Environmental RTDI Programme 2000–2006

Carbon Taxes: Which Households Gain or Lose?

(2001-EEP/DS7-M1)

Final Report

Prepared for the Environmental Protection Agency

by

The Economic and Social Research Institute

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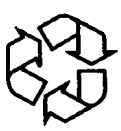

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1 Introduction

The purpose of this report is to analyse the effects of the introduction of a carbon tax in order to see how it would affect different households. The report focuses especially on vulnerable households, i.e. on households in low-income brackets, and this exercise is undertaken with a view to providing a means of alleviating adverse effects.

The starting point is the assumption that the carbon tax would be imposed on fuels according to their emissions of carbon dioxide, and that the tax is levied at the rate of €20/tonne of CO_2. The tax would be imposed on fuels in the manner of excise taxes currently in operation and the effects of their imposition on the economy as a whole have already been outlined (Bergin *et al.*, 2004). This report looks into the detail at household level and investigates the first-round effects, i.e. the effects before taking into consideration the broad impacts on the economy of re-spending the revenues. The first-round effects are the effects that are most 'visible' which, along with the effects on competitiveness, are the greatest cause for concern.

A simplification in this report is that the introduction of the carbon tax is assumed to be implemented in its entirety in 'year one', whereas in reality it would be phased in gradually with pre-announcement and preparation.

The discussion will proceed along the following lines. Section 2 looks at the direct impacts of the carbon tax on households in different income brackets and shows how these impacts are regressive, i.e. they make low-income households relatively worse off than high-income households. Broad types of compensation strategies for addressing this problem are then described in Section 3. How best to target vulnerable households is discussed in Section 4. In Section 5, using the compensation strategy and the selected targeting method, the net effects of the reform (the carbon tax net of compensation) are presented, enabling the gainers and the losers to be identified. Section 6 discusses other supporting measures that might be introduced to help losers and ease the transition to carbon taxes generally, and Section 7 closes the report.

2 Impacts

Having to hand the results of the Household Budget Survey (HBS) (CSO, 2002) for 1999–2000, it is possible to describe household purchases of fuels and associated expenditure in considerable detail.[1] The accompanying information on household income enables one to categorise households according to their levels of gross household income. In this exercise, the population of households is evenly divided into ten groups, called deciles, depending on their income levels.[2] Figure 2.1 shows the annual quantities of fuels used for residential use and for own transport, aggregated and converted to tonnes of oil equivalent (TOE), broken down by decile. Fuels used in the generation of electricity are included and the conversion factors used are reproduced in Appendix 1. The households with the lowest incomes are represented by the bars on the left-hand side of Fig. 2.1. The decile with the highest income is represented by the tenth pair of bars, on the right-hand side. The 'average' household is also shown, in the bars on the far right-hand side.

As expected, households in the higher-income groups use more fuels. The fuels have been broken down into transport fuels and fuels used in the home, and the even stronger correspondence of quantities with higher incomes where transport fuels are concerned is striking. By contrast, residential use is relatively flat. This fact has important policy implications, as will be shown. Associated with the use of these fuels are the emissions of carbon dioxide, shown in Fig. 2.2.

Expenditure on fuels, expressed as a proportion of household income, is described in Fig. 2.3, and it is the pattern shown here that drives this inquiry. (Appendices 2 to 5 provide the detailed source data for these figures.) As can be seen, expenditure on fuels forms a higher and sizeable share of the incomes of households in the lower deciles. When expenditure on fuels is expressed as a proportion of disposable income[3] (the second in each pair of bars) as opposed to gross income, the overall pattern is similar. Disposable income will be the measure of income used from here on.

The expenditure in Fig. 2.3 is rearranged in Fig. 2.4 to give the breakdown into expenditure on fuels for residential use and expenditure on transport fuels, as a share of disposable income.

It is interesting to note from Fig. 2.4 that, while expenditure on residential fuels is regressive, as expected, expenditure on transport fuels as a share of disposable income is highest for middle-income households. This finding may reflect the fact that rich households tend to have cars but can afford better lifestyles that involve less expenditure on fuels for commuting to work. On the other hand, those in middle-income brackets cannot afford to live close to their place of work and may be commuting, sometimes long distances. Poorer households are less likely to own cars and, therefore, spend less on transport fuels. Compensation for the introduction of carbon taxes will therefore need to be mindful of strains on middle-income households as well as on low-income households.

When the carbon tax of €20 per tonne of CO_2 is imposed, the patterns of annual carbon tax paid would be as shown in Fig. 2.5. The carbon tax paid over a year by the average household would be €246 but there would be variation depending on the decile. The tax paid by households in deciles 2 and 9, for example, would be €186 and €305, respectively.

When broken down into the tax paid on residential fuel use and transport fuel use, the pattern is as shown in Fig. 2.6. Here the pattern of carbon tax per household on use of residential fuel is remarkably flat, as expected. Appendix 6 gives the figures.

1. The authors are grateful to the Central Statistics Office for providing the data file, in which household information has been rendered anonymous. The number of households participating in the survey was 7644 and the results have been grossed up to represent the entire population.
2. Income deciles are constructed as follows. Households are ranked in ascending order of gross income. They are then evenly divided into ten groups of households, the first group of households having the lowest incomes is called decile 1, the next group is decile 2 and so on up to decile 10.
3. Disposable income is gross income (direct income plus State transfers) after subtraction of direct taxation.

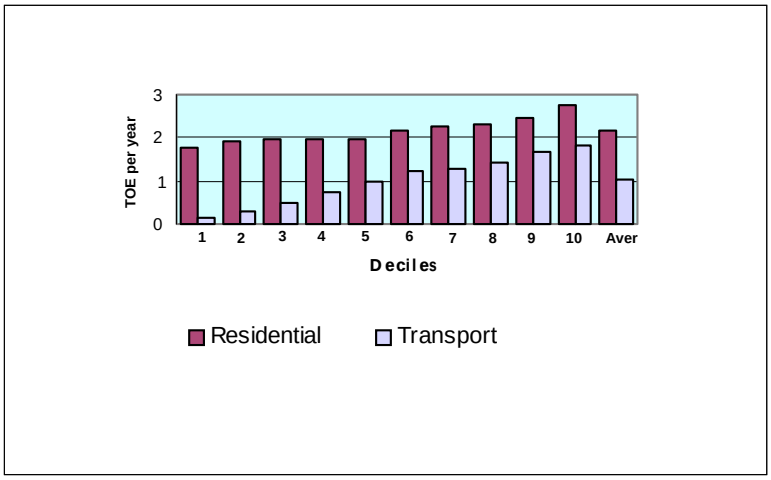

Figure 2.1. Average annual quantity of fuels used per household, TOE.

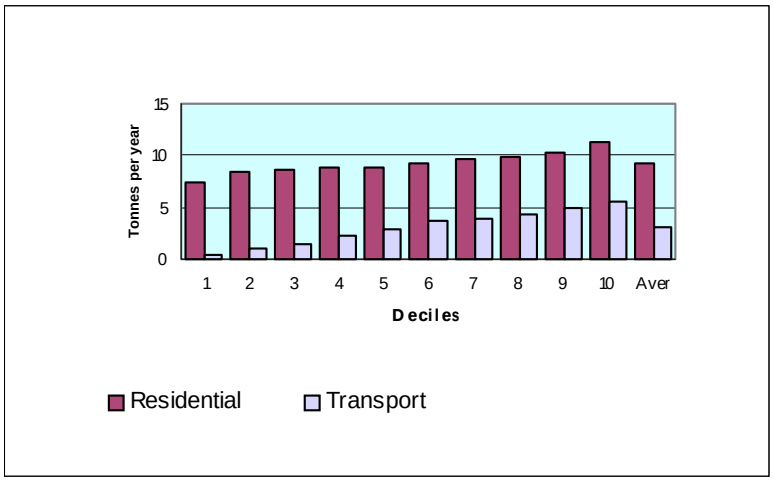

Figure 2.2. Average annual emissions of carbon dioxide per household, tonnes.

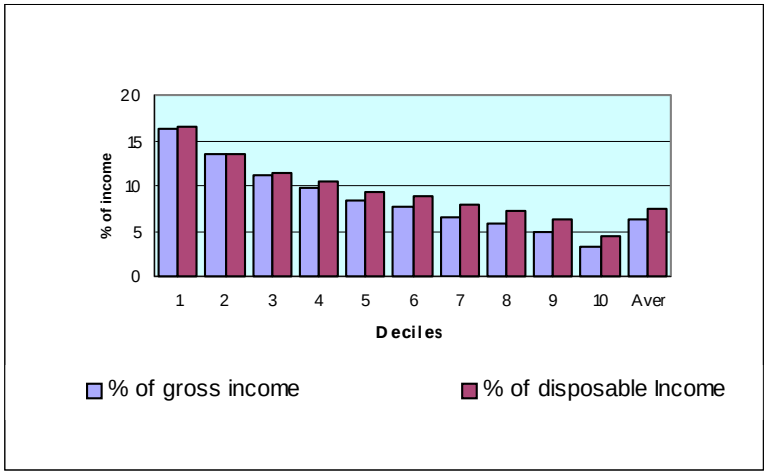

Figure 2.3. Expenditure on fuels as a proportion of household income, %.

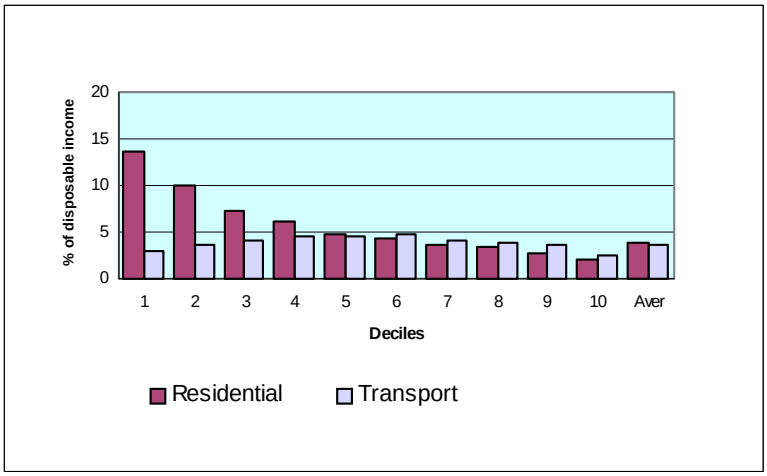

Figure 2.4. Expenditure on residential and transport fuels as a share of household income, %.

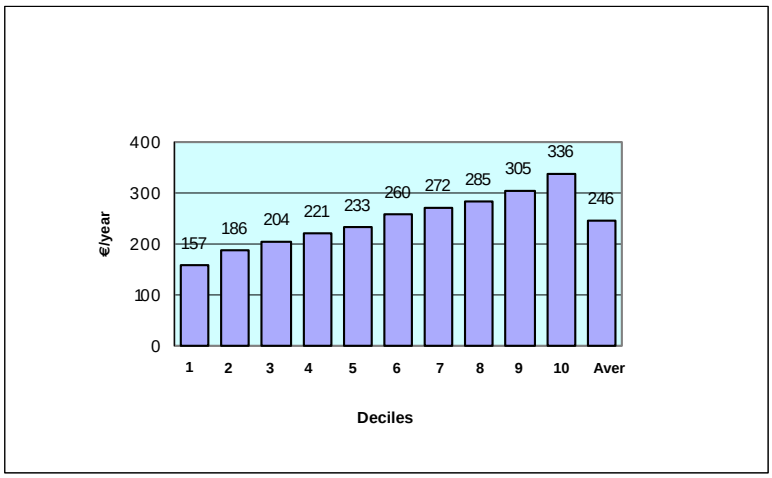

Figure 2.5. Carbon tax per household, €/year.

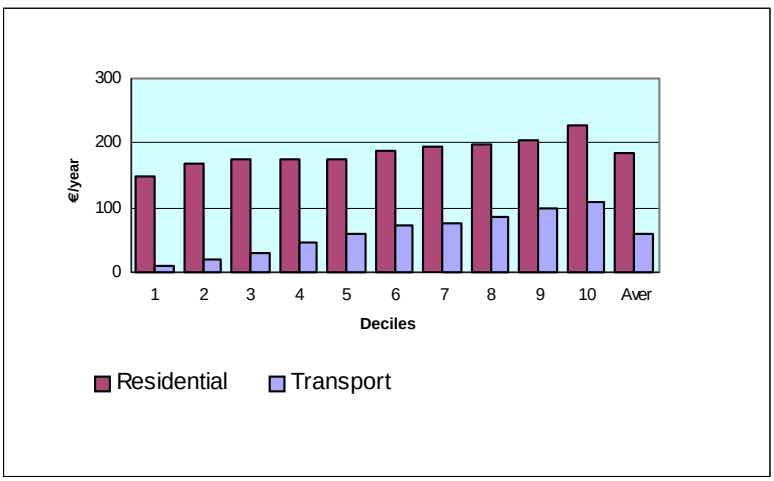

Figure 2.6. Carbon tax per household, broken into residential and transport components, €/year.

When expressed as a proportion of their disposable incomes, shown in Fig. 2.7, the regressive nature of this tax is again plain to see. This is most easily described by comparing deciles 2 and 9 again. The share of tax as a proportion of disposable income in decile 2 is over three times the share of tax in decile 9. This is steeper than the relative shares of fuel expenditure shown in Fig. 2.4, where the share of expenditure in decile 2 is about twice that of decile 9. The steepness of the tax reflects the fact that the fuels used more intensively by low-income households tend to be big emitters of carbon dioxide. Big emitters are the solid fuels, consisting mainly of coal, anthracite and turf. Electricity is also a big emitter but, unlike the case of solid fuels, households in the lower half of the income distribution use less of it than the average household. We see that for the 30% of households in the three lowest deciles, the carbon tax would on average take over 1.5% of their disposable incomes, which is a sizable share and a potential source of hardship.

As mentioned, only the first-round effects of the introduction of the carbon tax are considered here. The effects on the economy of re-spending the revenues for macro-economic objectives are covered in the paper by Bergin *et al*. (2004). It is worth pointing out that a previous study for Ireland (Barker and Köhler, 1998) modelled the outcome of recycling revenues to reduce PRSI contributions and simultaneously looked at the repercussions on income distribution. While their results showed that every decile's income increased, they also showed that the outcome was "weakly regressive", meaning that the improvements enjoyed by the poor were proportionately less than those enjoyed by the rich. Income increased but so did inequality. Such a result suggests that it is low-income deciles that warrant attention. More importantly, there may also have been cases of hardship hidden by averaging at decile level because, as will be investigated later, the variation within decile is considerable.

While discussing the data on household energy use and the implications for carbon taxes, one should look at energy use and numbers in the household. This is because the effects of numbers on energy use may suggest that energy per head, rather than energy per household, should be the focus of analysis. Figure 2.8 shows energy spending per head for households with different numbers of inhabitants. (Appendix 7 shows household spending on fuels by numbers in the household and Appendix 8 shows household spending based on different types of household composition such as single elderly adult, or married couple with 1, 2 or more children, and so forth.) As is to be expected, expenditure per head declines as the number of persons in the household increases.

This decline in expenditure should be considered when devising the mode of compensation, i.e. in deciding whether compensation should be granted per person or per household. Comparing this decline with the relative flatness of the carbon tax per household for residential fuels shown in Fig. 2.6, there is a case for awarding compensation on the basis of the household. This is not to say that a carefully graded compensation based on the numbers of persons could not be administered and should not be considered, but for the purposes of this analysis compensation on a household basis is a sensible expedient.

It is worth briefly digressing further to look at a more carefully graded breakdown of fuel use and of income, not per household nor per person but per 'adult equivalent'. This makes allowance for the numbers and types of person in the household, by counting the first adult in a household as one person, subsequent adults as 0.66 persons and each child as 0.33 persons. These weights are used in the monitoring of poverty trends (Nolan *et al.*, 2002) and are based on a study by Conniffe and Keogh (1988). The household income can then be expressed as income per adult equivalent and the deciles of household income can be split up according to the household's income per adult equivalent. The same graphs can be produced with the new possibility of expressing emissions or carbon tax 'per adult equivalent'. The grouping of households on the horizontal axis can be made according to 'household income per adult equivalent' or 'equivalised income' for short. By virtue of there being large numbers of adult equivalents in, for example, a particular high-income household, that household could actually find itself in a lower decile of 'equivalised income' when the income is divided between the equivalent adults.

Results of such a calculation show that while, as already seen, the carbon tax per household would average €246

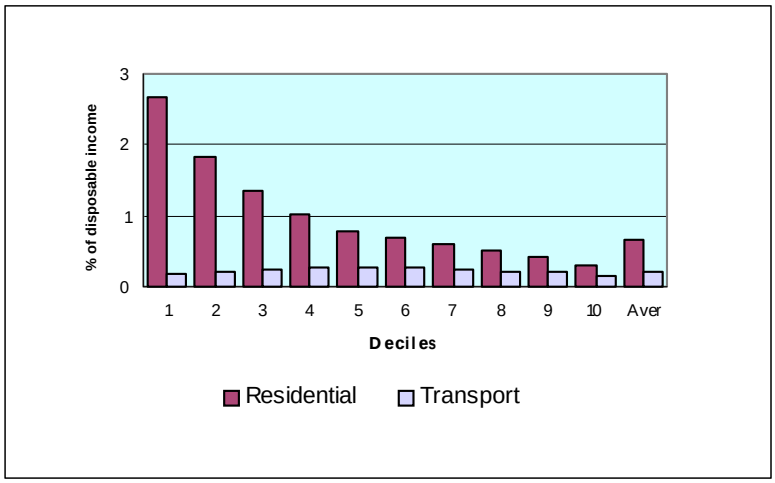

Figure 2.7. Carbon tax as a proportion of disposable income, %.

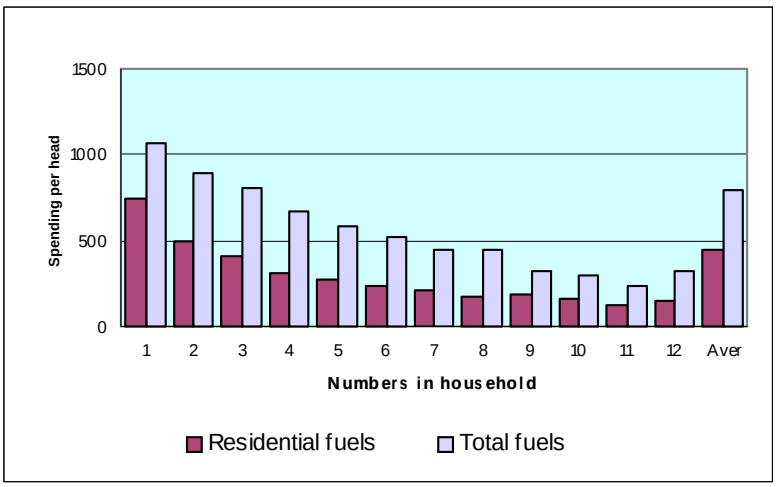

Figure 2.8. Annual expenditure on fuels per head, by numbers of persons in the household.

per year, the carbon tax per adult equivalent would be €122. (Appendix 9 shows the carbon tax expressed per household and per adult equivalent, breaking down households into deciles based on equivalised income. Appendix 10 breaks down the carbon tax per adult equivalent into its residential and transport components.) Taken over the whole sample, the standard deviation (a measure of typical variation around the mean) of the carbon tax on a per household basis is in absolute terms double that on a per adult equivalent basis, at €180 versus €97. However, as a proportion of the average tax, the standard deviation per household is slightly lower than that per adult equivalent. From these investigations, there is not much to choose between targeting compensation at the household or the 'equivalent adult', except that the present mechanisms are broadly capable of compensating on a per household basis, which will be the compensation method investigated here.

Before discussing the various types of potential strategy for compensating households, it should be noted that any strategy chosen ought to be 'energy neutral', i.e. it should not distort decisions. For this reason, exemptions, waivers or free-fuel schemes are not ideal and other compensation mechanisms should be sought that leave intact the tax on carbon-emitting energy use. In particular, households with young people whose attitudes and habits are in the process of being formed ought to be compensated by some mode other than one that makes energy 'cheap'.

3 Strategy

The design of a compensation strategy to help low-income households needs to keep several issues in mind. The first (positive) issue is that there will be no shortage of funds available to ensure that vulnerable households are protected. This is because the revenues from the carbon tax will be very large. The second issue is that there are very real benefits to be derived by using the funds for purposes other than compensation, in the manner described by Bergin *et al.* (2004) that removes distorting taxes in general and improves the functioning of the economy. Thirdly, one wants to employ a compensation strategy that does not involve setting up a complicated administration and that targets vulnerable households without simultaneously giving windfall gains to households that do not need them.

It should be noted that we do not at this stage have the means to undertake an exercise along the above lines in a fully integrated manner, for example using the ESRI's SWITCH model. The SWITCH model is based on the ESRI's *Living in Ireland Survey* (ESRI, 2003) and is not currently compatible with the Household Budget Surveys. However, though restricted to using the latter survey, it is possible to look in detail at the first-round effects of the carbon tax and apply a basic compensation strategy to find useful indications.

The broad compensation choices to hand, discussed elsewhere already (Scott, 2002; Scott and Eakins, 2002), are reforms to indirect and direct taxes, increases in social-welfare provisions, subsidies to improve technical performance of housing fabric, of equipment and the like, and other supportive measures such as education and help-lines.

Reforms to indirect taxes can be briefly investigated first. Because indirect taxes are deemed to fall heavily on the poor, using the carbon-tax revenues to reduce VAT is an option worth considering. An exercise to this effect was undertaken by Bergin *et al.* (2004) in their Option 3, where it was found that redistribution of all the revenues from the carbon tax enabled the *weighted average* rate of VAT to be reduced from 12.25 to 11.1%. It is reasonable to assume that if a reduction in VAT were to be introduced, it would be concentrated on reducing the 'standard rate'. On this basis, it is calculated that the standard rate of 21% could be reduced to 18.4%. The HBS enables all the items on which standard VAT is charged to be identified, so that the reduction in household spending on foot of the VAT reduction can be calculated here. Figure 3.1 shows by household income decile the net effect, i.e. the introduction of the carbon tax less compensation via the VAT cut. The net effect shown

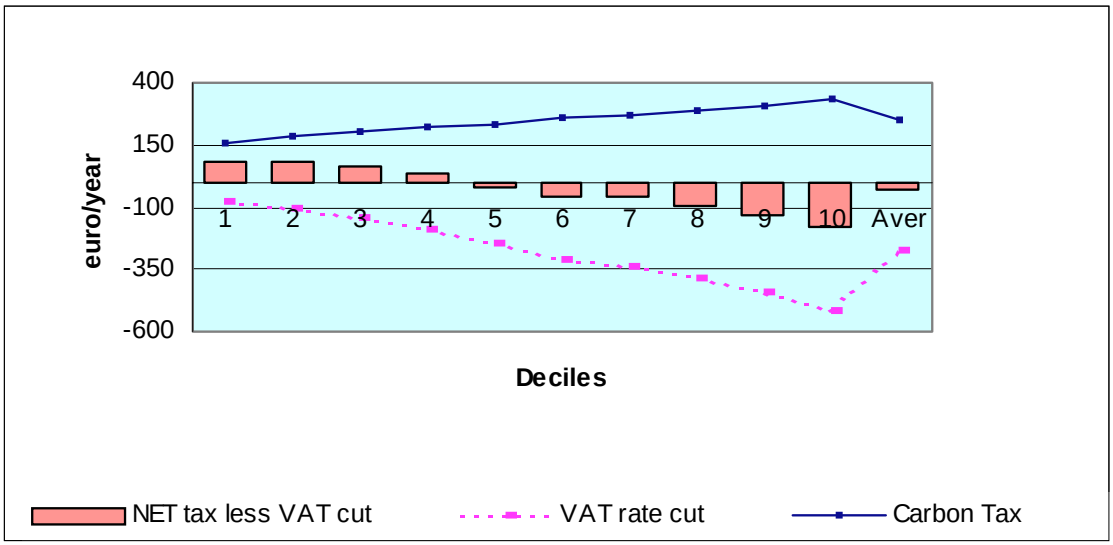

Figure 3.1. Net carbon tax paid (carbon tax less VAT cut) by households, €/year.

by the bars in the figure is the difference between the carbon tax, at the top of the figure, and the 'VAT rate cut' at the bottom.

As can be seen, the net tax is still positive for low-income households, meaning that the VAT reduction does not offset the carbon tax paid by these households. By contrast, rich households have negative net tax and are thus made better off by this reform. One reason for the regressive outcome of this option is that items such as food are already zero rated and, therefore, cannot have their VAT further reduced in order to target low-income households. Another reason is that rich households spend correspondingly more on standard VAT rated goods and thus benefit more. This option of compensating households by way of VAT reductions is therefore left aside.

A lump-sum compensation strategy is often mentioned and its progressiveness has some appeal. It is the Option 4 calculated in Bergin *et al.* (2004) It takes all the revenues from carbon taxes paid by the domestic sector and simply returns them to households as an equal cash sum. Each household would receive a lump-sum equivalent to the carbon paid by the average household. Setting aside such issues as household size and so forth, the attraction is that high emitters would be worse off, low emitters would be better off, so that the incentives to good environmental behaviour are correct and the funds paid by households match the funds received by households in total.[4] The appeal lies perhaps in the idea that the earth's atmosphere belongs equally to everybody and that the revenue, arguably reflecting damage done, should, therefore, be distributed evenly to compensate the 'owners'. An example of lump-sum compensation is shown in Fig. 3.2 where the average revenue from households is redistributed to each household. The lump-sum compensation of €246, shown by the flat line, is given to each household, for example like a cheque in the post. Taken in conjunction with the carbon tax, the *net* carbon tax, shown in the shorter bars, leaves low-income households better off than before, and high-income households worse off. The 'average' household experiences no net effect.

The drawback of this strategy is that it would forego advantages to be derived from using part of the revenue in a way that reduces some taxes that are distorting. We can do better. As shown already by Barker and Köhler (1998) and now in more detail by Bergin *et al.* (2004), the well-being of society as a whole can be improved by using what revenue can be spared to bring about macro-economic reforms. But, as stated, the earlier study also showed that better-off households would do relatively better from the macro-economic reforms and, therefore, it is the households in the lower-income deciles that warrant special attention in the search for a compensation strategy.

A few magnitudes set out in Table 3.1 help to set the scene. This table gives an idea of the orders of magnitude to be considered. As shown in the first strategy in Table 3.1, the sum of tax paid by the lower five deciles amounts to €129 million, which is 15% of the total revenue, and this could be used as the basis for a compensation strategy. However, large numbers of losers would result and it would be difficult to compensate by amounts that would be close to the tax paid in individual cases, as there is currently no redistribution mechanism that is sufficiently discerning to do this. A higher sum of revenue would need to be used to reduce the risk of widespread under-compensation.

The third strategy in Table 3.1 represents the lump-sum compensation already discussed, where every household is compensated and where macro-economic reforms from re-spending any carbon-tax revenue from the domestic sector are foregone. The middle strategy is closer to the compensation strategy to be aimed for. If low-income households, represented here by deciles 1–5, were compensated by €246 per year, the total cost would be €158 million or nearly 19% of the total revenue from carbon taxes. It would be a scheme that approximates implementing mainly the left-hand side of the lump-sum strategy shown in Fig. 3.2.

4. This option was investigated for the introduction of water services charges in *Green and bear it?* (Scott and Eakins, 2002). Such recycling would be facilitated were a system of refundable (or non-wastable) tax credits in place, so that people whose income was low and who paid no income tax would still be able to benefit.

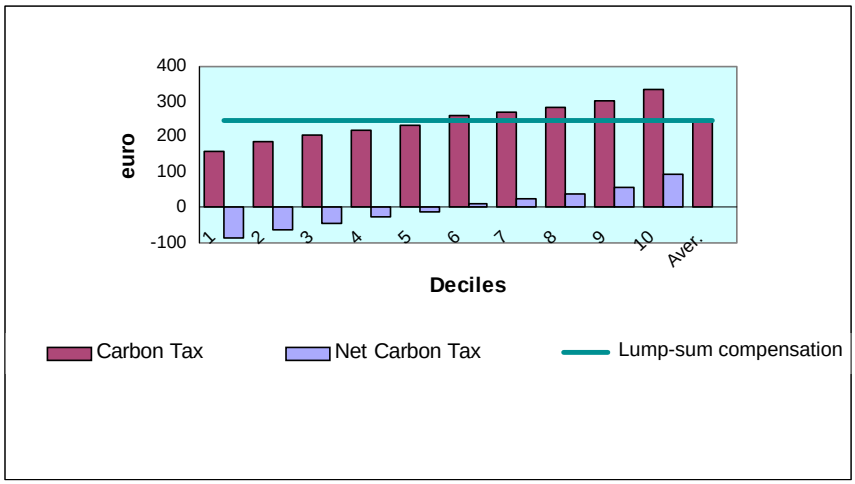

Figure 3.2. Carbon tax, lump-sum compensation and net carbon tax, €/year per household.

Table 3.1. Possible compensation strategies and funds required.

Strategies		Compensation per household	Compensation sum[a]	Share of total carbon tax revenue[b] required
Compensate households in deciles:				
(1)	1–5 by the average tax paid by deciles 1–5	€200	€129m	15%
(2)	1–5 by the overall average tax	€246	€158m	18.5%
(3)	1–10 by the overall average tax	€246	€317m	37%

[a]Based on 1.288 million households in 2002 (Stationery Office, 2003) and assuming that consumption patterns conform to those in the Household Budget Survey of 1999/2000.

[b]Total revenue from carbon taxes, including revenue from carbon taxes imposed on other sectors such as industry, is €850 million (Bergin *et al.*, 2004).

The middle strategy chosen as a basis appears generous because the compensation to low-income deciles, at €246, is greater than the carbon tax they pay as a group; for example, households in deciles 1–5 pay just under €200 on average. Despite this, the middle strategy's cost of €158 million is still less than the total sum that would need to be set aside. This is not only for reasons of administration and targeting, but also in order to provide extra funding for back-up schemes to help with house insulation and fuel switching and with special cases arising from variations within deciles, already mentioned.

It is, therefore, decided for the purpose of this exercise that a slightly more generous strategy than the middle strategy will be investigated, and that extra funds will also be set aside for schemes. Thus, it is proposed to set aside a round figure of some €200 million of the €850 million total revenue from carbon taxes. This sum of €200 million represents about 23% total revenue from carbon taxes and it is assumed to be ear-marked for compensation, remedial measures and back-up. It leaves €650 million for use on macro-economic reforms, which in turn will also benefit low-income deciles, though these benefits are not taken into account here.

4 Targeting

The issue of how to target the compensation is now addressed. As mentioned, we concentrate on the options that use the main procedures that are already in place for helping low-income families. These procedures consist of the various social-welfare schemes and the income-tax system.

There are many social-welfare schemes in existence and the question is whether there is any particular scheme or combination of schemes that would be a simple vehicle for compensation. For example, possible targeting could include households that are on low incomes and receive payments which qualify them for fuel allowances, and/or that are in possession of one or more Medical Cards, that receive Family Income Supplement and that receive Unemployment Benefit, and so forth. Those that pay non-zero income tax can also be targeted to benefit by receiving reductions in income tax.

Looking at some of these welfare schemes in more detail, it is found that there is no particular scheme already in existence that accesses all households in low-income deciles. In theory, the Medical Card might be used as a 'passport' to compensate for carbon taxes, but as this scheme becomes increasingly broadly applied, its use is not recommended here.

Adding the compensation to Fuel Allowances has strong appeal. These allowances are paid out under the National Fuel Scheme, paid in cash, and not to be confused with the Free-Fuel schemes. Fuel Allowances help households that are dependent on long-term social-welfare or health-board payments and that are unable to provide for their own heating needs. Only one allowance is payable to any household. Eligibility involves a means test and includes receipt of certain other welfare payments. On checking through the 'active' recipients of qualifying welfare payments, i.e. those receiving non-zero payments according to data from the Household Budget Survey, we see that some 60% of households in deciles 1–5 would be covered. The 'fuel allowance qualifying' criterion is the first criterion in Table 4.1 which, along with other possible targeting criteria, shows numbers of households that can be targeted in column 1.

The question is, can one target low-income households better and more comprehensively by including households other than just those qualifying for fuel allowances? The second criterion in Table 4.1 (which incidentally excludes Child Benefit because they are not targeted at low-incomes) shows that the improvement from including all benefits is not sizeable, as this brings the coverage of households in income deciles 1–5 up from 60% merely to 68%.

The third criterion shows that in deciles 1–5 only 39% are targetable through the income-tax system, though in fact the numbers would be rather higher than this because additional households are on Revenue's books, without being active payers. The fourth criterion in Table 4.1 shows that if households are selected that are actively in either the welfare net or tax net, and some are in both, then coverage improves to 91% of the low-income deciles. This is more promising. The tax part of the strategy would need to target the compensation carefully, by a judicious blend of thresholds and bands, to concentrate compensation on households in the lower-income deciles.

There is a small group of households, the 9% of deciles 1–5, that are neither in the welfare net nor in the tax net. By not being immediately targetable they may constitute a problem. The fact that they are not covered by social-welfare schemes could mean that some are disqualified owing to the level of their assets or whatever,[5] or that they have slipped through the welfare net. This is a problem that cannot be easily addressed here. They might also consist of individuals such as students and so forth, whose situation could be improved by indexing their grants. We will leave aside these cases that are not easily targeted at this stage.

5. For this reason, some researchers, e.g. Conniffe (2000), classify households in the HBS by deciles of total household expenditure rather than by deciles of income. This route may be worth pursuing as it overcomes the fact that low-income deciles may include people who are only temporarily receiving low income or who are not stating their income from assets.

Table 4.1. Qualifying criteria to target compensation and numbers of households[a] that can be targeted ($\times 10^3$ households).

Qualifying criteria		Qualify (i.e. readily targeted)	Do not qualify	Total households in the State
Households that:				
1.	Receive benefits qualifying for fuel allowance	465	756	1221
	Per cent of all households	38%	62%	100%
	of which: those in deciles 1–5	368	242	610
	per cent of deciles 1–5	60%	40%	100%
2.	Receive all benefits[b]	554	667	1221
	Per cent of all households	45%	55%	100%
	of which: those in deciles 1–5	415	195	610
	per cent of deciles 1–5	68%	32%	100%
3.	Are active taxpayers[c]	826	395	1221
	Per cent of all households	68%	33%	100%
	of which: those in deciles 1–5	240	370	610
	per cent of deciles 1–5	39%	61%	100%
4.	Receive all benefits or are active taxpayers[d]	1149	72	1221
	Per cent of all households	94%	6%	100%
	of which: those in deciles 1–5	552	58	610
	per cent of deciles 1–5	91%	9%	100%

[a]All numbers are based on the HBS 1999–2000.

[b]Except Child Benefit, which is universal rather than targeted at low incomes, all benefits listed in HBS are included (i.e. HBS codes trl 459–481).

[c]We call these active taxpayers because they comprise those households with non-zero payment (of income tax plus social insurance contributions) entered in the HBS. The same means of selection has been applied to identify recipients of welfare benefits, i.e. recipients of non-zero amounts. The number of households in the tax system is larger than the figures given here, which would improve potential coverage of households. This is because there are over 600,000 persons (note: persons not households) who are exempt from tax but who are on the tax records.

[d]Some 231,000 or nearly 19% of the total both receive benefits and pay taxes.

5 Compensation

To sum up so far, the strategy selected here is to compensate households in low-income deciles by an annual amount equivalent to the all-households average carbon tax, namely €246. In the calculations presented here, the compensation is targeted at all households that are actively in either the welfare net or the income-tax net.

The following assumptions are made. The Fuel Allowance scheme is enlarged in order to pay this extra sum of money, which effectively doubles the disbursements of the scheme as it now stands. The administration is also scaled up in order to be able to cope with increased numbers of claimants, as low-income households will be encouraged to claim. The system is already set up to give out only one payment per household, which is what is required here. For those low-income households paying income tax, compensation of €246 is assumed to be awarded through reductions in income tax. For those households that pay less than €246 in income tax and, therefore, cannot benefit fully from the reduction (which is likely in the lower deciles), it is assumed that they are compensated to the extent that their tax payment allows. Were a system of tax credits in place, such as the non-wastable or so-called refundable tax credits that are currently under discussion by the Tax Strategy Group of the Department of Finance, compensation would be simplified. However, it is not an option at present and is not discussed here.

We see that some 19% of households currently receive benefits and also pay income tax, so that they could stand to be compensated twice (Table 5.1). This would be wasteful. In order to avoid this, one extra phrase could be added to a question that is already posed in the Income-Tax form. There is a question that asks whether the taxpayer is in receipt of Social-Welfare Pension, Unemployment Benefit or Disability Benefit. To this question could be added "Fuel Allowance under the National Fuel Scheme". Those who indicate that they do get it would not receive a reduction in income tax, and those that do not get it would receive a reduction in tax. Those who do not pay sufficient income tax to benefit to the full extent of €246 would be notified that they stand to qualify for Fuel Allowances and would be advised to apply.

With these compensation methods in operation, it is helpful to summarise the categories and numbers of recipients. Table 5.1 shows the four-way classification of households into those that do or do not receive welfare benefits at present, by those that do and do not pay income tax (including social insurance contributions).

In summary, the compensation described here consists of extending the Fuel Allowances to all households that are benefits recipients, i.e. to the households in the two lower quadrants. Some of these households will be in deciles higher than deciles 1–5. Those that pay tax, in the two right quadrants, are asked in the income tax return

Table 5.1. Total households tabulated by income-tax payers and welfare-benefit recipients, $\times 10^3$ households.

		Pay income tax:		
		no	**yes**	**Totals**
Benefits recipients:	**no**	72 6%	595 49%	667
	yes	323 26%	231 19%	554
	Totals	395	826	**Total households 1,221**

whether they receive the Fuel Allowance, the coverage of which will have been extended. If they do not receive the fuel allowance (they are in the top right quadrant), they are compensated by having their income tax reduced and, in cases where their income tax is too low, they are compensated to the extent that their tax payment allows and advised to apply for the Fuel Allowance. Only income-tax payers on low incomes, however, should have their income tax reduced. A simple tapering adjustment is applied here, wherein deciles 1–4 receive €246 deducted from their income tax, and the next three deciles each receives a quarter less. So decile 5 receives three-quarters of €246, decile 6 receives half of €246, decile 7 receives a quarter and higher deciles receive nothing by way of income-tax reduction. The reason for extending some compensation above the decile 5 mark is that, as was seen from Figure 2.4, middle-income households could be relatively disadvantaged. This tapered approach is just an illustration and it is assumed that the tax system would apply something broadly of this nature through a mix of adjustments to thresholds and rates.

The next task is to apply this compensation package to the data. Table 5.2 shows stepwise the net carbon tax paid, i.e. the tax net of compensation by households. First, the compensation is shown for welfare recipients. Next, the compensation pattern is shown for those households paying income tax (but not receiving welfare benefits). Finally, the compensation is shown if those that either receive welfare benefits or pay income tax qualify. The final outcome (the penultimate row of Table 5.2) is illustrated in Fig. 5.1, which shows the carbon tax again and then the carbon tax net of compensation.

Several observations on Fig. 5.1 are called for. The carbon tax net of compensation displays good distributional characteristics. The poor would tend on average to be better off, the rich obviously not. The assumption is that energy use would not change after the price hike, which is unrealistic and, therefore, gives a more negative picture than the likely outcome. Use of the social-welfare net alone would mean that the share of households receiving compensation peters out rather strongly at deciles 4 and 5. As is to be expected, use of the income-tax net alone is unsatisfactory with regard to coverage of the four lower deciles, and deciles 1 and 2 are not fully compensated and their net carbon tax is positive. Using the two systems combined provides good coverage and benefits, and this would be the targeting strategy to adopt. It goes without saying that special provisions would be required for households where, for example, the medical condition of an inhabitant calls for unusually high levels of energy. There are some procedures in place already for special cases but these procedures may need to be enhanced.

The overall exchequer cost of this compensation strategy is now considered. The cost of compensation through the social-welfare system amounts to €136 million and the cost of the compensation via the tax system amounts to €44 million, bringing the overall cost to €180 million. This is more than the sum of €158 million derived initially in Table 3.1, where broad magnitudes were investigated on the basis of the lower five deciles only. The overall cost is short of the total €200 million, the final sum that was set aside for compensation. That is cause for satisfaction, though it does not leave much left over for associated purposes, such as house insulation and the like.

5.1 Gainers and Losers

Finally, there is the important question as to whether there are still individual households, among those that have been targeted, who would lose out from the package. Do the above results, where households are averaged at decile level, conceal significant differences within decile? Do some households with low incomes use more energy than the average for all households?

The answer is a clear ‘yes’. The size of the standard deviation around the results flags the fact that variation within deciles is high. This is to be expected to the extent that there are considerable differences in the characteristics of households. Table 5.3 shows the standard deviation of the net carbon tax compared to its average, for each decile. For example, in the third decile the standard deviation of the net carbon tax is €158 so that typically these households would vary between being €196 better off and €120 worse off. This wide variation has been found elsewhere (Dresner and Ekins, 2004) and it points to the need for measures over and above compensation – measures that would help households to reduce their CO_2 emissions.

Table 5.2. Net carbon tax paid after compensation[a] and coverage of households.

	Household income deciles									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Households in receipt of social-welfare benefits (including those also paying tax)										
Net carbon tax after compensation, €	–92	–63	–38	–32	–14	16	24	75	100	156
Coverage of all households, %	86	85	72	55	43	30	27	23	20	14
Households paying income tax (but not in receipt of social-welfare benefits)										
Net carbon tax after compensation, €	30	20	–39	–13	48	134	210	273	289	326
Coverage of all households, %	4	6	16	35	51	66	70	75	79	85
Households in receipt of social-welfare benefits or paying income tax										
Net carbon tax after compensation, €	–87	–58	–38	–25	20	97	158	227	250	302
Coverage of all households, %	90	91	88	90	94	96	97	98	99	99

[a]Note that a negative tax indicates that the households are gainers after compensation.

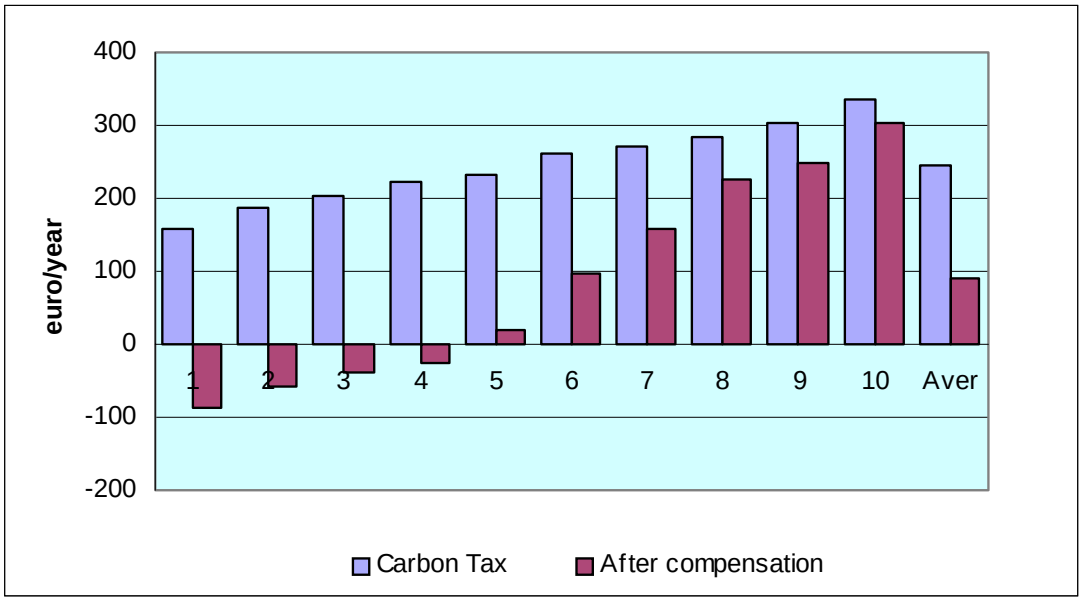

Figure 5.1. Carbon tax and net carbon tax after compensation, by household decile, €/year.

In addition, there are those households that we have not been able to target because they are not in receipt of welfare benefits and do not pay income tax. They, therefore, bear the tax with no offsets. The lower part of Table 5.3 gives the numbers. It can be seen that of the 71,800 non-targetable households, 58,000 or 80% are in deciles 1–5, pointing to the need for special measures to target them.

Given the wide variation in net carbon tax within decile, this warrants examination. Concentrating on deciles 1–5, Table 5.4 shows the proportion of targeted households that would find themselves out of pocket, even after having received the reasonably generous compensation of €246. Numbers of losers are relatively small in the lower deciles. They range from 16% of those targeted in decile 1 up to 47% of those targeted in decile 5.

These households must be emitting a good deal of greenhouse gases by comparison with others in their decile and it is worth looking at their characteristics. A helpful way to look at these is to compare the characteristics of losers with those of gainers.

A comparison of the household characteristics of losers against gainers in the first five deciles reveals some differences, but only a few are striking. Losers tend to be more rural than urban and they comprise somewhat more farming households in the higher deciles. Where household composition is concerned, slightly fewer loser households consist of single persons or elderly single

Table 5.3. Standard deviation of the net tax paid by households, and numbers of households that are non-targetable, by decile.

Deciles	1	2	3	4	5	6	7	8	9	10	Aver
St. dev.[a]	192	155	158	152	152	168	198	185	198	208	224
Net tax	–87	–58	–38	–25	20	97	158	227	250	302	90
Non- targetable[b]	12.7	11.3	14.3	12.0	7.7	4.6	4.0	2.9	1.0	1.3	71.8

[a]Standard deviation of the net carbon tax, after compensation (all in euro). This relates to those households that are in the welfare or income-tax nets.

[b]Measured in thousands of households, these are the households that neither receive social-welfare benefits nor pay income tax and, therefore, cannot readily be targeted for compensation through those systems. They constitute 6% of all households, but 9% in deciles 1–5.

Table 5.4. Proportion of targeted households in each decile that are losers.

	Household income deciles				
	1	**2**	**3**	**4**	**5**
Losers as % of targeted households	16	25	26	33	47
Broken down between those:					
In receipt of welfare benefits, %	14	21	23	19	16
Paying income tax, %	2	4	4	14	31

persons. If anything, more losers than gainers own their houses outright, or own their houses with a mortgage. Relative to gainers, losers also tend to include less economically inactive households. These differences, however, are not marked.

Table 5.5 gives an example, for the second decile, of a comparison of household characteristics as between gainers and losers. These are households in receipt of welfare benefits and only those characteristics that show some *differences* have been entered, which does not mean that these characteristics are in themselves prominent. The table also shows in the final column some characteristics of non-targetable households, again in decile 2.

Looking at the first row, the table shows that 68% of gainers happen to be urban, while only 43–47% of losers and non-targetable households are urban. The next row shows that a majority of losers, 52%, are rural (non-farm) households and, taken in conjunction with the third row, 53% of the non-targetable households are rural or farm households.

Subsequent rows show that losers do not consist of more elderly or economically inactive households as might have been expected. In fact, the reverse is the case but, in all these, differences are not very large.

It is only when one looks lower down the table at the method of heating that real differences emerge. Among gainers, the proportion of households that heat their homes in winter by oil-fired or gas-fired central heating is a combined 51%, compared to only 28% of losers. The corollary is that the proportion of losers that have central heating based on an open-fired back boiler or a solid-fuel cooker amounts to 39%, while the proportion of gainers with such high-emitting forms of space heating amounts to only 18%. Surprisingly, the proportions of gainers and losers[6] that have central heating of whatever type are practically identical in each decile, though rising from 71% in the first decile to about 88% in the fifth decile. As for the methods of heating that do not involve central heating, again marginally more losers than gainers use solid fuels.

Turning to the tax-paying households, differences between losers and gainers are similar to the above and are not shown here. Losers are again more likely to be rural and somewhat more likely to be farmers. They are not especially likely to be old, and they are predominantly married or married with children and are more likely to own their house outright. They tend to be marginally less educated and are marginally less economically active. But, again, it is in terms of their fuels used for space heating in winter that losers differ most from gainers. Less use of gas but more use of solid fuel are the distinguishing characteristics of losers, compared to gainers.

These results for the targetable households suggest that whether one is a gainer or loser under the operation of a full carbon tax with compensation depends not so much on socio–economic factors, but more on geography (rural versus urban) and on the type of fuel used. In other words, it is more of a technical distinction than a socio–economic one. This is a helpful result and gives a clear indication of where extra policy measures could be directed.

As for households that cannot be readily targeted for compensation because they are outside the welfare and

6. Not shown here. These are still households in receipt of social-welfare benefits.

Table 5.5. Characteristics of gainers and losers among households that are social-welfare recipients, and of non-targetable households, in decile 2 (per cent[a]).

	Gainers	Losers	Non-targetable
Household characteristics			
Urban	68	43	47
Rural (non-farm)	29	52	32
Farm	3	5	21
1 adult aged 14–65	8	3	25
1 adult 65+	31	11	27
Married couple	34	46	29
All pensioners	29	21	31
None active (no pensioners)	50	48	29
Head of household			
Widow/er	28	14	33
Single aged 15+	21	20	33
Is only economically active person	15	23	35
Education: Leaving Certificate or lower	96	97	86
Skilled manual or less	82	82	61
Method of space heating in winter			
CH oil	30	24	42
CH back boiler (open fire)	11	20	10
CH gas	21	4	9
CH with solid-fuel cooker	7	19	10

[a]Note: The figures in the table are to be read as the percentage of households under the column heading which have the characteristics listed down the left-hand side.

tax nets, by definition they are losers and bear the full brunt of the carbon tax. They tend to be more rural, by comparison with the above-discussed gainers, and consist of more farmers. Compared to both gainers and losers, they consist of households where the head is more likely to be economically active and they consist of more single-person households, aged between 14 and 65 years, and tend to have higher levels of education completed. These non-targetable households would, therefore, consist of a mixture of types, including farmers and students. As for fuel use, non-targetable households may be more rural than are the gainers, but rather than use more solid fuel, they use more oil. This ties in perhaps with their higher likelihood of being economically active.

A final characteristic of losers, not alluded to as yet, is the use of their own turf. Burning turf emits a heavy load of carbon dioxide and use of turf by households that produce their own is included in this analysis as a basis for carbon tax. The quantity that they use is recorded in the HBS and their bought turf (if any), is added in. In fact, of course, there would be little scope for imposing a carbon tax on own turf use, nor indeed on some other purchases of turf that might be somewhat informal. In this respect, the above estimates of carbon tax paid are exaggerated. It is indeed found among recipients of social-welfare benefits that 15% of losers compared to only 2% of gainers use their own turf. If one considers usage of turf in general, i.e. bought turf and own turf combined, 30% of losers as against 7% of gainers are users.

It is now possible to summarise who are the gainers and who are the losers from the imposition of a carbon tax with compensation. Setting aside those households that are not readily targetable and high-income households that are obviously losers on average, if the compensation to all welfare recipients is set at the average tax per household in the state, and if taxpayers in the lower-income deciles have their income-tax bills correspondingly reduced, the following emerges. It is

found that about three-quarters of households or more in deciles 1–3 are gainers, two-thirds of households in decile 4 and over a half of households in decile 5 are gainers.

How does one characterise the losers in deciles 1–5? Among welfare recipients and those that pay tax, the losers are found to be not very different from gainers in terms of socio–economic characteristics. There are less losers at the lower levels of income, because they use less fuels. Losers are not more likely to be elderly but they are more likely to be rural or somewhat more likely to be farm households. The main distinguishing characteristic is the type of fuel used for space heating in winter. Losers tend to use less gas, by virtue of being more likely to live outside the gas grid and are more likely to use solid fuels, and solid-fuel cookers. In addition, of course, losers are those that emit well above the average amount of greenhouse gases for their decile, for good reasons or otherwise.

It should be noted that the calculations here have erred on the negative side. That is, the tax is possibly exaggerated by means of inclusion of tax on own turf (the substitute would also bear tax, though less), and the compensation is understated because more households could probably be targeted than assumed here. This is by virtue of the fact that Revenue have more people on their books than actually pay non-zero income tax.

6 Supporting Measures

Compensation is not the only policy measure to hand. There are several other potential supporting measures that would play an important role and for which, as was seen, there would be some funds available. As many of the supporting measures have been described elsewhere (Fitzpatrick Associates, 2003; Healy, 2004) they will only be outlined here.

The major advantage of the introduction, indeed the mere announcement, of carbon taxes is their encouragement to the many scientists and commercial enterprises that have been investigating energy-saving technologies for the past few decades only to be disappointed by fuel price stagnation or declines. One of the objectives of the carbon tax is to bring about changes in energy-using technology. Many of the advances in energy efficiency, such as low-energy lighting and cars, were stimulated by the energy price rises of the seventies and, once adopted, technologies do not tend to become 'unadopted' when prices fall (Conniffe, 1993). The benefits persist. Furthermore, as estimates of responsiveness to price hikes show, the response is greater when people have had time to respond (see, for example, Scott, 1980, 1991; Fitz Gerald *et al.*, 2002). In particular, it takes time to get round to finding out about, and getting round to, improving the efficiency of energy use. If schemes are put in place that improve the efficiency in households in deciles 1–5, this will provide a universal information spin-off that can be acted upon by all.

There are two aspects of efficiency improvement in particular that need to be addressed. One is the insulation of the houses, and the other is the heating systems used. The HBS data show that full or partial central heating is now widely installed, the levels rising with income decile. If one looks at "main fuel used for heating in winter", of those with full or partial central heating, in the region of a quarter rely on solid fuel. Of those without partial or central heating, some two-thirds rely on solid fuel. There is thus considerable scope for technical improvements, including switching to oil, gas and renewables such as heat pumps.

Schemes have been investigated to help improve the housing stock and heating systems (Brophy *et al.,* 1999; Healy, 2002; Fitzpatrick Associates, 2003). Some 240,000 households are classified as 'energy inefficient', in the sense that they lack five or more out of the seven standard energy-saving features. These features comprise (i) lagging jacket, (ii) roof insulation, (iii) draught stripping, (iv) cavity-wall insulation, (v) central heating, (vi) controls upgrade, and (vii) low-energy double glazing. A 10-year programme to improve these would have sizeable benefits, not only in reduced emissions per upgraded house of approximately 2.6 tonnes of CO_2 per year but also in increased warmth and comfort for the inhabitants.

Other supporting measures required to avoid creating difficulties for the voluntary sector and community organisations would include giving financial support to Community Groups to upgrade the energy efficiency of town halls, churches, cultural venues and so forth.

Existing measures to preserve peatlands would need to be enhanced to tip the advantage away from burning turf as fuel, when the carbon tax is introduced.

Help-lines would be required for social-welfare recipients, or potential recipients, to inform them about how to obtain the enhanced cash Fuel Allowances. A domestic Energy Advice help-line would be required to answer questions about domestic energy efficiency and about how to access reliable services.

The public transport subsidy would also require to be enhanced and focused on passenger numbers, rather than on subsidising diesel.

Technical improvements could be encouraged, such as development of long-overdue user-friendly controls on energy use. Meters and bills could be made more easily readable and give helpful information.

7 Conclusions

This report investigated the options for compensating households in low-income deciles on foot of the introduction of a carbon tax. In this study, the carbon tax is assumed to be introduced fully in one go, though in reality it will be phased in gradually. An analysis that further integrated the tax and welfare systems would give more refined figures but, at this preliminary stage, answers to major questions can already be given.

Using data from the 1999–2000 Household Budget Survey, it was found that even with existing systems in place, namely the income-tax and social-welfare systems, over 90% of households in income deciles 1–5 can be targeted for compensation.

Setting the level of compensation at the overall average carbon tax per household means that each targeted household should receive €246 per year. Households on social-welfare benefits (excluding Child Benefit) would receive their compensation through an enhanced Fuel Allowance scheme. Households outside the social-welfare net can be compensated to a large extent through reduction in income tax, weighted towards low-income deciles. On this basis, households in the welfare or tax nets in income deciles 1–4 gain, on average, from the reform. The compensation to higher deciles is tapered, so that middle deciles pay little net carbon tax.

However, though most low-income households are gainers there are also some losers. Some 16% of targetable households in decile 1 would be losers, rising to 33% of households in decile 4. Losers are those households that emit more than average carbon dioxide and in particular those that use solid fuels. Indeed those using their own turf may require special measures, including incentives, to reduce their levels of extraction and use.

Schemes to help households to adapt the fabric of their homes and their energy-using equipment would need to be put in place. Users of solid fuels would need to be helped to switch to less carbon-intensive fuels. Community and cultural venues would also need assistance in upgrading the efficiency of their energy use.

In the example used here, compensation would take up some €180 million of the €200 million, or 23% of total carbon-tax revenues, that is set aside for such measures in the study by Bergin *et al*. (2004). This means that there would be some funds available to spend on energy-efficiency schemes.

Other supportive measures would need to include help-lines to ensure that people obtain their compensation, and domestic energy advice centres to impart technical information.

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Appendix 1

Conversions and emission factors.

HBS fuels	HBS units	Conversions TOE per unit	Emission factors[a] tonnes CO_2/TOE
Gas	kWh	0.000086	2.300
Electricity	kWh	0.000086	8.785
Anthracite	kg	0.000700	4.110
Coal	kg	0.000665	3.960
Turf loose	cwt	0.015900	4.340
Turf briquettes	bale	0.005538	4.140
Central-heating oil	litre	0.000868	3.050
Paraffin oil	pint	0.000473	2.980
Liquid petroleum gas	kg	0.001126	2.670
Motor fuel: petrol	litre[b]	0.000794	2.990
Motor fuel: diesel	litre[b]	0.000868	3.050
Motor fuel: LPG auto	litre[b]	0.000579	2.670

[a]For electricity, the fuels for generation are included.

[b]Expressed in euro in the HBS.

Appendix 2

Household weekly expenditure on fuels (€).

Fuel	Deciles of Gross Household Income										Average
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	household
	≤ €132.08	≤ €214.46	≤ €306.03	≤ €411.89	≤ €531.57	≤ €664.60	≤ €810.95	≤ €1016.84	≤ €1339.34	> €1339.34	
Gas	1.501	2.022	1.884	2.131	2.714	3.096	3.597	3.458	4.630	5.972	3.100
Electricity	4.133	6.065	7.207	8.494	8.771	9.931	10.054	11.294	10.838	12.400	8.919
Anthracite	0.056	0.087	0.062	0.070	0.044	0.040	0.055	0.093	0.098	0.093	0.070
Coal and coke	3.136	3.162	2.922	3.198	2.545	2.187	2.257	1.832	1.566	1.402	2.421
Peat briquettes	1.014	0.666	0.736	0.458	0.506	0.318	0.451	0.653	0.488	0.583	0.587
Turf	0.928	1.358	1.152	0.883	1.006	0.873	0.828	0.809	0.717	0.463	0.902
Central-heating oil	2.397	2.682	3.094	3.851	3.927	4.776	4.671	5.688	5.881	6.284	4.325
Paraffin oil	0.016	0.013	0.000	0.067	0.001	0.041	0.001	0.031	0.072	0.091	0.033
Liquid petroleum gas	0.842	1.014	0.870	0.651	0.563	0.741	0.707	0.553	0.701	0.345	0.699
Wood and kindling	0.390	0.180	0.286	0.193	0.135	0.055	0.209	0.334	0.093	0.117	0.199
Motor fuel: petrol	2.782	5.647	8.662	12.925	15.862	19.042	21.396	24.733	28.166	32.123	17.133
Motor fuel: diesel	0.285	0.698	1.479	1.997	3.223	5.042	4.060	3.814	4.808	4.178	2.958
Motor fuel: LPG auto	0.000	0.000	0.000	0.001	0.057	0.000	0.000	0.000	0.009	0.000	0.007
Expenditure on all fuels	17.479	23.594	28.354	34.918	39.355	46.143	48.287	53.292	58.066	64.051	41.353
Gross income of household	107.231	175.804	256.443	354.665	472.046	598.185	732.452	906.460	1161.446	1901.060	666.720
% of gross income	16.300	13.420	11.057	9.845	8.337	7.714	6.592	5.879	4.999	3.369	6.202
Disposable income of household	106.406	174.396	249.338	331.929	422.938	515.639	618.848	743.888	925.091	1428.710	551.600
% of disposable income	16.427	13.529	11.372	10.520	9.305	8.949	7.803	7.164	6.277	4.483	7.497

Appendix 3

Household weekly quantities of fuels in HBS units.

Fuel	HBS units	Deciles of Gross Household Income										State average
		1st ≤ €132.08	2nd ≤ €214.46	3rd ≤ €306.03	4th ≤ €411.89	5th ≤ €531.57	6th ≤ €664.60	7th ≤ €810.95	8th ≤ €1016.84	9th ≤ €1339.34	10th > €1339.34	
Gas	kWh	45.220	55.280	58.029	55.588	77.392	89.138	104.534	100.616	138.606	184.366	90.871
Electricity	kWh	43.938	58.440	70.952	81.328	84.365	91.810	95.800	103.123	102.162	120.285	85.219
Anthracite	kg	0.219	0.581	0.242	0.260	0.163	0.107	0.187	0.345	0.456	0.278	0.284
Coal	kg	13.312	13.175	12.673	13.278	9.690	9.205	9.309	7.634	7.178	5.969	10.142
Turf loose	cwt	0.466	0.526	0.461	0.333	0.366	0.327	0.378	0.271	0.278	0.190	0.359
Turf briquettes	bale	0.514	0.347	0.350	0.254	0.237	0.182	0.219	0.326	0.195	0.292	0.291
Central-heating oil	litre	7.052	8.426	9.714	11.628	11.741	14.842	13.840	16.942	17.477	19.980	13.164
Paraffin oil	pint	0.046	0.028	0.000	0.210	0.003	0.112	0.000	0.100	0.324	0.286	0.111
Liquid petroleum gas	kg	0.610	0.703	0.642	0.455	0.423	0.593	0.548	0.534	0.660	0.342	0.551
Motor fuel: petrol	litre[a]	0.019	0.015	0.000	0.079	0.001	0.049	0.001	0.036	0.085	0.108	0.039
Motor fuel: diesel	litre[a]	1.077	1.297	1.113	0.833	0.720	0.948	0.905	0.708	0.897	0.441	0.894
Motor fuel: LPG auto	litre[a]	0.734	0.338	0.539	0.364	0.254	0.104	0.394	0.630	0.175	0.221	0.375

[a]Motor fuels are expressed in euro in the HBS and have been converted to quantities here.

Appendix 4

Household weekly quantities of fuels in TOE.

Fuel	Deciles of Gross Household Income										Average
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	household
	≤ €132.08	≤ €214.46	≤ €306.03	≤ €411.89	≤ €531.57	≤ €664.60	≤ €810.95	≤ €1016.84	≤ €1339.34	> €1339.34	
Gas	0.0039	0.0048	0.0050	0.0048	0.0067	0.0077	0.0090	0.0087	0.0119	0.0159	0.0078
Electricity	0.0038	0.0050	0.0061	0.0070	0.0073	0.0079	0.0082	0.0089	0.0088	0.0103	0.0073
Anthracite	0.0002	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0002	0.0003	0.0002	0.0002
Coal	0.0089	0.0088	0.0084	0.0088	0.0064	0.0061	0.0062	0.0051	0.0048	0.0040	0.0067
Turf loose	0.0074	0.0084	0.0073	0.0053	0.0058	0.0052	0.0060	0.0043	0.0044	0.0030	0.0057
Turf briquettes	0.0028	0.0019	0.0019	0.0014	0.0013	0.0010	0.0012	0.0018	0.0011	0.0016	0.0016
Central-heating oil	0.0061	0.0073	0.0084	0.0101	0.0102	0.0129	0.0120	0.0147	0.0152	0.0173	0.0114
Paraffin oil	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0002	0.0001	0.0001
Liquid petroleum gas	0.0007	0.0008	0.0007	0.0005	0.0005	0.0007	0.0006	0.0006	0.0007	0.0004	0.0006
Motor fuel: petrol	0.0026	0.0053	0.0082	0.0122	0.0150	0.0180	0.0202	0.0233	0.0266	0.0303	0.0162
Motor fuel: diesel	0.0003	0.0008	0.0016	0.0022	0.0036	0.0056	0.0045	0.0042	0.0053	0.0046	0.0033
Motor fuel: LPG auto	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total TOE	0.0367	0.0434	0.0479	0.0526	0.0569	0.0651	0.0681	0.0719	0.0793	0.0878	0.0610
TOE residential	0.0338	0.0373	0.0381	0.0382	0.0383	0.0416	0.0434	0.0443	0.0474	0.0529	0.0415
TOE transport	0.0029	0.0061	0.0098	0.0144	0.0186	0.0236	0.0247	0.0276	0.0319	0.0349	0.0195

Appendix 5

Household weekly tonnes CO_2 emitted.

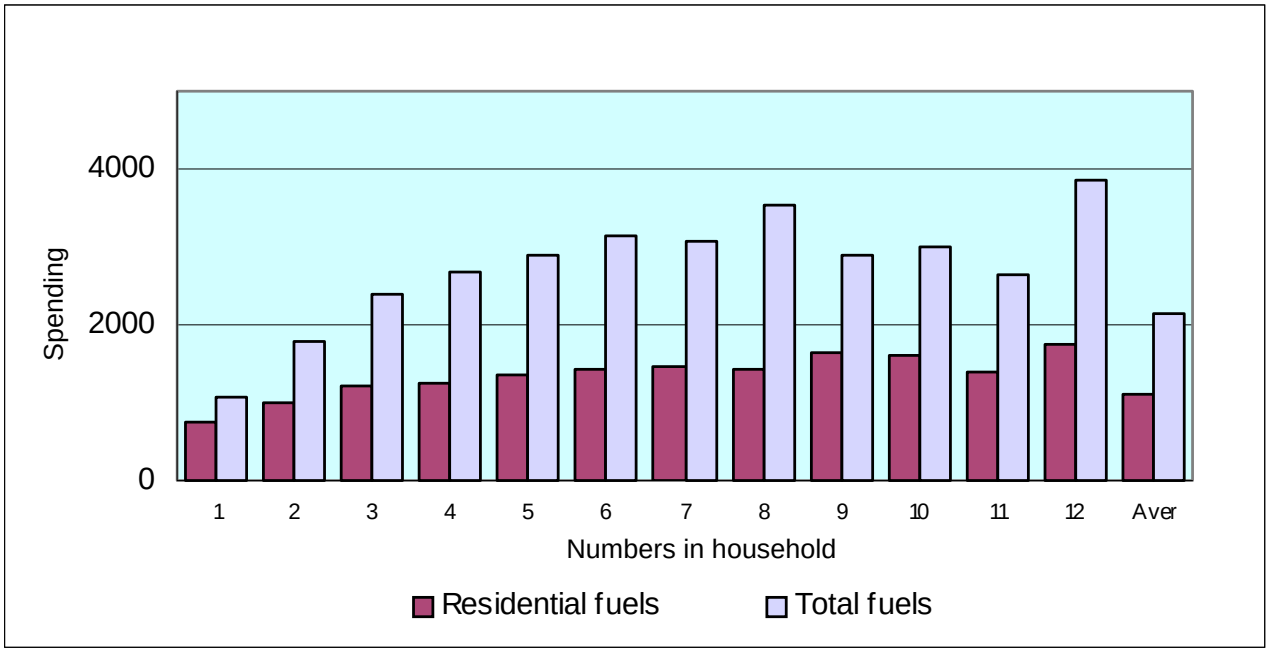
Fuel	Deciles of Gross Household Income										Average
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	household
	≤ €132.08	≤ €214.46	≤ €306.03	≤ €411.89	≤ €531.57	≤ €664.60	≤ €810.95	≤ €1016.84	≤ €1339.34	> €1339.34	
Gas	0.0089	0.0109	0.0115	0.0110	0.0153	0.0176	0.0207	0.0199	0.0274	0.0365	0.0180
Electricity	0.0332	0.0442	0.0536	0.0614	0.0637	0.0694	0.0724	0.0779	0.0772	0.0909	0.0644
Anthracite	0.0006	0.0017	0.0007	0.0007	0.0005	0.0003	0.0005	0.0010	0.0013	0.0008	0.0008
Coal	0.0351	0.0347	0.0334	0.0350	0.0255	0.0242	0.0245	0.0201	0.0189	0.0157	0.0267
Turf loose	0.0321	0.0363	0.0318	0.0230	0.0252	0.0225	0.0261	0.0187	0.0192	0.0131	0.0248
Turf briquettes	0.0118	0.0080	0.0080	0.0058	0.0054	0.0042	0.0050	0.0075	0.0045	0.0067	0.0067
Central-heating oil	0.0187	0.0223	0.0257	0.0308	0.0311	0.0393	0.0366	0.0448	0.0463	0.0529	0.0348
Paraffin oil	0.0001	0.0000	0.0000	0.0003	0.0000	0.0002	0.0000	0.0001	0.0005	0.0004	0.0002
Liquid petroleum gas	0.0018	0.0021	0.0019	0.0014	0.0013	0.0018	0.0016	0.0016	0.0020	0.0010	0.0017
Motor fuel: petrol	0.0078	0.0159	0.0244	0.0364	0.0447	0.0537	0.0603	0.0698	0.0794	0.0906	0.0483
Motor fuel: diesel	0.0010	0.0024	0.0050	0.0068	0.0109	0.0171	0.0137	0.0129	0.0163	0.0141	0.0100
Motor fuel: LPG auto	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total weekly tonnes CO_2	0.1511	0.1784	0.1960	0.2126	0.2238	0.2502	0.2615	0.2743	0.2929	0.3227	0.2364
Annual tonnes CO_2	7.8580	9.2783	10.1930	11.0563	11.6401	13.0122	13.6004	14.2635	15.2287	16.7792	12.2909

Appendix 6

Carbon tax (€/year by decile) broken down into residential and transport components.

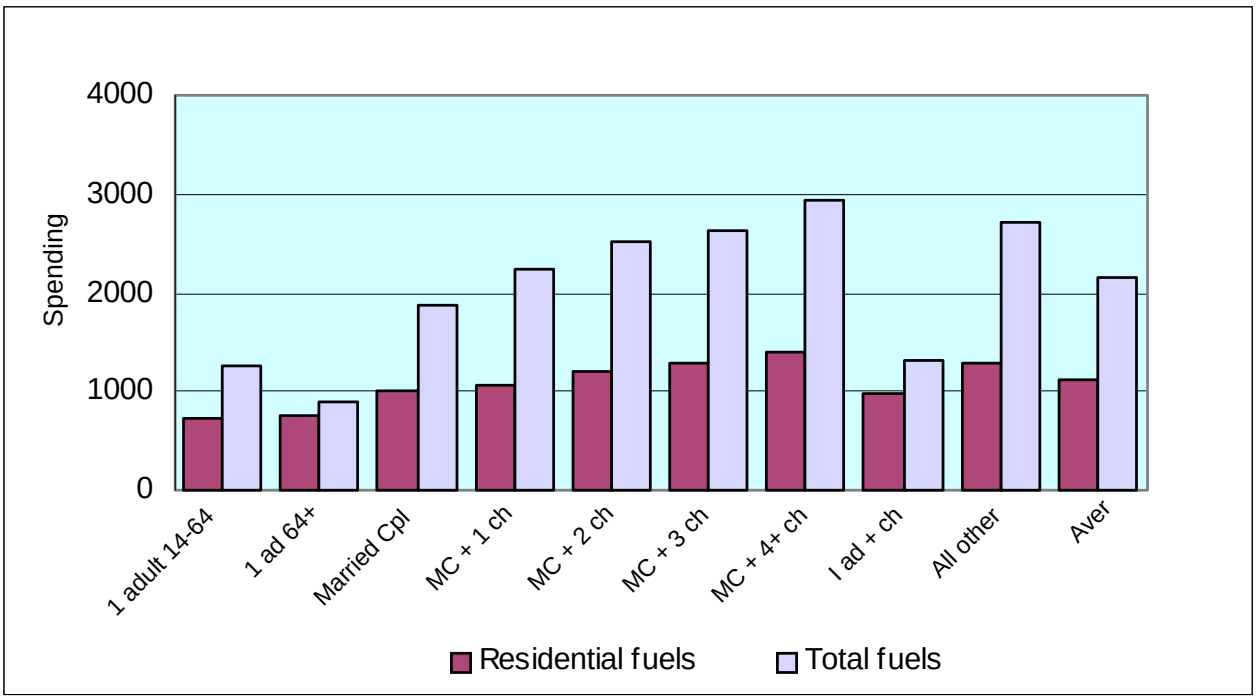
Deciles	1	2	3	4	5	6	7	8	9	10	Average
Residential	148	167	173	176	175	187	195	199	205	227	185
Transport	9	19	31	45	58	74	77	86	100	109	61
Total	**157**	**186**	**204**	**221**	**233**	**260**	**272**	**285**	**305**	**336**	**246**

Appendix 7



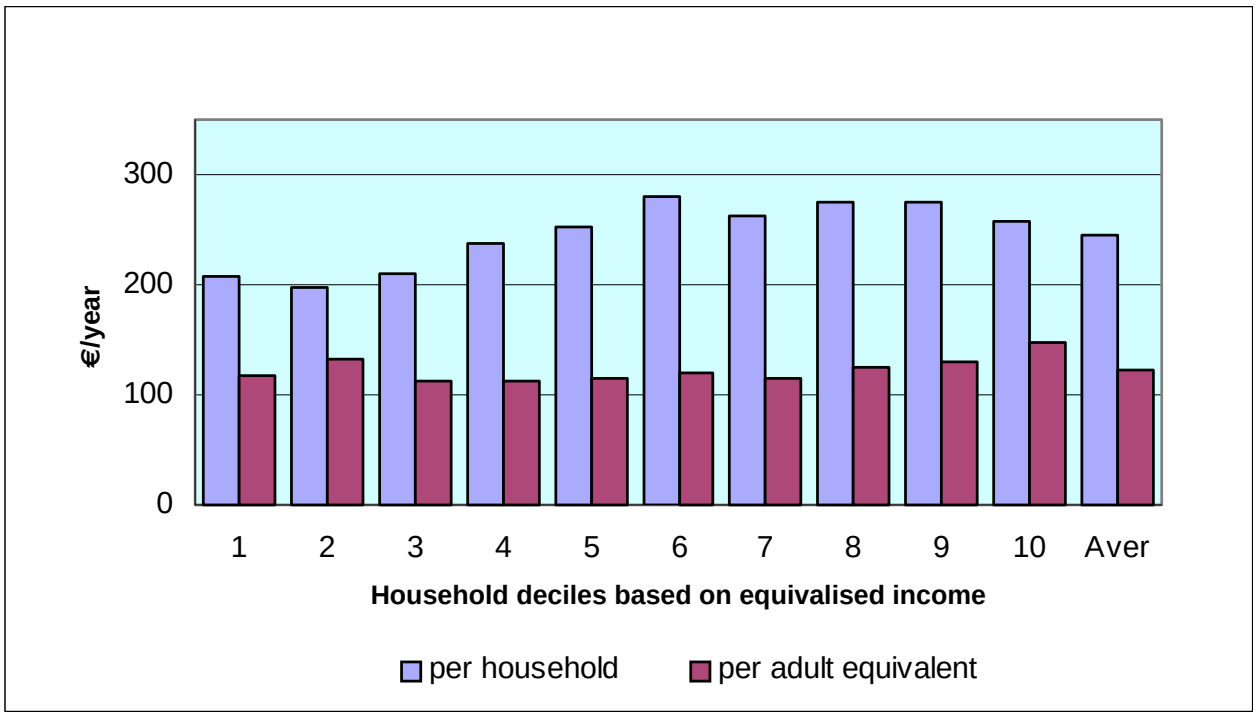
Spending on fuels per household by numbers in the household, €/year.

Appendix 8



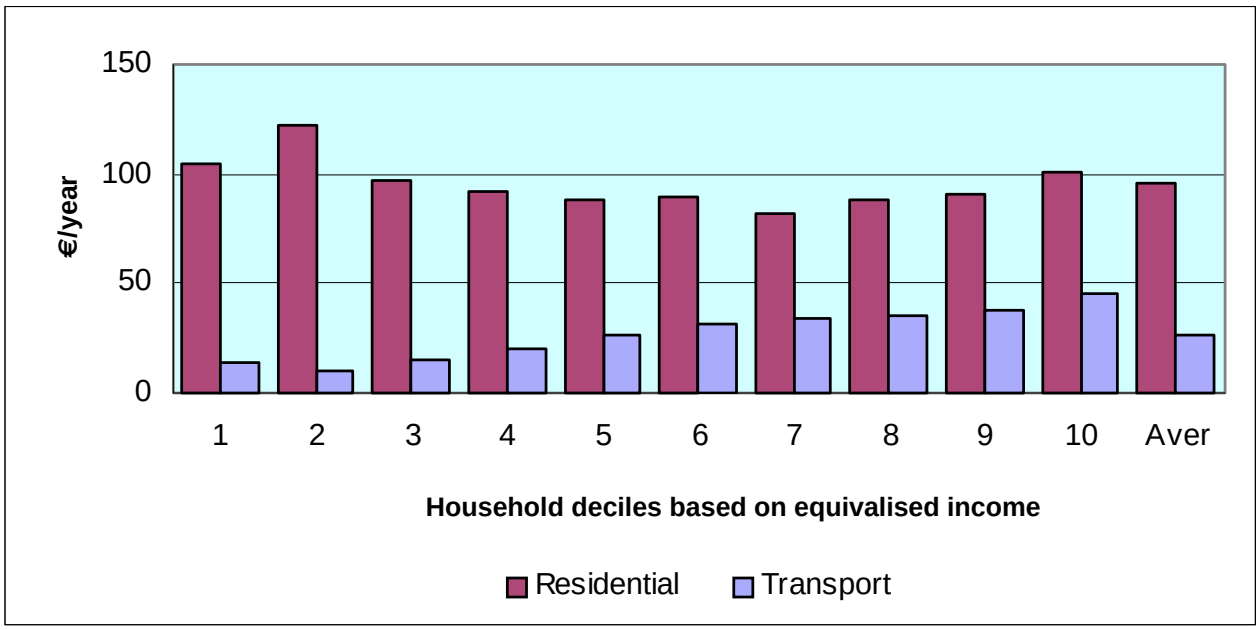
Spending on fuels per household, by household composition, €/year (1 adult 14–64, one adult aged 14 to 64 years; ad, adult; MC, married couple; ch, child or children).

Appendix 9



Carbon tax per household and per adult equivalent, by deciles of equivalised income, €/year.

Appendix 10



Carbon tax per adult equivalent, broken into residential and transport components, €/year.