European Union Efforts to Promote More Efficient Use of Electricity: the PACE Programme

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Improving the efficiency with which energy is consumed has long been a central theme of energy policy within the European Union. Because electricity has a particular importance in the energy sector, with electricity generation accounting for about 35 % of total primary energy use, the Council adopted in 1989 a Union action programme for improving the efficiency of electricity end use, PACE. Under the programme, a number of different actions are being pursued. These actions are selected so as to achieve the biggest impact in terms of cost and effort of achieving these savings. So far, efforts have been concentrated in the domestic sector (refrigeration,wet appliances, water heaters, lighting and home electronics), commercial sector (lighting and office equipment) and industrial sector (electric motors).

A range of policy instruments, such as minimum efficiency requirements (mandatory or voluntary), energy labels, quality marks and technology procurement, are used to achieve the potential energy efficiency improvements and market transformation. The main criteria in selecting the policy instrument are: favourable cost/benefit ratio, low cost of implementation and low impact on manufacturers.

Currently, there is a debate in the Union on the need for legislation to promote energy efficiency improvements and on the role of market forces. There is also an important harmonization dimension in selecting the policy instrument: if a Member State were to introduce mandatory efficiency requirements or labels, this would create a potential barrier to trade.

INTRODUCTION

Given electricity particular importance in the energy sector, with electricity generation accounting for about 35% of total primary energy use and about 30% of all man-made CO_2 emissions, the European Council adopted on 5 June 1989 a Decision establishing a Union action programme for improving the efficiency of electricity end-use, PACE. The Decision calls for the Commission to manage actions within the Member States by playing a co-ordinating role and, where appropriate, leading its own actions.

Under the PACE programme a number of different actions are being pursued in the domestic, commercial and industrial sectors. These actions in the different areas are all based on a common principle: they must be economically viable and achieve energy savings, i.e. the efficiency improvement cost must be paid back in a reasonable time by the electricity saved (Bertoldi 1995).

This paper focuses on policy options and measures to transform the market and foster the penetration of more efficient electricity end-use products in the domestic and commercial sectors. The need of governmental action to transform the market is, at present, subject of long discussions among policy-makers in the European Union: several policy-makers claim that 'if energy efficiency is economically viable it should happen by itself' and insist on the need to reduce legislation and governmental intervention in economic affairs, this has largely affected energy efficiency policy and programmes and it has resulted in an increased use of non-regulatory options such as voluntary agreements.

POLICY TOOLS

Energy efficiency improvement is a rather complex phenomenon, which is affected by the decisions of different actors: manufacturers, retailers, consumers, professional consultants, etc. Although energy efficiency is economic in that investments are repaid in a few years, the measures actually taken to improve energy efficiency in general, and electricity end-use in particular, are far less than the economics justify: this is partly because the relevant decision making is dispersed between the different actors. As illustrated in several studies (Hirst 1990; Nadel 1994; Reddy 1991), there are several barriers to the penetration of energy efficient products such as: consumers' lack of both information and capital for investment, very high rate of return for energy efficiency investments, equipment owner not paying for running costs etc. As a result of market failure to achieve the 'economical' efficiency improvements, governments have implemented policy and programmes to remove barriers to energy efficiency.

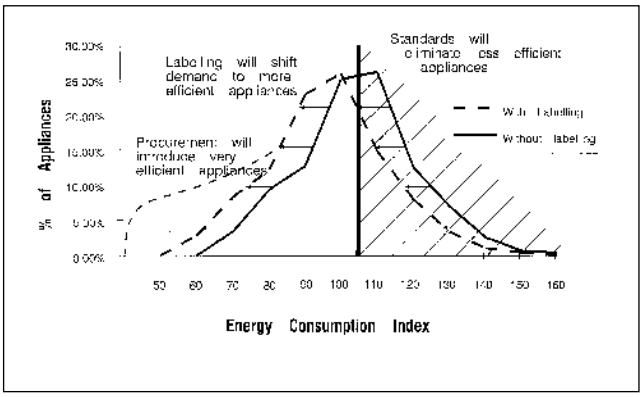
In the Union a coherent strategy has been developed to transform the market using a combination of policy tools as shown in Figure 1, which represent the 'energy efficiency distribution curve'.

As demonstrated in other works, (Engleryd 1995; Geller 1994; Swisher 1994) the combination of different policy tools could succeed in achieving the potential efficiency improvements. Minimum efficiency requirements are a very effective way to remove low efficiency appliances from the market, achieving a large share of energy savings at low cost for society. Consumer information could also be effective in shifting the whole energy efficiency distribution curve: however the effectiveness of energy labelling schemes is more difficult to evaluate than for other policy measures, because labelling relies heavily on consumer behaviour. To be successful labelling schemes need support from national authorities, utilities and retail staff. The last policy tool which is discussed in the paper is technology procurement, which accelerates the penetration of very efficient equipment in the market. Other policy tools such as financial incentives, grants, etc. are not part of the PACE 'tools box', because they are more effective when implemented at national or local level and, indeed, several actions have been carried out in Member States; therefore these policy options are not presented or discussed in the paper.

Minimum efficiency requirements

Minimum efficiency requirements (or maximum energy consumption limits) are a very powerful and effective tool in transforming the market: they act on the low-efficiency end of the market and are particularly effective when consumers are not influenced by information and labels (Nadel 1994). In the European context the introduction of minimum efficiency requirements presents some additional aspects. One of the aims of the European Union is to create an internal market for, inter alia, tradable goods: Member States cannot introduce national legislation which may lead to barriers to trade unless justified on the basis of very limited criteria such as protection of human health, environment etc.. Some Member States (Denmark and the Netherlands) which have a more ambitious energy efficiency policy have, as required by the European Treaties, notified the Commission of their intention to introduce in their territory minimum efficiency requirements. The Commission has the power to stop the introduction of national legislation, if it establishes that it is not justified according to the criteria laid down in the Treaties. To solve the conflict between the 'internal market' and energy efficiency policy, one solution is to introduce common minimum efficiency requirements throughout the Union. However the introduction of mandatory minimum efficiency requirements must be agreed by all 15 Member States, this is allowed only if it presents a favourable cost/benefit ratio for the whole Union (the impact of minimum efficiency requirements is also evaluated at national levels to make sure that no Member State would be disadvantaged).

Figure 1. *The Energy Efficiency Curve*



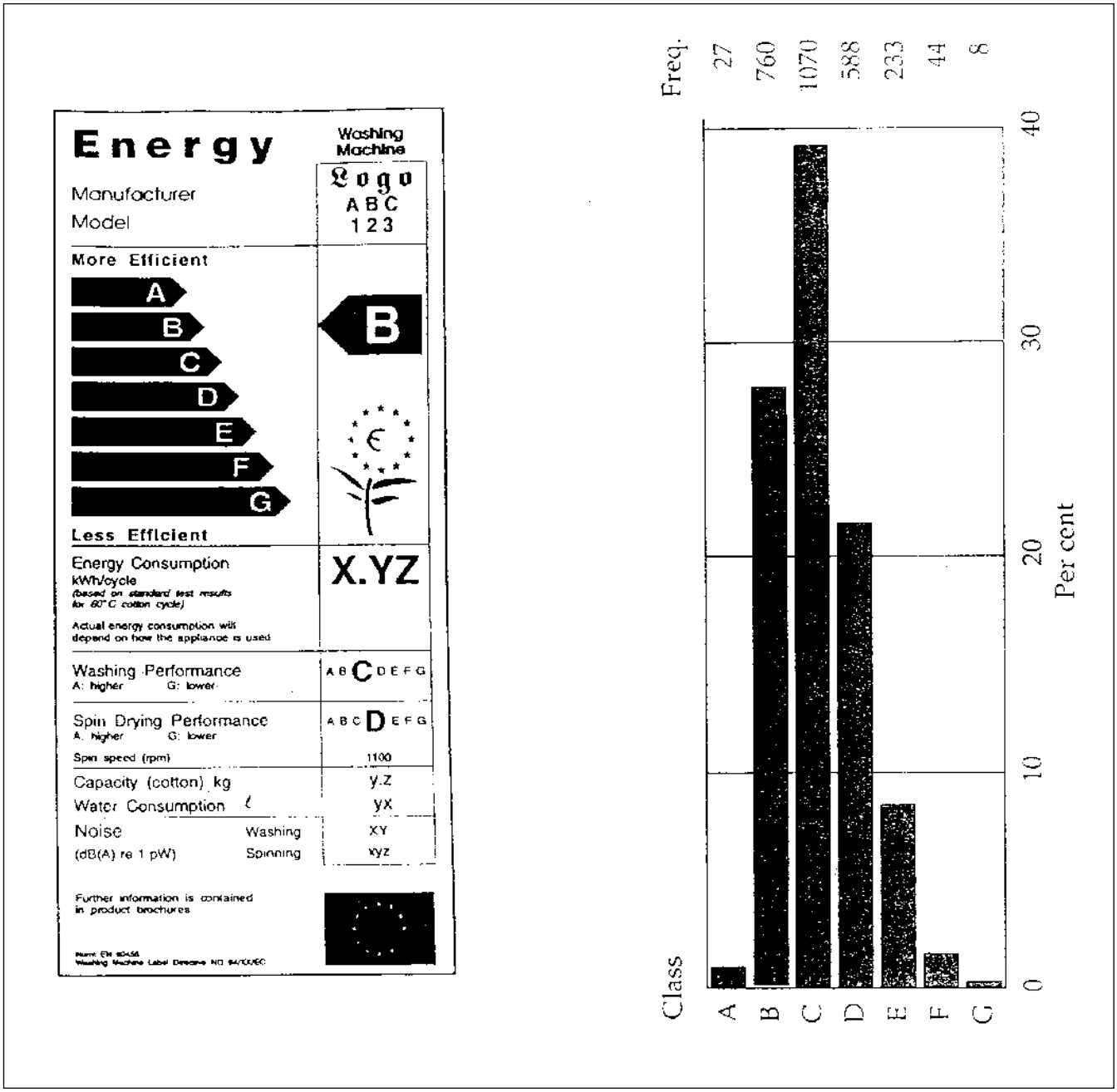
Labels

To increase consumers' awareness and persuade them to make the rational choice, a European energy labelling scheme for domestic appliances has been established. A common European energy labelling scheme minimizes the cost to manufacturers and maximizes the impact on consumers. The scheme requires showrooms and mail order catalogues to display energy information labels which rank appliances in 7 efficiency classes (Figure 2).

So far labels have been adopted for refrigeration appliances, dryers and washing machines; labels for lamps and dishwashers will be adopted in 1996, while labels for ovens, electric water heaters and room air conditioners will be finalized during 1997. A big effort is being made to increase consumer awareness of the labels and to train retail staff through pilot projects in Member States. The first evaluation of the impact of labelling in the European Union has been carried out in France and covers the sales of a large French retailer (about 3% of the market). The evaluation shows that there has been a shift toward sales of more efficient appliances: 27% of 1994 sales of refrigerators were in categories A,B, and C, while in 1995 the percentage raised to 42% (Figure 3); it is important to note that this was also combined with an undertaking by the retailer to offer more high-efficiency appliances and to train is retail staff on energy efficiency issues.

Although the labelling scheme is necessary and will result in worthwhile energy saving, it will not by itself come anywhere near to achieving all potential energy saving that could be achieved at a net saving to consumers. The energy labelling scheme covers only domestic appliances, because it is assumed that equipment intended for the commercial and industrial sectors would be selected by people having

Figure 2. *The European Union Energy Label for Washing Machines*

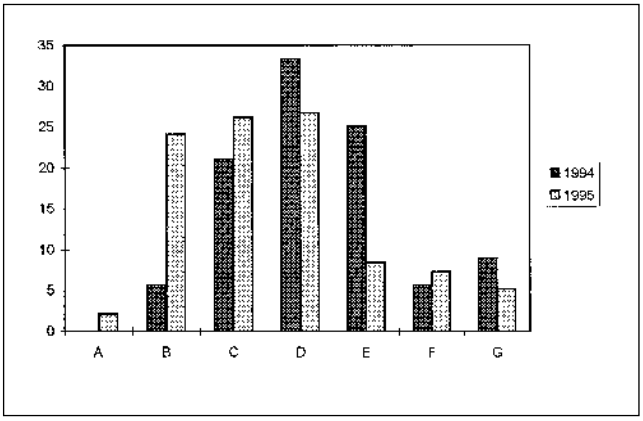


access to all the necessary technical information including energy consumption.

Technology procurement

Technology procurement acts on the higher end of the market by accelerating the penetration of products into the market place (Engleryd 1995; Geller 1994; Nilsson 1992; Nilsson 1994). Technology procurement aims at encouraging new products to meet the demand (in this case for energy efficiency) that existing products on the market are unable to fulfil. Technology procurement is used to match producers' and consumers' perspectives, in order to make the market work more efficiently with regard to energy efficiency. The idea is that a group of knowledgeable and influential purchasers, defined as a 'buyers group', formulate product specifications and let producers compete to meet these demands. Technology procurement is part of market-pull activities, characterized by showing manufacturers a large potential

Figure 3. *Evolution of the French Refrigerator Market Since the Introduction of the Label*

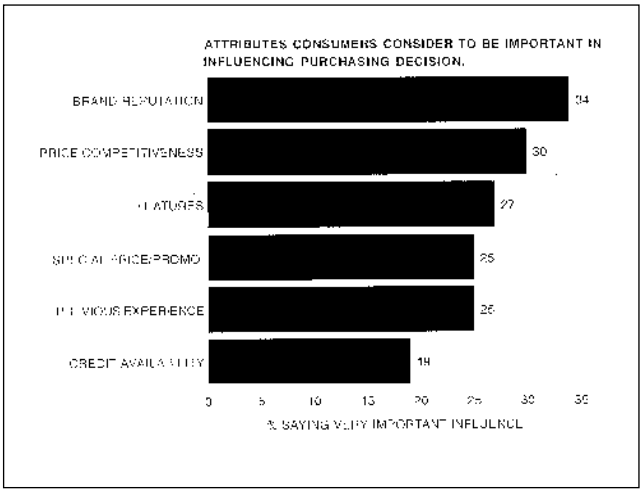


markets (important buyers) and by providing manufacturers with consistent efficiency targets.

ACTIONS IN THE DOMESTIC SECTOR

During the initial phase of the programme particular attention has been paid to the domestic sector, because it accounts for about 30% of total electricity demand in the European Union. In addition it was indicated by experts working for the Commission that the traditional barriers to penetration of energy efficiency technologies were particularly difficult to remove in the domestic sector. One of the main barriers is lack of consumer awareness, information, and technical knowledge on energy consumption of individual appliances and possible energy savings. Figure 4 shows the ranking of purchase criteria for washing machines in the United Kingdom, running cost and energy efficiency are not among purchasers' highest concerns.

Figure 4. *Customers' Criteria for Washing Machines Purchase*



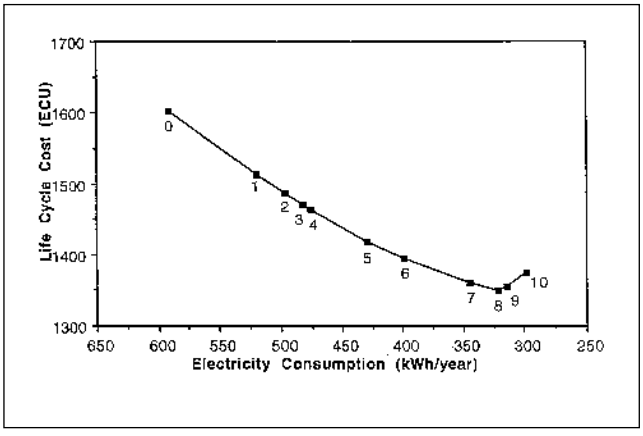
In addition, the white goods industry is rather static and conservative in terms of technological innovation, compared to other equipment manufacturers such as the consumer electronics industry, and is reluctant to introduce more efficient products. Although in recent years the energy efficiency of major domestic appliances has improved, appliances with much lower efficiency are still widely available on the European market. In the following paragraphs the actions taken for refrigeration appliances, washing machines and home electronics are reported; other activities are ongoing at the moment on electric water heaters and air conditioners.

Refrigeration Appliances

The first appliances for which action was taken are refrigerators and freezers, the largest electricity consuming domestic appliance in the Union, with a total consumption of about 120 TWh per year (about 20% of domestic electricity consumption). The statistical analysis (Group for Efficient Appliances 1993) was used to establish the efficiency classes of the energy label, which was introduced on 1 January 1995. The technical-economic analysis (Group for Efficient Appliances 1993) showed (Figure 5) that the minimum life cycle cost corresponded to about a 50% reduction in energy consumption of the 1993 'base case' model.

The report indicated that the best policy measure to achieve the largest part of the potential saving was to introduce mandatory maximum consumption limits; the report also suggested adopting a dynamic approach with the introduction of more stringent efficiency requirements over time in such a way to follow technological progress. The impact analysis on manufacturers and consumers showed that the maximum price increase, which would not reduce sales of new refrigerators was about 2%.

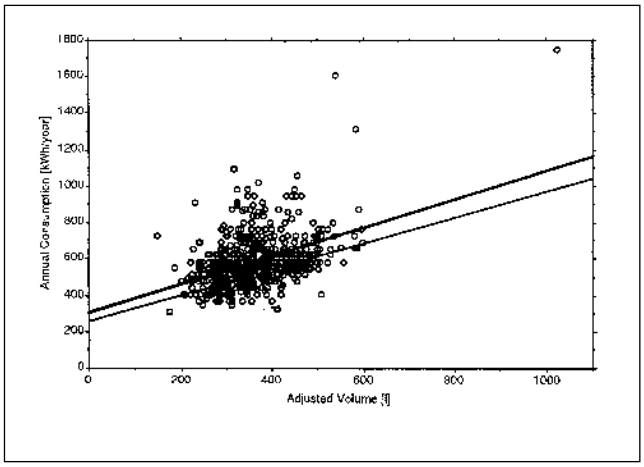
Figure 5. *Life Cycle Cost for 4 * Refrigerator/Freezers*



The first level corresponding to a 15% efficiency improvement has been chosen to keep the price increase below 2%. Because the number of models to be redesigned or phased out was about 50%, to avoid imposing an excessive burden on manufacturers an implementation time of three years was foreseen. The proposed first level would result in a total amount of 10 TWh saved in the first three years. A second level of a further 25% efficiency improvements (40% efficiency improvements on 1993 levels) to come into force about three years later was also proposed, in such a way to have an average pay-back time of 3 years; although this is far from the full economic and technical potential available, it still represents a significative energy saving amounting to 40 TWh per year or about 2% of the total Union electricity consumption by year 2020. Figure 6 shows the 1993 distribution of energy consumption for '4 star' refrigerator/freezers and the proposed maximum consumption limits.

Minimum efficiency requirements for refrigeration appliances will result in large savings for private customers and society as a whole (even without calculating the cost of the avoided CO_2 emissions). The European legislation (Directive) to introduce minimum efficiency requirements should be adopted by the end of 1996; this long delay, considering that the impact analysis was completed by end of 1993 and the Commissions' Directive proposal was ready by end 1994, is due to strong opposition of both manufacturers and policy makers, who believe that market forces are enough to bring about the optimal energy efficiency level. Throughout the drafting of the directive a long negotiation took place with manufacturers to reach a satisfactory voluntary agreements yielding the same results as the proposed minimum efficiency requirements, but due to the very competitive structure of the market, manufacturers were not in a position to agree among themselves any substantial efficiency improvements.

Figure 6. *Minimum Efficiency Requirements for 4 * Refrigerator/Freezers*

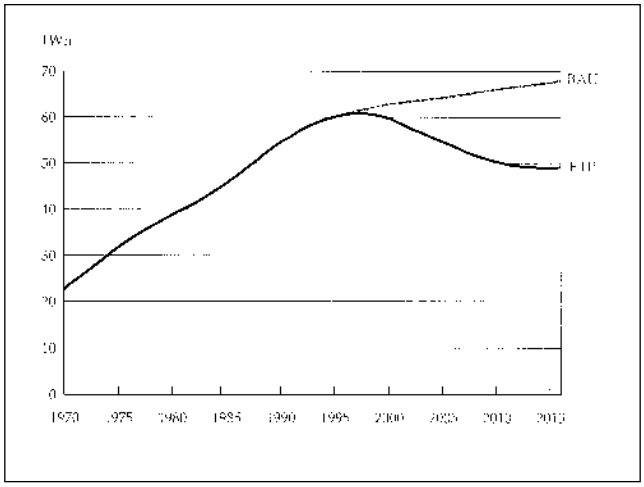


Wet appliances

The market assessment, saving potentials and technical-economic analysis were completed by mid 1995 (Group for Efficient Appliances 1995). Based on the results of the market assessment the efficiency classes for the labels for washing machines and driers have been defined; the labels is mandatory as from 1 April 1996; for dishwashers some additional work is needed to define the energy measurement standard. The total energy consumption of wet appliances in the Union is around 60 TWh and is estimated to increase to 70 TWh by year 2015, if current trends continue. The analysis concludes that technically feasible and economically viable efficiency improvements on the average European machine, defined as the 'base case' model, are of the order of 25% for washing machines, 33% for dishwashers and 10% for driers. If appropriate policy measures were implemented to achieve the full economic and technical potentials, the total electricity consumption of wet appliances is estimated to be, by year 2015, 20 TWh lower than the 'business as usual' scenario, as shown in Figure 7.

Because of the large energy savings and the availability of measuring standards, it was decided to concentrate the initial effort on washing machines. The analysis indicates that there is quite a substantial difference in average energy efficiency between Northern and Southern Europe, this difference is partly explained by consumers' awareness and information on environmental issues and partly by different climatic and socioeconomic situations. A more refined sensitivity analysis (Van Holsteijn en Kemna 1996) was carried out using different European prices for water and electricity and regional 'base case' models (reflecting the average washing machine performance for each region) to check if the 'optimal' Euro-

Figure 7. *Total Electricity Consumption for Wet Appliances; 'Business as Usual' and 'Technical-Economic' Scenarios*



pean model would be the rational choice for the different groups of consumers in the Union. The sensitivity analysis concluded that 'economical optimum' is 0.22 kWh/Kg for Northern Europe and 0.24 kWh/Kg for Southern Europe (and the UK). On average, using the two different targets the projected energy savings for the European Union would be 26 % or about 10.5 TWh per year. The analysis indicated also that a single energy level, between the two optimum one, of 0.23 kWh/Kg for the '60°C' cotton cycle, proposed for all Europe, is relatively robust.

Two options are open to achieve these targets: either propose legislation for mandatory maximum consumption requirements, which must be the same for the whole European Union (e.g. 0.23 kWh/Kg for the '60°C' cotton cycle), or negotiate voluntary agreements by manufactures to reach a European average maximum consumption of 0.23 kWh/Kg, allowing for higher consumption in the Southern countries and marketing the more efficient appliances in the Northern. The latter approach shows the most favourable cost/benefit analysis, because of lower price increases; to this end negotiations with appliance manufacturers have started.

In addition, some other 'soft targets' are being investigated, relating to certain features that may only be appropriate for certain groups of customers or regions, or which present particular marketing problems. For washing machines these include: hot and cold fill which is almost universal in the United Kingdom, but is not in practice available in other areas where 'cheap' hot water (from gas, district heating, etc.) would make it cost effective; high spin speed, which makes sense for users of tumble driers, but the extra expense is not justified for those, in particular in Southern Europe, who dry in the open air; multi-component detergent systems, which, by allowing the various elements of detergents to be added only as they are needed, could give better washing results, or alternatively, a lower use of (hot) water, or lower wash temperatures. To achieve these 'soft targets' technology procurement is the most appropriate policy option. Negotiations are continuing to persuade large domestic appliances retail chains to participate in competitions for high efficiency washing machines incorporating the 'soft targets', which are relevant for their local market.

Consumer electronics

The analysis (Novem 1995) of the present power load and saving potential for televisions and video recorders was completed in 1995. It indicates that large savings can be achieved with a reduction of the stand-by power from the present average of 8 Watts, for televisions, and 10 Watts, for video recorders, to 1 Watt each. The best policy option would be a maximum consumption limit for the stand-by mode. Given the fast changing technology, voluntary agreements allow for flexibility and are more rapid in following technological evolution than mandatory standards implemented through legislation. Negotiations are continuing to reach an agreement on maximum stand-by consumption of 3 Watts for televisions and 5 Watts for video recorders by the end of 1996, this will result in saving of 10 TWh per year once all the current appliances have been replaced, i.e. in about 10 years time, as shown in Figures 8 and 9. The negotiation could lead to a progressive reduction each year of the maximum consumption limits toward 1 Watt.

Energy labelling of television and videos is not foreseen because of the difficulty of establishing energy efficiency criteria in the on-mode; for the stand-by mode, the voluntary agreement will only allow the marketing of the more

Figure 8. *Total Electricity Consumption for Televisions; 'Business as Usual' and 'Technical/Economic' Scenarios*

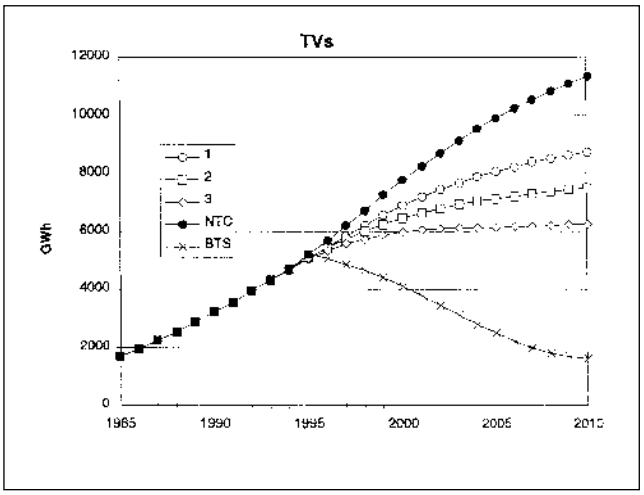
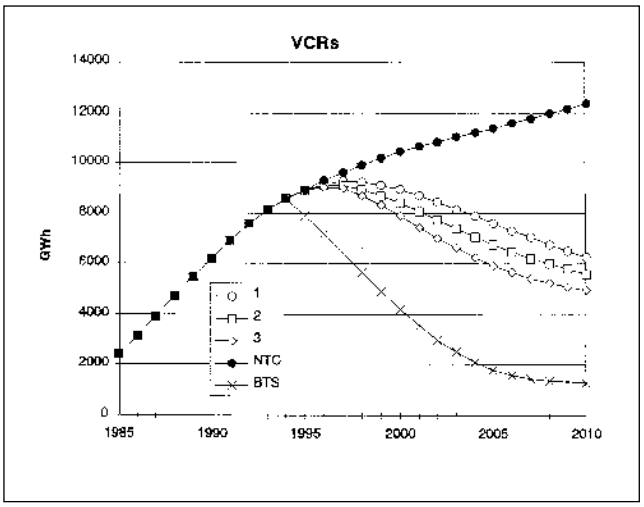


Figure 9. *Total Electricity Consumption for Video Recorders; 'Business as Usual' and 'Technical/Economic' Scenarios*



'energy-efficient' models (although this is very similar to a minimum efficiency standards, it will not be encoded in legislation, but voluntarily accepted by manufacturers, who are signing the agreement) , therefore energy labels or quality marks are not needed. Technology procurement could further accelerate market penetration of the more 'energy efficient' models with stand-by consumption of less than 1 Watt.

Other Appliances

A market assessment, saving potentials evaluation and technical economic analysis for water heaters will be carried out during 1996. Following these analyses the best policy options will be chosen. Future investigation will cover room air conditioners and ovens. Domestic lighting has also been investigated and the only policy options so far envisaged are compulsory energy label and procurement; at national level several incentive schemes both for consumers and manufacturers have been proposed as part of utility DSM campaigns and governmental efforts to reduce energy consumption in the domestic sectors.

COMMERCIAL SECTOR

The commercial (office and retail space) sector's electricity consumption is about 400 TWh per year, of which lighting is about 40% and HVAC is about 32%. Under the PACE programme actions are undertaken in the commercial sector in the field of fluorescent lighting and office equipment. While in the domestic sector the main barrier to the penetration of energy efficiency is lack of information, for the commercial sector the main barriers to energy efficiency investment are 'split incentives', due to the fact that a large amount of office and retail space is rented, and the rate of return for energy efficiency investments is very high. Associated with the activities described in the following sections, the Commission under the SAVE programme is promoting third party financing as one of the key instruments to achieve economically feasible energy savings in the commercial sector.

Lighting

A study (Building Research Establishment 1994), carried out in 1994, indicates that in the Union lighting in both offices and retail shops is predominately provided by fluorescent lamps: for offices it is estimated that approximately 80% of the energy used for lighting is consumed by linear fluorescent lamps; for retail shops fluorescent lamps account for about 66%. In 1992 about 75% of the sales of fluorescent lamps were halophosphate lamps, while triphosphor lamps accounted for 25%. In addition, 95% of the fluorescent lamp ballasts were conventional wire-wound ballasts, only 5% were high frequency electronic ballasts.

The study conclusions indicate that mandatory standards are likely to produce the largest energy savings and that the major technical potential for energy savings in lighting of offices and shops lies in two areas. The first is improvement of the efficiency of the components which form the lighting installation. The second is reduction of the hours of lighting through appropriate design of the building to optimise daylight and through the design of the lighting installation and its controls. Both these areas can be directly addressed through equipment prescriptive standards, system performance standards or building regulations. However, system performance standards or building regulation are the responsibility of individual Member States. While the European Union could develop model standards, it would not be able to compel Member States to adopt them. Component performance standards on the other hand would address only the first area, the efficiency of the components which form the lighting installation, but such standards could be developed and introduced by the Union.

The Commission has therefore considered component performance standards in detail. The introduction of performance standards, particularly for fluorescent lamp ballasts, is one of the most effective actions which the Union could take to reduce energy consumption for lighting in commercial buildings and is thus worth further consideration and development. Their cost effectiveness and impact on future energy consumption is being examined in detail during the first part of 1996, preliminary results are shown in Figure 10.

Office equipment

Office equipment represents the fastest growing electricity load in the European Union. To evaluate the actual power load, the potential savings, and the best ways to achieve them, a study group was set up in 1993. The final report (University of Bordeaux 1994) indicated that the present office equipment power load in Europe is around 10 GVA, growing at a rate of 20% per year, this means that every year, 2 more large power plants will be necessary for office equipment alone. Office equipment consumes about 45 TWh per year, this will increase to 60 TWh by year 2000; savings of 30% can be achieved using the existing technology, resulting in savings of 20 TWh per year, or about 1% of all electricity consumption in the Union as shown in Figure 11. The report recommends that the Commission considers and implements a Union-wide programme to reduce significantly energy demand and achieve these potential savings. The report suggests the adoption of a labelling scheme for the more 'efficient' products and the promotion of the scheme by a recommendation to public administrations of the 15 Member States to buy, in their procurement of office equipment, only labelled equipment. The report also concludes that the programme would be more successful if based on

Figure 10. *Total Electricity Consumption for Fluorescent Lighting; 'Business as Usual' and 'Minimum Efficiency Standards for Ballast and Lamps' Scenarios*

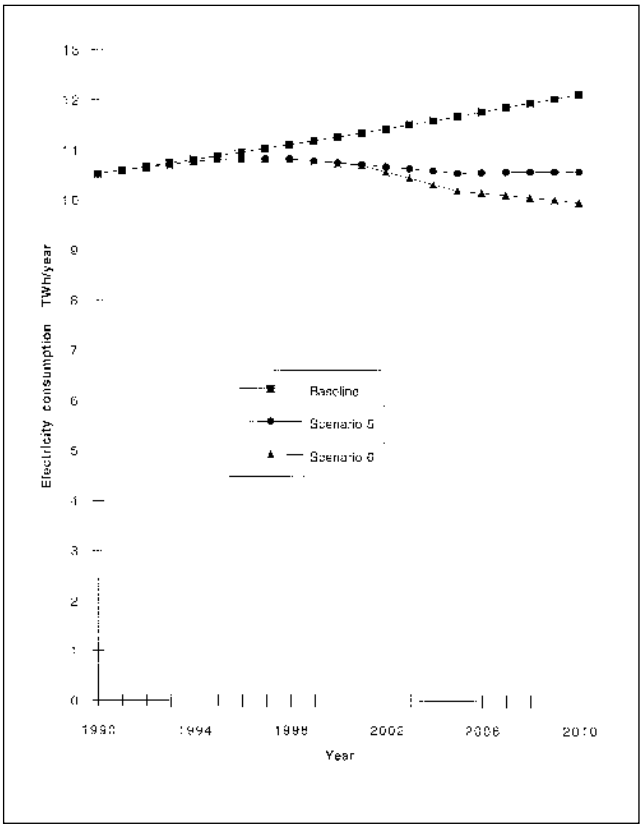
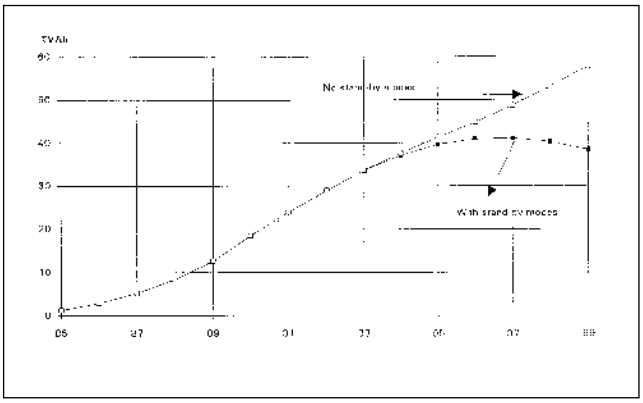


Figure 11. *Total Electricity Consumption for Office Equipment; With and Without Stand-By Mode*



collaboration with the USA and Japan programmes. Negotiations to extend the US EPA Energy Star labelling programme to the Union were consequently started and should be concluded by the end of 1996. Technology procurement is also being investigated with a view to introducing more 'energy efficient' equipment to the market.

CONCLUSIONS

This paper has illustrated the activities undertaken in the Union under the PACE programme. A variety of different policy options have been investigated, proposed and implemented, each designed to achieve the potential energy savings. The process of establishing the best actions to achieve the savings is similar for all the sectors described above: independent experts evaluate the actual consumption, potential savings and the technical-economic feasibility. The findings and results are discussed with manufacturers, national administrations and other interested parties to reach a consensus on the analysis and best policy measures.

The paper has illustrated that the current appliances and equipment sold in the Union are still far from the 'economical' optimum energy efficiency level. The potential savings are quite large; the actions described in the paper, if fully implemented, would lead to an electricity savings of 150 TWh per year or about 8% of total Union electricity consumption.

There are several barriers to the introduction of more efficient appliances, both in the domestic and commercial sectors and this justifies the European Commission's efforts in the promotion of energy efficiency. The paper has illustrated that a combination of different but complementary policy tools, such as minimum efficiency standards, labelling and procurement are needed to transform the market.

Although market forces are used whenever possible to contribute to market transformation, some legislative measurers are also needed and, in the case of the European Union, minimum efficiency standards yield the largest energy savings at the lowest implementation cost. Given the present political climate, which favours deregulation, preference in each sector is given to voluntary agreements with manufacturers for the introduction of labels and maximum consumption limits. Voluntary agreements can be a valid alternative to the introduction of legislation, if they include the following three elements: i) commitments by manufacturers accounting for most of the appliances sold on the Union market (80% at least), ii) quantified commitments to significant improvements in the energy efficiencies of the appliances they produce over a reasonable timescale, and iii) an effective monitoring scheme with some degree of independence to monitor the energy efficiency improvements achieved.

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