made, and compared to the additional unit-manufacturing cost (Table 2).

Combining design improvements is not always possible and the resulting energy savings are not always cumulative. Some of the design options were considered to be unacceptable to the consumer and these were not considered in the final estimate of potential energy savings. Thus, the single design option with the largest potential, low-emissivity, was not finally taken into account.

Table 2: Estimated electric oven efficiency gains with potential improved design options

	Design option [a]	Range	Midpoint	Additional unit-manufacturing cost (Euro)	Consumer response [b]
1a	Improve thermal insulation	0-11	6	8	Acceptable
1b		0-11	6	37	Acceptable
2	Improve thermal isolation of cavity	7-8	8	6	Acceptable
3	Reduce thermal mass of even structure	10-18	14	6	Acceptable
4	Unglazed door	7-25	16	1	Unacceptable
5	Optimise glazed door design	4-12	8	20	Acceptable
6	Passive cooling for glazed door/facia	0-8	4	29	Unacceptable
7	Forced convection	0-8	4	10	Acceptable
8a	Optimise vent flow	8	8	4	Acceptable
8b		12	12	14	Acceptable
9	Low-emissivity oven design	35	35	35	Unacceptable
10	Uncover lower element	8	8	2	Unacceptable
11	Reduce auxiliary energy	1-4	3	10	Acceptable
12	Fit reflector above upper heating element	1	1	2	Acceptable

a) Design options 1 and 8 are subdivided to reflect two distinct implementation options. Option 1 may be achieved through using an extra layer of standard low-cost thermal insulation. If, owing to space constraints, a single layer of high quality insulant must replace the insulation, then the implementation cost will be greater. Attention to vent sizing may achieve small energy saving at a relatively low cost (option 8a). A more sophisticated vent controls system may achieve greater energy savings but would be more expensive (option 8b).

b) Possible consumer acceptance to design options. This is the expected initial response by consumers, which may or may not change or be influenced by fashion or through advertising.

Previous SAVE appliance studies estimated an economically justified and technically feasible (ETP) potential. At this level the life cycle cost of the oven would be minimised, which means that, for the consumer, the increased purchase price is offset by savings due to higher efficiency. Using the information in Table 2, as well as data on average usage and energy prices, it is possible to estimate the point beyond which improvements in efficiency are not cost effective to the consumer.

For electric ovens, consumption at ETP level was estimated to amount to 0.87kWh, a reduction of 28% compared to the reference case of 1.2 kWh. Due to the low price of gas none of the design options would pay back within the ovens lifetime for an average gas oven. The study also examined an ‘economic package’ including additional design options as long as they would not raise the appliance’s life cycle cost for the consumer above the present level. Under this scenario, energy savings would be higher than at the ETP level, which aims at achieving minimum life cycle cost for the consumer. In this case the potential for electric ovens is a 33% reduction compared to the reference case. The potential for gas ovens is approximately 9%.

4. Policies for market transformation

A high proportion of product policies is at present aimed at increasing the average efficiency of products being sold. A range of policy options is available, and is being employed, to effect this change and shift the market in favour of more efficient products. One common procedure is to rank products according to test performance (regarding energy efficiency), and to make the information available to the customer through labels or databases. Providing information on running costs is usually enough to move the market towards more efficient products to a certain extent, though this tendency can be encouraged further through rebate and procurement schemes specifically promoting these products. Moreover, the development of new, efficient products can be assisted through research, development and procurement programmes, and the resulting, highly efficient appliances increasingly enter the market. Finally, the most inefficient products can be removed from the market. For more information on market transformation see, for example, DECADE (1997).

4.1 Labelling

The main reason for conducting the 'ovens' study was to provide relevant background information to the EU Commission so domestic ovens could be labelled in accordance with the framework-labelling directive. Drawing on the information contained in the database on electric ovens provided by manufacturers, it is possible to rate the efficiency of electric ovens. A corresponding rating for gas fuelled ovens would, at present, have to be based on a smaller set of data, obtained from a provisional test procedure. Since there are two types of fuel under consideration, the study also examined the options for placing both types of oven on the same rating scale, where appliances would be rated according to carbon emissions produced. The resulting distribution of gas and electric ovens would be very similar to the one resulting from a comparison based on usage of primary energy. Table 3 shows the efficiency ratings on an A to G scale of the ovens on which information was available in the database, and indicates the number of appliances that would fall into each category.

Table 3: Potential combined electric and gas label for EU domestic ovens

Indirect CO_2 emissions (g)	Efficiency class	All (n=86)	Electric (n=73)	Gas (n=13)
<200	A	0	0	0
200-299	B	9	0	62
300-399	C	7	3	31
400-499	D	8	8	8
500-599	E	62	73	0
600-699	F	12	14	0

>699	G	2	3	0

NB: data based on EU sample available to study.

It can be seen that most of the gas appliances pertain to the top categories, while electric ovens are concentrated towards the bottom of the scale. However, with further improvements it would be possible for electric ovens to gain a higher classification. This scale of ratings gives a fair reflection of carbon emissions caused by appliance use. However, it may be argued that a common rating system does not sufficiently emphasise the differences in efficiency between ovens using the same type of fuel, thus potentially reducing the effect of labelling.

So the choice between establishing a common rating system for appliances using different fuel types or instituting two separate scales (one for each fuel) has to be made according to whether the primary aim is to show the correct environmental impact of different appliances or to maximise the potential effect on sales. For further discussion on labels and carbon dioxide see Boardman (2000) and Fawcett *et al* (2000).

4.2 National policies (rebates, procurement)

To complement EU level policies, national agencies still have the scope to implement measures aimed at improving the efficiency of products. Usually, this will be done in the form of providing rebates for more efficient products. Other options include procurement programmes to bring together purchasers to bulk-buy efficient products.

4.3 Minimum standards

Removing the most inefficient products from the market by implementing minimum standards would reduce the environmental impact of ovens. The 'ovens' study recommends two phases for the removal of less efficient electric and gas ovens from the market, based on a proposed labelling scheme. In the first phase appliances rated as EFG under the proposed scheme would be eliminated, followed by the removal of products pertaining to the D category. The combined effect of this two-stage process would be to reduce electric oven consumption by 40% and gas consumption by 25%.

Table 4: Average EU test consumption figures under different scenarios

	ELECTRIC		GAS		
	kWh	(% of RC)	kWh	MJ	(% of RC)
Reference Case	1.201	100.0	1.515	5.454	100.0
ETP	0.874	72.8	1.515	5.454	100.0
'Economic Package'	0.755	62.9	1.379	4.963	91.0
Policy 1 (remove EFG)	1.117	93.0	1.348	4.854	89.0
Policy 2 (remove (DEFG)	0.721	60.0	0.894	3.218	59.0
Best on market	0.700	58.3	1.140	4.104	75.2

Note: the A-G scales are different for gas and electric in this case.

At present there is a preference on the part of the Commission for implementing voluntary measures (CEC, 2000), based on negotiation with industry associations.

However, if a voluntary agreement cannot be reached, mandatory efficiency standards at EU level would be appropriate.

4.4 Carbon emissions

An estimate of carbon emissions resulting from energy consumption of household ovens shows that emissions caused by EU electric ovens have been relatively stable since the 1980s (Figure 1). Earlier emissions are estimated at a higher level, due to the higher carbon content of EU generated electricity in the past. Accordingly, the conversion factor employed to calculate historical CO_2 emissions caused by electric ovens progressively declines to 0.4 $kgCO_2/kWh$ (EU average for 1998). Emissions are projected to remain relatively constant in the future, as the growth in the total number of ovens offsets changes in the fuel mix as well as the assumed increase in appliance efficiency.

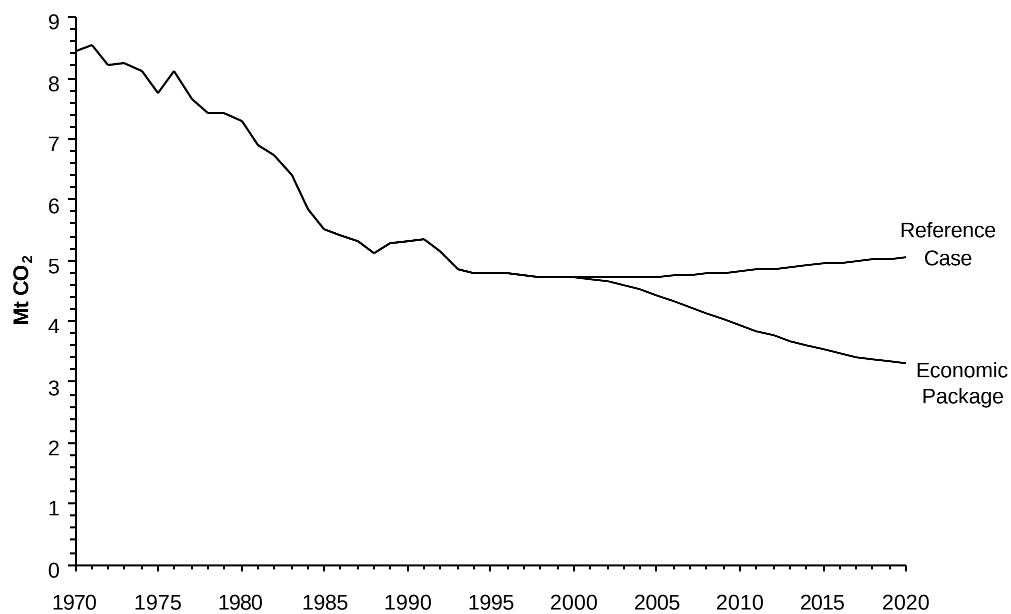

Figure 1: Estimated CO_2 emissions by EU electric ovens

Emissions by gas ovens have declined over the period under consideration, due to reduced usage of ovens as well as increasing consumer preference of electric over gas ovens, a trend which is projected to continue into the future.

5. Conclusions

EU electric ovens currently consume approximately 12TWh of delivered electricity and over 8TWh of delivered gas per annum. At present, this costs EU domestic oven users 1,200 MEuro worth of electricity and 350 MEuro worth of gas in running costs per year.

Table 5: EU summary of RC, EP scenario and potential savings

	RC, 1998	RC, 2020	EP, 2020	RC-EP, 2020

ELEC	**Delivered GWh**	11,757	12,530	8,215	4,315
	CO_2 ($MtCO_2$)	4.70	5.01	3.29	1.73
	Cost Elec (Meuro)	1,176	1,253	821	432
GAS	**Delivered GWh**	8,765	7,548	6,909	639
	Delivered TJ	31,554	27,173	24,874	2,300
	CO_2 ($MtCO_2$)	1.67	1.43	1.31	0.12
	Cost gas (MEuro)	351	302	276	26

Note: LU, GR, PO excluded from analysis.

Significant energy and running cost savings could be achieved by 2020 if manufacturers produce, retailers supply and consumers purchase cost effective ovens (as under the Economic Package scenario). Projected electricity consumption could be reduced from 12.5TWh to 8.2TWh, and gas consumption could be decreased from 7.5 to 6.9 TWh (ie 27.1 to 24.9 PJ), by the year 2020.

Carbon emissions caused by electric ovens have fallen over the last 30 years due to changes in the electricity generating fuel mix away from carbon intensive modes of electricity production and to the improvements in oven efficiency. They should remain relatively constant into the future, from 4.7$MtCO_2$ to approximately 5$MtCO_2$ by 2020 under the Reference Case scenario. If the 'Economic package' potential is realised, emissions could decline by around 1.7$MtCO_2$ by the year 2020.

The purchase of more efficient gas ovens to achieve the 'economic package' savings potential would reduce associated emissions by approximately 0.1$MtCO_2$. In total, improving the efficiency of ovens, both electric and gas-fired, can potentially reduce emissions by over 2$MtCO_2$ by the year 2020.

To realise these potential reductions in carbon emissions several measures need to be enacted at the European level. Firstly, as a prerequisite for correctly labelling both gas and electric ovens, the 'brick' test for gas appliances needs to perfected. At present, this still requires round robin tests to be funded and carried out. The Commission will then be in a position to prescribe labelling procedures – whether on a common scale or on different scales according to fuel type. If the Commission decides on separate labels for gas and electric ovens, then labelling for electric ovens could be implemented before test procedures for gas ovens have been perfected. To complement labelling, measures aimed at eliminating the most inefficient ovens should also be implemented, whether on a voluntary level through negotiations with industry associations, or by mandatory regulations at EU level.

6. References

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