

**A STUDY ON THE COSTS AND BENEFITS ASSOCIATED WITH THE USE OF TAX INCENTIVES TO PROMOTE THE MANUFACTURING OF MORE AND BETTER ENERGY-EFFICIENT APPLIANCES AND EQUIPMENT AND THE CONSUMER PURCHASING THESE PRODUCTS
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WHAT HAVE WE LEARNT – A SUMMARY BY DG TAXUD

The scope of the study

The study deals with the fiscal instruments that could potentially be used to promote energy efficiency in the EU. It focuses on *direct fiscal incentives* (subsidies, tax credits to consumers, tax credits to manufacturers) and compares their costs and benefits with those of conventional *tax instruments* (energy taxation) and a regulatory measure. The costs and benefits are assessed for four different appliances selected for their high energy saving potential: *refrigerators, washing machines, boilers and compact fluorescent lamps (CFLi)*. In each case the assessment is carried out for two different EU Member States in order to capture the impact of different using patterns, price levels and market penetration of products. The countries included in the analysis are France, Denmark, Italy and Poland.

For each of the eight cases (four products, two Member States) to be assessed two policy options are formed. It is assumed in all cases that the policies are applied on top of the baseline, which implies a 12% energy price increase due to the Emissions Trading Scheme or tax policy.

Policy option 1: A subsidy or tax credit is accorded to those who purchase/ produce a product belonging to the highest energy-efficiency category. In two cases the policy in question is a direct subsidy (refrigerators, CFLi); in one case a tax credit for consumers (boilers) and in one case a tax credit to the manufacturer (washing machines).

Policy option 2: An energy tax leading to the additional increase of electricity/ gas prices by 10% is introduced (refrigerators, boilers, CFLi). In the case of washing machines this policy is replaced by a regulatory measure consisting of removing from the market B- and C-class appliances.

In addition to the cost-benefit analysis the study provides information on the following topics, which will also be summarised below:

- the market situation with respect to different energy-efficiency categories of the four appliances in question in Western and Eastern Europe
- the overview of the current use of subsidies and tax incentives for energy efficiency purposes in the EU and US

- the review of economic literature concerning the impacts of subsidies and tax incentives used for energy efficient purposes.

The main results of the cost benefit analysis

The results of the cost-benefit analysis are reported in tables 1 and 2 of the annex. On the basis of the results the following conclusions could be drawn:

- Energy taxation appears as the most cost-effective policy to promote energy-efficiency in the EU. In all the six cases the benefits (the monetary value of CO₂ reduction) exceed the costs (welfare and administrative costs) entailed by the policy.
- Subsidies and tax credits have, however, a considerable potential of generating energy savings. In some cases energy savings induced by subsidy schemes (direct subsidies or tax credits) exceed those generated by energy tax increases manifold (refrigerators in France and Denmark, CFLi in Poland). The subsidy schemes tend to have, however, higher welfare costs than the increases of energy taxation, which makes their benefit- cost balance in some cases negative (refrigerators in France).
- The comparison of different incentive instruments reveals that direct subsidies and tax credits to consumers are much more cost effective than tax credits to manufacturers. In the latter case the welfare costs/ ton of CO₂ (€ 650 in Italy and € 234 in Poland) exceed by far all the reasonable estimates of the CO₂ externality, and hence such policies would cost much more to the society than the benefits they could generate.
- The regulatory measure (removing class B or lower from the market) also turns out to have a relatively low capacity to generate energy savings compared with other policy options and therefore a fairly negative benefit- cost balance¹.

The methodology applied in the cost-benefit analysis and in the calculation of welfare costs and gains is explained more in detail below.

Market analysis

In the first step of the study the markets of the four products in question were analysed and the data required by the cost-benefit analysis was collected. The analysis provides information on product characteristics, evolution of the sales, market penetration and prices of different energy-efficiency categories.

The analysis is done separately for Western Europe (including the following MSs: AT,BE,DE,ES,FR,GB,IT,NL,PT,SE) and Eastern Europe (CZ,HU,PL,SK), which allows interesting comparisons.

The description of the markets is very detailed and comprehensive in the report, and in the following only a few conclusions that can be drawn from this analysis, are presented.

Refrigerators

¹ It should be pointed out that for comparability reasons the analysis applied in this study does not include the value of energy savings as welfare gain in net welfare cost calculation. However, as far as the benefits of the policy for the consumers are concerned, the energy saving from the use of more efficient appliances over the life-cycle of the product about offsets, in the cases considered in this study, the costs from the need to buy more expensive equipment, which is included as welfare cost.

- The speed of innovation has been rapid in the EU since 1995, as the shares of the most energy-efficient categories (A, A+) have increased rapidly and the least efficient categories (below B) had practically disappeared from the market by 2005. Ten years earlier the two most efficient categories (A+, A++) did not exist, and were introduced only in 2002.

- The share of the most energy-efficient categories (A++) in sales is still low in both Western and Eastern Europe, but the share of A+ -labelled refrigerators reached 17.9 % in WE and 24.5 % in EE in 2007.

- At the same time, the shares of bigger models have increased at the expense of smaller ones in both WE and EE (which may be taken as evidence of the existence of rebound effect).

- The prices of A+ and A++ increased between 2002 and 2004 in Western Europe (by 14% and 17.7% respectively), while those of lower categories decreased, which has apparently hampered the market penetration of the most efficient models. In 2004 the price of A++ category was 4% higher than the price of category A. In Eastern Europe the prices of all categories decreased between 2002 and 2004, the price decrease of category A being 65.5%. Prices of all categories except A++ are lower in Eastern Europe than in Western Europe in 2004. The price of category A++ exceeds the price of category A by 45% in Eastern Europe in 2004, which explains low sales numbers.

- Price differences between different energy-efficiency categories also reflect in part differences in product qualities other than energy-efficiency, and also pricing strategies of the manufacturers, who usually set higher profit margins on the most energy-efficient models. These pricing strategies are not as such analysed in the report.

- An implication of the data presented could be that tax incentives could boost the sales of the most energy-efficient models, provided they are passed through to sales prices or otherwise targeted directly to the consumers.

Washing machines

- The speed of innovation has been spectacular, and currently the energy-efficient models completely dominate the market: the share of A (incl. A+) is 92.2% in Western Europe and 94.5% in Eastern Europe in 2007.

- Between 2002 and 2004 the prices of all categories decreased in both Western and Eastern Europe, and the price differences between energy-efficiency classes have diminished, which may explain the rapid market penetration of the most efficient models. In 2004 the class A+ was still 22% higher than the price of class A in Western Europe, and 24% higher in Eastern Europe. Prices in Western Europe were on average 30% higher than in Eastern Europe.

- Concerning the reasons for price differences and their policy implication the same observations apply as in the case of refrigerators.

Compact fluorescent lamps (CFLi)

- The energy saving capacity of compact fluorescent lamps is substantial compared with traditional incandescent lamps. The life cycle assessment indicates that the use of CFLi could reduce energy consumption and the emissions of greenhouse gases by 77 % compared with an incandescent lamp, and also generate several other environmental benefits.

- The sales of CFLis have increased and their prices gone down, in particular since 2005, although the evidence in this respect is scarce. Market penetration varies a lot between the Member States: for instance, in Austria, Germany, Czech Republic, Cyprus, Luxembourg and Slovenia 70% or more of the households own at least one CFLi, while the corresponding share is below 20% in Spain and Latvia.

- Prices of the CFLi vary between 3.5€ and 5.6€ in the Member States (IKEA prices). There are no systematic price differences between Western and Eastern Europe, as in the case of washing machines.

- Prices don't seem to be the major barrier to the market penetration of energy-efficient lamps, but rather the technical quality of products (light colour, colour rendering etc.) and insufficient information available to the consumers. Although the technical qualities of CFLi have improved a lot in last twenty years, the poor image still hampers their market penetration. It seems also that the information for comparing the light output between CFLi and incandescent lamps is often erroneous or insufficient. In the light of this analysis it seems that the measures, such as information campaigns, could be a better means of increasing the use of CFLi than tax incentives, which only affect prices.

Boilers

- Since the implementation of the Boiler Efficiency Directive in 1992 a major improvement in boiler efficiency has taken place. The share of condensing boilers (the most-energy efficient category) in sales has increased: it is currently 42% in the EU and is predicted to increase to 58% by 2010. The increase has been boosted also by the Energy Performance of Building Directive 2002/91/EC, which set new minimum efficiency standards to boilers. The EU-wide labelling scheme for the energy performance of boilers exists, but it is not systematically applied in all the Member States.

- There are big differences in the market penetration of condensing technology between the Member States. In some countries (NL, UK, DK) the market is close to saturation (the share of condensing boilers exceeds 90%), while in the other countries a large potential for increasing market shares remains. The reasons for these differences are not as such analysed in the report. They imply that uniform incentive schemes would not be efficient at the EU level.

- The penetration of energy-efficient (condensing) boilers is hampered by a market failure, often labelled "the principal-agent problem" in economic literature. It arises, since the housing developers, who usually are in charge of the first installation of the boiler, are not concerned with the energy costs, which are paid by the resident. The developers are thus not willing to go beyond minimum efficiency standards, if that would impose additional costs on them, which they cannot recuperate in the price of a new house. In the case of replacement the choice of the boiler is often influenced by the

installers, who have the tendency to prefer the models which they know to be steady, reliable and have low call back rates, and thus would not necessarily select the most energy-efficient categories.

- The nature of market barriers in case of boilers implies that if fiscal incentives are used in addition to regulatory measures (energy efficiency standards), they should be directed to property developers and commercial owners rather than residents. Better information tools, such as the EU-wide labelling schemes, could also help the residents to select more energy-efficient models, which could play an important role in the case of the replacement of old boilers.

Experiences of subsidies and tax incentives in the EU and US

EU Member States

- In the EU the most common form of incentive scheme to promote energy-efficiency has been a subsidy or rebate provided after the purchase or paid directly at the checkout. In the case of domestic appliances it is usual that the subsidy is delivered only against replacement of the old appliance, which could be one way of diminishing the rebound effect. Subsidy schemes for refrigerators and washing machines have been used, on the basis of government or private initiatives, at least in the Netherlands, Spain, Hungary and Denmark. Austria, Ireland and the Netherlands apply a subsidy scheme for condensing boilers, while Denmark applies it for natural gas and biomass boilers.

- Tax credits are much less used in the EU. Italy provides a tax credit on income tax for the purchasers of cold appliances and in France a tax credit for condensing boilers is used since 2005. Comparing the costs of various schemes indicates that tax credits tend to be more costly relative to energy saving achieved than subsidy schemes.

No systematic evidence about the impact of these policies on energy savings exist, but in many cases a remarkable increase in the market shares of the most efficient appliances have been observed. It should be pointed out, however, that the schemes are often implemented for a limited period of time, sometimes for a few months. The higher market shares may thus result from this "sales promotion" aspect of the schemes. The schemes have also been stopped, because they have turned out to be inefficient; this was the case in the Netherlands, where the subsidy scheme for white goods was stopped because of the high amount of "free riders" (people who would buy an energy-efficient appliance even in the absence of the subsidy).

US

- In the US, where the level of energy taxation is much lower than in the EU, energy efficiency is promoted basically by regulation (energy efficiency standards) and a wide range of tax credits and other financial incentives accorded at both the federal and state level to manufacturers, property owners and consumers. In addition, efficiency labels and information/ education campaigns are also used.

- Examples of corporate tax incentives at the federal level include tax credits to the manufacturers of the energy-efficient cold appliances and washing machines, and tax

deduction for the owners of commercial buildings for installing energy-efficient boilers. In addition a wide range of grant programs exist at the state level.

- Personal income tax credits for energy conservation exist mostly at the state level.

- An example of another type of tax incentive is found in the State of New York, which provides a property tax exemption for energy efficiency measures.

- Also sales tax exemptions are used for energy-efficient products in four States, usually on a very short-term basis (a few days).

In the US more studies assessing the effectiveness of subsidies/ tax incentives have been carried out, but no very systematic conclusions can be drawn out of these studies. The literature review included two studies (reported below), which provide relatively robust results concerning the effectiveness of subsidies and energy taxes respectively.

Literature review

The review deals with economic studies that assess in quantitative terms the various policy measures aimed at promoting the use of energy-efficient appliances and equipment. These studies focus more on the impacts of regulatory measures, but in some case also the effects of information tools (labelling schemes, energy audits) and subsidy schemes are included. The effectiveness of tax incentives for energy efficiency purposes has not been systematically examined in any of the European studies so far.

Several studies report estimates of the price elasticities of energy, which can be used to assess the potential impact of the policies affecting the prices paid by consumers or the industry for energy (energy taxation). The estimates vary depending on the method of estimation, the sector and the time span, but tend to be clearly smaller than unity in absolute terms (higher than -1) implying that 1% increase in energy price would deliver less than 1% decrease of energy use.

Engineering models are used to assess the energy saving potential of policy measures in the technical sense, without taking into account behavioural responses. In this sense they provide estimates about the maximum amount of energy savings that could be made in case the policy is adopted. They don't usually provide any estimates about the costs of policies, or provide any assessment of the cost-benefit balance. In the EU such a model has been used, for instance, to assess the impact of the Boiler Directive of 1992. The results indicate that the saving capacity is about 2.9% of energy used for space heating and warm water in households and in the tertiary sector.

In the US more studies can be found that assess more directly the effects of subsidies/ tax incentives on energy conservation. In the review two of such studies are reported (Hassett – Metcalf (1995) and Jaffe – Stavits (1995)). Both studies estimate econometrically the impact of energy prices (indicating the impact of taxes) and adoption / purchasing costs (indicating the effect of subsidies/ tax incentives) on investments in energy saving in buildings. In both studies the latter effect is found to be somewhat bigger than the former, implying that the investment decisions are somewhat more affected by investment costs than energy prices, which can be taken as evidence of

the effectiveness of subsidy schemes. This is in contrast with several previous studies, in which tax incentives were found to be ineffective. The studies don't compare, however, the costs of the two policy measures, or assess their benefits in monetary terms.

Evidence on the rebound effect

The rebound effect refers to the fact that energy efficiency improvements, which reduce the price of energy and lower the households' energy bill, may increase energy demand (directly or indirectly) and thus partly or entirely cancel the energy savings that potentially could be made by energy efficiency improvements. A large number of empirical studies has been done on the topic, but the evidence on the size of the rebound effect is inconclusive so far. The "consensus" estimates or "best guesses" found in the literature would be that for heating efficiency improvements the direct rebound effect would be typically less than 30% meaning that only 70% of the expected energy savings would be achieved. On household heating the estimates of the direct rebound effect would be in the range of 10 -58% in the short run and 1.4 - 60% in the long run, the reasonable figure being again around 30%. For household electric appliances the rebound effect is usually found to be smaller. These estimates do not include, however, indirect effects, which could make the economy-wide effect bigger. The estimates of indirect effects are even more uncertain than those of the direct effects. As a whole, economic literature indicates that, although the rebound effect may be significant, it would not make energy efficiency policies totally ineffective.

The methodology of cost-benefit analysis

The study is one of the first to compare the costs and benefits of energy taxation and subsidy schemes for consumer durables in a systematic fashion. Therefore innovative methodological solutions were required. The data availability also constrained methodological choices. The data consists of the sales, prices (incl. VAT) and energy consumption (in kWh) of the appliances belonging to different energy-efficiency categories for the four products and four countries that are the subject of the study. The data covers several years between 2001 and 2007, but is not sufficiently long to estimate directly price elasticities for different product categories and thus assess the changes of energy consumption on that basis. Therefore an economic model of consumer behaviour is developed, which is used to simulate how much the sales of different energy-categories change as a result of policy options (described above, see the scope of the study). The economic model assumes that consumers rationally choose the product, for which the net present value (NPV) of the operational costs of the services it provides during its lifetime are the lowest. The NPV is the difference of the two elements: 1) the discounted value of services minus energy costs during the lifetime of the product, and 2) the price of the product.

The cost-benefits analysis (CBA) consists of comparing the benefits that the policy instruments generate to the costs associated with their use.

The *benefits* are presented in the study as the monetary value (in €) of the reductions in CO₂ emissions achieved through the reductions of energy consumption resulting from the shifts to more energy-efficient categories of appliances. Country-specific coefficients of CO₂ emissions per kWh of electricity generated in each country are used. The monetary value of a ton of CO₂ emissions is €20.

The costs are the sum of *welfare costs and administrative costs*.

These are calculated in the following way for different policy instruments.

Subsidies and tax credits

- Welfare costs arise because of the necessity to raise taxes to finance the policies. The size of the cost is assumed to be 26% of the revenues raised (equal to the marginal cost of public funds).

- Welfare gains are of the two types:

a) financial gains to the manufacturers from the extra sales of more efficient equipment (calculated on the basis of product-specific profit margins: 6% for CFLi, 8% for refrigerators and 8.5% for boilers)

b) the welfare gain resulting from the lower emissions of non-GHG pollutants ((SO_x, NO_x, PSs, POPs, heavy metals) associated with lower energy consumption.

Administrative costs are assumed to be 5% of the revenue costs for the subsidy, and zero for tax credits.

Energy taxes

- Welfare costs consist of (1) the dead-weight loss from the imposition of the tax, based on energy consumption, and (2) the cost arising from the fact that consumers are made to buy more expensive equipment (calculated as the difference between the price of the appliance before and after the imposition of the tax).

- The two welfare gains are calculated in the same way as in the case of subsidy/ tax credit.

An additional welfare gain arises, because taxes generate revenues and therefore reduce the cost of raising taxes from other sources. The size of this gain is calculated on the basis of the marginal cost of public funds (26%).

Administrative costs are assumed to be 0.20% of the tax revenue.

Removing the products of class B and below from the market

- Welfare costs arise from the fact that consumers are made to buy more expensive equipment.

- The two welfare gains (financial gains to the manufacturers and the reduction of non-GHG emissions) are calculated in the same way as in the case of subsidies/ tax credits.

Administrative costs are assumed to be zero.

The summary of the CBA results are presented in table 1.

In the table the following indicators are used:

Net welfare cost / ton of CO₂:

Net welfare costs are the difference between the costs and gains, as explained above.

A negative value of the indicator implies that the gains exceed the welfare costs. In such a case the policy is worth adopting in any case, since it increases overall welfare. If the indicator is positive (welfare costs exceed the gains), the policy is still worth taking, if its value is below a reasonable estimate of the CO₂ externality (around 20€/ ton of CO₂), as the cost of the action would be lower than the social benefit it gives.

Benefits – costs:

The indicator is the difference between the benefits of the policy, calculated as the monetary value of the CO₂ emissions reduction, as explained above, and the sum of net welfare costs and administrative costs. A negative value implies that the total costs of the policy exceed the benefits and that the policy is costly compared to the benefits it can generate.

Energy savings (GWh)

The indicator shows simply, how much energy savings can be achieved with different policy instruments, which is often considered as a measure of the effectiveness of the policy (see, literature review), disregarding the costs.

Sensitivity analysis

Some sensitivity analysis was carried out in order to test the extent to which the CBA results depend on the assumptions regarding certain key parameters of the economic model and policy options. This was done in each case only for one or two of the case studies. Results are as follows:

1) Removing only class C from the market instead of classes B and C (washing machines in Italy and Poland)

Removing only class C from the market instead of classes B and C would reduce the net welfare costs of the policy and make the benefit – cost relationship less negative. At the same time the effectiveness of the policy would be reduced, as the energy saving achieved would be in Italy only one fifth and in Poland less than one third of what could be achieved by removing both classes B and C. In both countries the removal of only class C would still remain more attractive than the alternative policy, i.e. tax credit to manufacturers.

2) Mean discount rates (washing machines in Italy, tax credit to manufacturers)

The discount rate indicates the weight the consumer places on the immediate costs relative to the costs taking place in distant future in making the choice between the appliances of different energy-efficiency classes. The higher the discount rate, the more the purchase price and the less the future energy costs weigh in the consumer's decision. The economic model assumes that the discount rates are normally distributed with the mean 39% and standard deviation 18.7% corresponding to the estimates found in relevant literature. Two other rates were tested: 45% (with std 25%) and 20% (with std 10%).

The lower discount rate would lower the net welfare costs, but also the benefits of the policy, as the tax credits which affect the purchase price of the product would be less effective than in the main case. The benefit –cost ratio of the policy would still remain negative. For higher discount rates the results are qualitatively very similar to those of

the main case. The ranking of the policy options would remain the same, i.e. the removing of classes B and C from the market would still be preferred to the tax credit.

3) Marginal cost of public funds (refrigerators, France, subsidy to consumers)

The marginal cost of public funds (MCPF) is a measure of welfare costs of raising revenues by distorting taxes, expressed here as a percentage of the tax revenues raised². Its size depends on the nature of taxes raised and a number of other factors, and a wide range of estimates is found in literature. The model assumes 26% and the sensitivity test is done for a lower (15%) and higher (30%) value.

The CBA results turn out to be rather sensitive to the size of the MCPF measure. With the lower rate (15%) the financing of the subsidy is less costly, and the welfare gains would exceed the costs and benefit-cost relationship becomes positive. The estimates of energy saving and CO2 reduction would not be affected. Hence the subsidy policy would be in that case efficient in the economic sense and would entail somewhat higher welfare gain than the tax policy. In the case of the higher MCPF rates the opposite results are obtained and the policy becomes even more costly than in the main case.

Limitations of the approach

Although the methodology applied in the study is innovative and provides interesting results, it has also a number of caveats so the CBA results should be interpreted with caution.

1) The CBA analysis is done in the partial equilibrium framework, and thus does not take into account the impacts of price changes across the markets. Such market interactions could influence, for instance, the energy savings achieved through the policies and could thus also influence the CBA results. The economy-wide effects, such as on employment or GDP growth, are not obtained either. The partial equilibrium approach has, however, the advantage of obtaining more detailed results for specific markets than would be possible with general equilibrium models, which was also the main interest of the study.

2) The CBA analysis is done in the setting in which the policies affect only the sales of different energy-efficiency categories of appliances, but the total number of appliances sold remains constant. Due to the partial equilibrium approach, spill-over effects between the markets are not taken into account either. This implies that the rebound effect is zero in all cases, and thus the energy savings achieved through the policies may be overestimated, or should be taken as an upper limit.

3) The distributional effects of the policies are not analysed here, which are, however, an important factor affecting policy choices. Notably, it could be assumed that subsidies and energy taxes have different distributional consequences, as flat-rate subsidies could have relatively more value for low-income households, while energy taxes, in particular on heating and electricity, are usually found to be regressive and would burden the households at the low end of the income scale relatively more than the households at the high end of the income scale. Again the data limitations excluded this kind of analysis, but this would need to be considered in future studies.

² The measure used in the study is more precisely marginal excess burden (MEB), which is equal to $MCPF - 1$.

4) The economic model underlying the CBA analysis assumes that consumers always make rational choices in the sense of choosing the appliance with the lowest net present value. In reality there may be many factors, such as inadequate information or liquidity constraints, that would prevent them from making such choices. The impact of these so called market failures were not analysed in the study, as they would be rather difficult to quantify, but certainly would deserve more consideration in the future. On the other hand, the mean discount rate used in the CBA analysis is rather high, and could be taken to reflect some kind of short-sightedness of the consumers, or equally the impact of liquidity or credit market constraints.

Policy lessons

The study highlights the circumstances under which subsidies and tax incentives could usefully complement energy taxation in promoting the EU energy-efficiency objectives. It provides information to policy-makers about the budgetary and welfare costs associated with their use relative to the benefits, in the form of energy savings or the reductions of CO₂ emissions, that could be achieved. It compares these costs and benefits to those of alternative policy measures, such as increasing energy taxes or banning inefficient products from the market.

The analysis indicates that the effectiveness and efficiency of incentive instruments depends largely on the market conditions prevailing in the country, on the design of the instrument and the nature of products. These should be always carefully assessed, when the subsidy policy is introduced.

An example of the influence of the market conditions is the case of tax credits for the purchases of condensing boilers. In Italy, the policy turns out to be much more effective than in Denmark in terms of energy savings generated, since the market penetration of condensing technology was initially much lower in Italy. Also the benefit-cost relationship of tax credits exceeds that of energy taxes in Italy, making the tax credit a preferred policy option, while this is not the case in Denmark. This implies that it is preferable to design subsidy policies on the basis of market conditions prevailing in each country rather than apply uniform policies across the EU Member States.

The design of instruments also matters, as direct subsidies and in some cases income tax credits to consumers turn out to be a much more cost-effective policy to generate energy savings and environmental benefits than the tax credits to manufacturers.

Finally, the market analysis indicates that for some products (CFLi) important non-price barriers, such as poor image and inadequate information, exist in the market. In such a case other policy measures than incentives affecting the price of the product could turn out to be effective, or could at least complement tax policy and reduce its costs.

In the case of boilers, better information about the technical properties of the products could also boost the demand for more efficient models, at least in the case of replacement. In the case of new installations energy taxes would not be efficient due to the "principal agent problem", and if tax incentives are used, they should be directed to the developers and property owners rather than residents.

The comparison of energy taxes with other instruments reveals that taxes, with a few exceptions, outperform incentive instruments in terms of economic efficiency. Distributional considerations, which are not analysed in this study, could be, however, an important reason for complementing taxes with subsidy instruments, provided they are designed in such a way as to ensure an effective and efficient outcome.

ANNEX

Table 1: Results of the cost-benefit analysis for the eight case studies: policy option 1*

Product	Policy	Country	Net welfare cost/tCO2 €	Benefits – costs €	Energy savings (GWh)
Refrigerator	Subsidy for consumers (€50 class A+ only)	France	60,27	-8 978,3	1 433
		Denmark	-0,41	288,4	114
Washing machine	Tax credit for manufacturers (€100/ appl. A+)	Italy	650,3	-18 558 636	59
		Poland	283,9	-2 994,2	18
Boiler	Tax credit for consumers (25% of appl. Price deducted form income tax)	Denmark	-23,9	4 565,9	310
		Italy	-14,2	692 476 292	4 0293,6
CFLi	Subsidy for consumers (€1 classes A and B)	Poland	-17,1	78 659 440	3 548,8
		France	-11,3	10 471 437	430

*) Policy 1 is applied on top of baseline scenario (12% increase of electricity price (refrigerators, washing machines, CFLi)/ 15% increase of gas price (boilers))

Table 2: Results of the cost-benefit analysis for the eight case studies: Policy option 2*

Product	Policy	Country	Net welfare cost/ tCO2 €	Benefits – costs €	Energy savings (GWh)
Refrigerator	Energy tax: further increase of electricity price (10%)	France	-185,5	3 371,8	237
		Denmark	-10,0	418,9	47
Washing machine	B class and lower removed from the market	Italy	650,3	- 5 052 113	26
		Poland	190,7	-2 315 257	23
Boiler	Increase in gas price (15%)	Denmark	-23,9	1 231 331	102
		Italy	-12,1	61 634 591	3 825
CFLi	Energy tax: further increase in electricity price (10%)	Poland	-141,6	22 110 662	226
		France	-761,3	24 613 529	430

* See, footnote in table 1