MAY 2012

Carbon taxation and fiscal consolidation:

the potential of carbon pricing to reduce Europe's fiscal deficits

An appropriate citation for this report is:

Vivid Economics, *Carbon taxation and fiscal consolidation: the potential of carbon pricing to reduce Europe's fiscal deficits*, report prepared for the European Climate Foundation and Green Budget Europe, May 2012

A collaboration between the European Climate Foundation and Green Budget Europe, in association with Vivid Economics. Prepared for submission to the Grantham Institute at the London School of Economics.

Acknowledgements

This report has benefited from the expertise and contributions of many individuals. First and foremost we would like to thank the CETRiE project team, who have provided us with useful input and feedback throughout the drafting of this report: Michael Jacobs, Stephen Boucher, and Tom Brookes from the European Climate Foundation; and Kai Schlegelmilch, Constanze Adolf, and Jacqueline Cottrell from Green Budget Europe. We would also like to thank Hector Pollitt and Yuee Zhao at Cambridge Econometrics, who have assisted us with the macroeconomic modelling in the most expert fashion. We are grateful to Stefan Speck for reviewing this work; it is much improved by his comments.

Furthermore, we would like to thank a number of national experts who have very kindly provided us with insights into their respective countries as well as commenting on the report: Xavier Labandeira, Tomasz Żylicz, Mireille Chiroleu-Assouline, Paul Ekins, Lukács András, and Swantje Küchler. Further input and clarifications were provided by Kornél Varsányi and Tomasz Terlecki. The report has benefited enormously from their range of expertise and perspectives.

The modelling of energy taxes and their display as energy tax curves has profited from fruitful discussions with Chiara Martini and Michelle Harding from the OECD. The contents of chapter 8 of this report have been improved by helpful comments from participants at a seminar at the Australian National University on 15 March 2012 and Vivid Economics is grateful to Frank Jotzo for organising the seminar and to him and Steve Hatfield-Dodds in particular for their comments.

Executive summary

The benefits of carbon pricing for closing deficits

The overriding challenge for many European governments today is to reduce major fiscal deficits with the least collateral damage to the economy. This report shows that carbon fiscal measures may raise significant revenues while having a less detrimental macro-economic impact than other tax options. This gives them an important potential role in fiscal policy; a role that is currently widely overlooked. This benefit arising from carbon fiscal measures goes beyond the usual arguments in their favour – namely that they are crucial, cost effective instruments to reduce Europe's greenhouse gas emissions.

Carbon fiscal measures offer two specific opportunities for governments:

1. They can introduce and/or increase national taxes on energy consumption. We explore these national tax reform opportunities through case studies of Hungary, Poland and Spain. These countries were selected for their fiscal deficits, their diverse locations, their different sizes, as well as for the range of economies that they represent. The analysis of these three countries may therefore provide insights for other member states even though particular circumstances, and hence policy, vary from member state to member state.
2. They can support reform of the European Union Emission Trading System with the potential to generate significant revenues.

We also present a detailed review of the existing carbon energy tax structure in the following six countries: France, Germany, Greece, Italy, Portugal, and the UK.

Energy taxes: an attractive way to raise fiscal revenues

In each of the three countries that we examine – Spain, Poland and Hungary – modelling suggests that energy taxes would cause less economic harm per unit of revenue than direct (i.e. income) or indirect taxes, while also producing other benefits.

- Direct taxes could have twice as much negative impact on GDP as energy taxes which raise the same revenues between 2013 and 2020. Indirect taxes (VAT) appear less damaging than direct taxes but still tend to perform slightly worse than energy taxes. In many cases, a key factor is that energy taxes lead to a reduction in imported energy. In other words, the decline in production and economic activity takes place outside the country (and in these cases often outside Europe). This has the added benefit of improving energy security.
- All taxes have similar employment impacts, although indirect taxes (VAT), which particularly penalise the retail sector (which is labour-intensive), tend to perform worst.
- Of course, energy taxes are also much more effective at reducing emissions. By 2020, the packages examined cause CO_2 emissions to fall by between 1.5 and 2.5 per cent relative to the baseline. The other taxes make no meaningful impact on emissions.

A valid concern regarding energy taxes is that they are regressive. Our analysis confirms this in one respect: energy taxes reduce the spending power of lower income households and other disadvantaged groups by proportionally more than the spending power of higher income households. However, the evidence also indicates that lower income and disadvantaged households may suffer even greater losses under direct or indirect taxes, as the greater squeeze on overall economic activity affects all social groups, including the most disadvantaged.

The report suggests that concerns over the regressive impact of energy taxes can be alleviated, with preferred options likely to vary from country to country. None is perfect, but each largely resolves the problem by using a small proportion of the revenue raised to off-set negative impacts on low income groups.

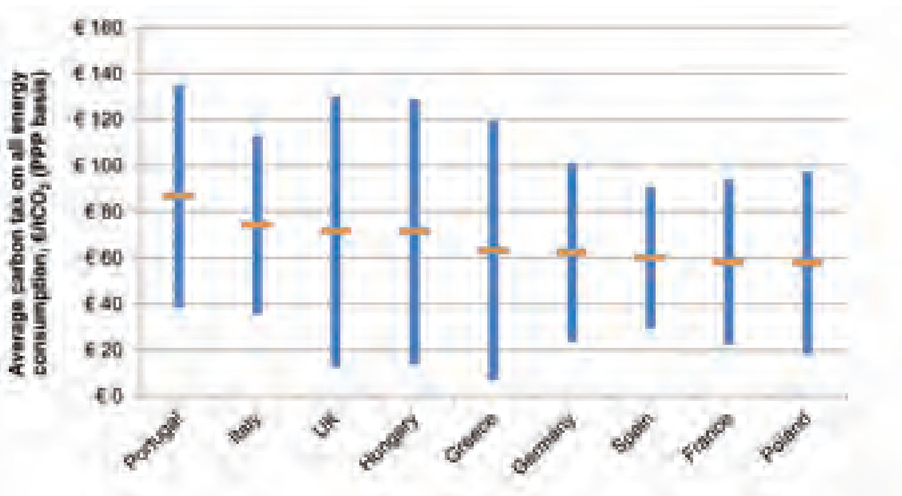
Scope for improving tax design

The amount of revenue that can be raised depends on which energy taxes are raised and by how much. The impacts described above reflect packages of reform chosen on the basis of a detailed review of the current profile of national energy taxes in Spain, Poland and Hungary. The same detailed review of national energy tax profiles was completed for a further six European countries: France, Germany, Greece, Italy, Portugal, and the UK. For each one, we converted current energy taxes into a rate per tonne of carbon dioxide. Economic analysis suggests that for maximum effectiveness and efficiency, the implicit rate should be sufficiently *high* that the tax induces changes in behaviour and be sufficiently *similar* across sources of emissions to ensure that behaviour changes wherever it is most cost effective to do so. In addition, taxes should focus on economic activity that is not covered by the EU ETS, to prevent double-burdening certain activities. In this way, the costs of raising revenue can be kept minimal.[1]

Judged against these two criteria, the report finds that current fiscal practice is far from optimal. In the three chosen countries, significant sources of emissions, including emissions from household energy consumption, are not taxed at all. Moreover, the pattern of taxes on commercial and industrial energy use is highly irregular, and in transport the implied CO_2 tax rate on diesel is much *lower* than that for petrol, despite its higher CO_2 content. If progress was made towards removing these discrepancies (as is broadly suggested by current proposals for reform of the European Union Energy Tax Directive) the effect would be to raise substantial amounts of revenue: between 1.0 per cent and 1.3 per cent of GDP in 2020 could be raised in each of the three countries (focussing on sectors not covered by the EU ETS).[2] This equates to more than €10 billion per annum in Spain, more than €5 billion per annum in Poland and more than €1 billion per annum in Hungary. With regards to current budget deficits, and in light of the need for fiscal consolidation, these revenues can make a significant contribution: in the short run (by 2013), they could reduce deficits by 4 (Poland) to 8 (Hungary and Spain) per cent of 2011 deficits; over the medium run (by 2020) the annual reduction increases to: 50 per cent of the 2011 deficit for Hungary, 25 per cent for Poland, and 15 per cent for Spain.

As an illustration of the scope for energy tax reform, figure 1 shows the average implied CO_2 tax rate on energy consumption in nine countries and a measure of the variation in rates within the country. To our knowledge, this is the first time these calculations have been made.

Figure 1. **Energy taxation: there is significant variation both within and between European countries**



Note: *Yellow bars indicate the weighted average for each country; blue boxes indicate the size of a standard deviation for each country, not minimum and maximum tax rates. PPP is purchasing power parity and takes account of the relative purchasing power of a euro/domestic currency converted to euros at market exchange rates.*

Source: *Vivid Economics*

1 As discussed in the body of the text, there are other externalities that can also justify energy taxation, most notably in relation to the consumption of transport fuels. The tax rates across fuels should reflect the magnitude of the externalities they cause.

2 For illustration, 1 per cent of EU-27 GDP in 2011 was approximately €130 billion; 1 per cent of German GDP approximately €26 billion; 1 per cent of UK GDP approximately £15 billion; and 1 per cent of French GDP approximately €20 billion.

The figure shows substantial variation in tax rates between and within countries. Between countries, Portugal taxes CO_2 more heavily than any other country, at around 50 per cent more than Poland or France. Within countries, the discrepancy in implied carbon tax rates is largest within the UK and Greece. This suggests further significant revenue raising potential from energy taxes in these countries as well.

EU ETS reform is a similar opportunity

There is a similar opportunity to reduce deficits through reform of the EU Emissions Trading System (EU ETS). Up to now, the debate on whether the EU should increase its emissions reduction target[3] has centred on whether the additional emissions reductions are worth the additional cost, given the wider international context. An alternative perspective is to ask whether the macroeconomic impacts of raising government revenues in this way are better or worse than the alternatives.

This report examines that question, and yields important insights. First, substantial revenues are available. By tightening the EU ETS cap and thus raising the carbon price, a further €30bn (0.20 per cent of 2013 EU GDP) of additional auction revenues might be raised across Europe on average per annum. Second, the macroeconomic costs of raising revenue in this way may be smaller than the costs of levying direct taxes of the same size: over the period 2013-2020 modelling analysis suggests that the cumulative loss in GDP from raising direct taxes could be around 50 per cent greater than from reforming the EU ETS. Employment losses from a tightening of the EU ETS might be only around one third of those that would result from higher direct taxes.

Beyond 2020: Longer term EU ETS reform options

The main focus of this report is on options for deficit reduction in the period to 2020. But carbon pricing can be used to raise revenues beyond 2020, indeed through to 2050. The EU's ambitious objectives for 80-95 per cent decarbonisation by 2050 will involve further tightening of the EU ETS cap. Already, the EU ETS Directive states the intention of moving to full auctioning of allowances by 2027. This is a significant fiscal prize: were it possible to introduce full auctioning earlier, by 2020, the amount of revenues raised by the EU ETS in 2020 would be more than €30 billion greater per annum (around 0.17 per cent of 2020 EU GDP).[4]

However, without a global agreement on emissions reduction which requires other economies to introduce comparable measures, further tightening of the cap will be hard to implement without additional measures. Some sectors have legitimate concerns about carbon leakage and declining competitiveness. Adjustments to the prices of traded goods, based on a measure of the greenhouse gases embodied in the goods, sometimes known as border carbon adjustments (BCAs), could alleviate these concerns. At present concerns over competitiveness are addressed by giving free allowances to potentially affected sectors. As mentioned above, a fiscal prize of up to €30 billion is thereby foregone; a cost which might be avoided partly by replacing free allocation with BCAs as the policy instrument to address competitiveness issues. BCAs could also preserve competitiveness more effectively than free allowance allocation: the modelling indicates that BCAs might cut output losses from carbon leakage in affected sectors by up to two thirds.

BCAs in their currently-discussed forms are not welcomed by some of Europe's major trading partners. Their concerns may be addressed through better design. This report proposes a new *smart* form of BCAs. Smart BCAs are calibrated to a trading partner's income level and take into account capacity to mitigate emissions. They also benchmark against other countries, comparing their carbon prices. The report explains some relatively simple mechanisms that could achieve these benefits.

3 From a 20 per cent reduction of greenhouse gases compared to 1990 levels by 2020, to a 30 per cent reduction by 2020.

4 In the case that the EU ETS cap was also tightened.

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1 Introduction

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Introduction

Aims and structure

This section explains the aims of the report and its relevance in the current political debate on fiscal re-balancing as well as proposed changes to the EU Energy Tax Directive and the EU Emissions Trading Scheme.

1.1 Aims and rationale for the study

This section explains the motivation behind the study, why it is of interest, what it aims to show and how it is different from what has come before.

1.1.1 Overall aims and rationale

The aim of the project is to assess the potential for carbon pricing to contribute to fiscal re-balancing in Europe while securing growth, competitiveness and fairness. It examines reforms to the energy taxation systems of a selection of European countries and to the emissions trading scheme for the EU as a whole. It compares both of these to the alternative: higher conventional taxation. For the selection of countries, this is a new, comprehensive and rigorous analysis of the outcomes from carbon pricing reforms.

The argument is constructed from five blocks of evidence. The first is an analysis of current carbon-energy taxes across a sample of one third of all member states, which are summarised graphically as energy tax curves. This reveals a great deal about current fiscal practice. The second block tests the economic impacts of a set of rational tax reforms which draw from the European Commission's recent proposals and from economic principles, and compares their performance with equivalent labour and value added taxes. This shows how reforms could be taken forward and enumerates their benefits. The third block considers the distributional effects of tax reforms and ways in which those effects could be modified to satisfy social policy objectives. Again, the discussion is accompanied by quantitative evidence to give the argument a firm foundation. The fourth block takes the same approach to economic investigation and applies it to reform of the EU ETS so that all energy consumption within the EU is covered either by the second or fourth block of analysis. Finally, having noted the high fiscal burden of the current arrangements for protection of trade-exposed energy intensive industry, longer-term alternatives in the form of border carbon adjustments are developed and put through the same quantitative economic examination as before.

The release of this work is timed to inform political discussions over fiscal reform at national level and on reform of energy taxation and emissions targets at European level.

- Fiscal consolidation remains a key policy driver in many EU countries. On 2nd March 2012, 25 European leaders signed the Treaty on Stability, Coordination and Governance containing a fiscal compact to limit the structural (cyclically-adjusted) deficit to 0.5 per cent (and for low-debt countries, 1.0 per cent) of gross domestic product. The Treaty also requires that general government debt does not exceed, or is sufficiently declining towards, 60 per cent of gross domestic product at market prices. Member states in non-compliance will be subject to the excessive deficit procedure (European Union, 2012, Article 3).
- A proposal to amend and restructure the Energy Tax Directive, proposed by the Commission in April 2011 is currently under discussion (European Commission 2011d);
- A discussion on whether to extend greenhouse gas emissions reduction targets beyond 20 per cent by 2020 (European Commission 2012) is also ongoing.

1.2 Structure of the report

The report is structured as follows:

Section 2 explains the historical experience with environmental tax reform (generally) and efforts to use taxes and other market based measures to tackle externalities from energy consumption (specifically). It illustrates that previous efforts at reform have typically been successful both economically and environmentally but, despite this, have often received a lukewarm reaction. This is supplemented by an analysis of the theory of indirect taxation, provided in Annex A.

Section 3 sets out the current profile of energy taxes,[5] expressed per tonne of CO_2, in nine EU countries. It shows that despite efforts at European harmonisation, not least the EU ETS, there are substantial differences in the effort directed by fiscal policy towards tackling emissions both within and between countries.

Section 4 assesses the options for national governments to raise revenues through a revised approach to energy taxation. It looks in detail at the opportunities for domestic energy tax reform in three EU countries: Hungary, Poland and Spain. These three countries represent a range of sizes, locations, and economic structures. In addition, they all require fiscal tightening to various degrees. Even though circumstances and policy requirements vary from member state to member state, this selection may therefore be useful to a number of states. It presents modelling analysis which shows that specific energy tax reforms are likely to have smaller negative impacts on GDP and employment than an alternative package of conventional taxes raising the same amount of revenue.

Section 5 gives more detail of the distributional impacts of the reform packages for Spain, Hungary and Poland. It also explores ways to ameliorate the regressive impacts of such reforms; one of the main stumbling blocks to their implementation.

Section 6 considers proposals at the European level for the harmonisation of energy taxes. An analysis of the European Commission's current reform proposals shows them to be broadly well-structured, though leaving room for improvements in certain respects. The latter half of the section outlines relatively modest amendments that seek to combine economic efficiency with political viability.

Section 7 looks at options to raise revenue from reform to the EU ETS. It shows that, compared to direct tax increases, a tightening of the cap and auctioning may be better for the EU and for the majority of its member states individually. It explains that each freely handed out allowance increases the macroeconomic costs of the EU ETS, independent of the tightness of the cap or the allowance price. Hence the smaller the proportion of allowances allocated for free, the more attractive the EU ETS becomes as a means of raising revenue.

Section 8 looks at the options beyond 2020 and at remedies for carbon leakage in emissions intensive trade exposed (EITE) sectors. One such policy option is the introduction of border carbon adjustments (BCAs). BCAs place a tax on the carbon content of imported goods, while providing a refund (again in line with their carbon content) on exported goods. It suggests that *smart* border-carbon adjustments, which we define as taking account of the principle of common but differentiated responsibility (CBDR) as well as of domestic carbon pricing efforts, could overcome some of the problems of existing designs while raising further revenues.

Appendices A to F contain descriptions, assumptions, caveats, as well as more detailed results from the two models used in the report. The Appendices further describe the three national tax reform packages introduced in section 4, the literature on BCAs, and the interactions between BCAs, World Trade Organisation (WTO) rules, and international climate change treaties.

5 Both including and excluding the EU ETS.

2

Energy tax reform: experience and theory

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Energy tax reform: experience and theory

Experience from past energy tax reforms in Europe

This section sums up the lessons from past energy tax reforms around Europe. Experience shows that carbon energy tax reform (and environmental tax reform more generally) has delivered environmental improvements and boosted economic performance while often being met with staunch political resistance.

To accompany this empirical overview, this section includes a brief discussion of the merits of hypothecation and earmarking. Taking hypothecation to mean a strict link between a tax and a spending programme, and earmarking to indicate a looser contribution to a programme, we find that hypothecation may not be optimal for energy taxes, though there may be a role for earmarking.

The interested reader is directed towards Annex A for further detail on the economic theory underpinning energy and carbon taxation. Four major debates are visited in the Annex: the rationale for energy taxation and optimal tax theory; the double dividend of environmental tax reforms; Porter's hypothesis about tax-induced innovation; and the Green Paradox. Ultimately none of these debates deliver decisive arguments either in favour or against carbon energy taxation, though they highlight some of the most important issues surrounding it.

2.1 Lessons from experience with carbon-energy tax reform

Generally successful in reducing greenhouse gas emissions

This section describes past analysis and experience of energy tax reform from across Europe, covering Germany, the UK, Sweden, Denmark, the Czech Republic, Estonia and extending to British Columbia. Key lessons are drawn out with examples highlighting, where appropriate, contradictory evidence.

Summary details of the some of the key examples of environmental tax reform, focussing particularly on those taxing energy and/or carbon emissions, are listed in table 1.

Table 1. **Environmental tax reforms have been introduced in many countries**

Country	Details of carbon-energy taxes
British Columbia	• taxation of all CO_2 emissions from the burning of fossil fuels within the province – c. 70% of total GHG emissions in British Columbia (Ministry of Finance British Columbia, 2008) • phased implementation from 2008 to 2012 initially set at C$10 per tonne of CO_2, increasing by C$5 per year to C$30 in 2012 (id.) • tax benefits to protect working families • from FY09 to FY14, cumulative revenue is estimated at C$4.9bn, and tax relief at C$6bn, with 41% of the relief directed to individuals and 59% to businesses (Ministry of Finance British Columbia, 2011)
Czech Republic	• implicit ETR phase (1995-2006): excise taxes on fuel increased, labour taxes and profit taxation decreased, although no explicit link drawn between the two (Šauer & Vojáček, 2009) • in 2008, new energy taxes were introduced to comply with the EC Directive No. 2003/96 (some exemptions); later in the same year, income taxes were cut – 15% flat rate for individuals and corporate profit taxation lowered from 24% to 21% (Šauer, Vojá ek, Klusák, & Zimmermannová, 2011) • between 2009 and 2013 air emission charges will increase in phases (SO_2, NO_x, PM. VOC) (id.) • SSC paid by both employees and employers reduced by 1.5% since 2009 (Šauer & Vojáček, 2009)
Denmark	• long tradition of energy taxes – petrol taxes since 1917, electricity since 1977, coal since 1992; CO_2 introduced in 1992 for households and in 1993 extended to businesses (Speck & Jilkova, 2009, p 27:32) • CO_2 introduced at a rate of 100DKK (€13.4)/tonne, nominal rate constant till 2005, then reduced to 90DKK (€12.1) per tonne; tax burden of the industry increased gradually during 1996-2000, then remained constant till 2004 (id.) • phase I (1994-98) aimed at households - tax reduction amounted to c. 2.3% of GDP in 1998, partly offset by increased revenues from ETR of 1.2% and payroll taxes of 1%; additional environmental taxes introduced (id.) • phase II (1996-2000) aimed at industries - tax shift smaller (0.2% of GDP); contributions to national insurance lowered by 0.11 percentage points in 1997, 0.27 in 1998, 0.32 in 1999 and 0.53 in 2000 (id.) • phase III (1999-2002) aimed at households - tax shift of 0.3% of GDP in 2002; higher revenues from environmental and corporate taxes used to reduce personal income tax rates and taxes on the yield of pension savings and share yields (id.) • new raft of proposals was adopted by Parliament in 2009 and will come into force between 2010-2019 – increased energy taxes, reduced marginal tax rates on labour income (The Danish Ministry of Taxation, 2010)
Estonia	• 2005: increase in pollution charges and natural resource taxes; income tax reduced from 26 to 24% and tax free allowance raised from 16,800 EEK (€1074) to 20,400 EEK (€1304) (Ministry of Finance of Estonia, 2009) • 2006-2008: - increases in transport fuel taxes (petrol and diesel) to EU minima, and introduction of tax on electricity; income tax gradually reduced to 21% and tax free allowance gradually increased to 27,000 EEK (€1,726) (id.) • 2009, 2010: further increases in excise rates, and relevant excise rates now higher than EU minimum rates, and linked to inflation (Schlegelmilch, 2011)
Germany	• 1999-2003: substantial increases in duties introduced in five phases: • overall, 31% increase in petrol duty, 48% increase in diesel, 50% in light heating fuels, 100% increase in natural gas • in 2003 reforms raised c. €18.6bn , (0.9% of GDP), in 2009 €18.9bn (0.7% of GDP); energy tax rates frozen since 2003 – as a result, their real value has fallen, and the revenues earmarked for reducing SSC have fallen as well • c. 89% used to reduce social security contributions (split 50:50 between employer and employee contributions). Public pension contribution rate 1.8% lower than otherwise • c. 10% for fiscal consolidation, c. 1% to promote renewables • 2005: a heavy vehicle charge on motorways was introduced and slightly extended to some other roads in 2011 • 2011: a nuclear fuel tax and an aviation tax were introduced while the reduced energy tax rates for industry were cut back to reduce environmentally harmful subsidies

Slovenia	• Slovenia was the first of Central and Eastern European Countries to introduce a carbon tax in 1997, at a rate of 1000SIT/€4.2 per tonne; it applied to all energy products, with the exception of coal used in energy production, exempt till 2003 (Speck & Jilkova, 2009, p 41:2) • raised to 3000SIT (€12.5) per tonne in 1998 (id.) • tax base is a pollution unit, defined in terms of carbon weight (id.) • revenues are not hypothecated (id.) • CO_2 tax for transport fuels was introduced as of October 1, 2011 (OECD and EEA database) • in December 2010, the Government Climate Change Office proposed a green tax reform that could increase Slovenia's CO_2 tax revenue by a factor as high as ten in the period 2030-45. The long-term carbon strategy is currently open to public debate and will last at least until the end of February 2012 (personal communication from the Government Climate Change Office, October 2011)
Sweden	• long tradition of energy taxes – petrol taxes since 1917, diesel since 1937 (Speck & Jilkova, 2009, p 42:6) • SO_2 tax (1991); NO_x charge (1992) (id.): CO_2 tax (1991) - €23/tonne – personal income tax reduced by c. SEK71bn/€9.5bn in 1991 (4.6% of GDP): average tax rates reduced by 30% or more (id.); 2001-2007: shift away from income tax with higher rates on CO2 and energy tax resulted in: €1.34bn reduction in income tax paid by low- and medium-income households; €220m reduction in social security contributions (id.) • 2008: major increase in CO_2 tax (in 2010 it stood at €108/tonne); revenue from labour taxes reduced by €7.4bn between 2007-10 (id.) • recent redesign of the carbon-energy tax regime in order to improve coordination with EU ETS (Ekins and Speck 2011, and personal communication from the Ministry of Finance, October 2011)
UK	• 1990s: Fuel Duty Escalator (FDE) - increased duties on fuel by 3% above rate of inflation (1993-94); 5% (1994-5 to 1997-8) and 6% in 1998-99 • 2001: Climate Change Levy on non-domestic consumption of electricity, gas, solid fuels and LPG: revenue neutral through reduction in employers' national insurance contributions; represents a relatively small share of tax receipts (raised £523m in 2009/10, ~0.1% of GDP) • reductions of 65% are available for energy-intensive industries, rising to 80% for electricity in 2013 • approx. 5% of revenues is channelled to investments in energy efficiency (via the Carbon Trust)

Source: Vivid Economics based on sources mentioned in the table

2.1.1 Sources of evidence and estimates

There is a substantial body of academic and consulting work on environmental tax reform and energy/carbon tax reform. The European Commission conducted a review of much of the evidence in a three-year project from 2004 to 2007. The Commission's project was called Competitiveness Effects of Environmental Tax Reforms (COMETR). It is selectively summarised in the discussion in the following paragraphs. The same researchers completed a sister project, named Productivity and Environmental Tax Reform in Europe (PETRE), which is also covered here.

Many of the results quoted from the project were obtained from a macroeconomic model called the Energy-Environment-Economy Model of Europe (E3ME) model, built and operated by Cambridge Econometrics. This model is also used later in this report. The sister project, PETRE, used both the E3ME model and another model called Global Inter-industry Forecasting System (GINFORS).

Quantitative analysis of the impacts of carbon and energy taxes and emissions trading schemes can be taken forward in one of two ways. First, the *ex post* empirical study of market outcomes, using statistical techniques. Second, *ex ante* simulations. The latter make use of either whole economy models, suitable for estimating tax interaction, inflation, and whole economy output and employment effects, or sectoral models, specifically designed to probe the impacts on firms specialising in a single activity.

One can further divide the whole economy models into two sub-types. This allows better understanding of the strengths and limitations of each. The first type is the computable general equilibrium model and the second the econometric macro-model. The general equilibrium type has strong theoretical foundations and, in particular, forces markets to clear, i.e. for prices to adjust so that supply meets demand. They capture the changes in the long term 'equilibrium' of the economy. The econometric macro-models use statistical relationships between variables derived from historic data and assume that past relationships continue to hold in the future. They are less reliant on theoretical assumptions. A further discussion of the merits of these two modelling approaches is provided in Appendix A.

General equilibrium and other macro-economic models have the advantage that they link together all or most parts of the economy. Consequently, changes in one or more sectors affect demand for factors of production (such as labour and capital) and so may result in changes in factor prices, with ripple effects through the economy and further adjustments in the sector(s) of interest. In contrast, the sectoral models explore partial equilibria which are isolated from the rest of the economy, and thus take into account no changes in factor prices or other wider economic responses.

Although they have this useful comprehensive, ripple-effect property, the general equilibrium and macro models involve certain compromises. One of the most significant is that they typically rely on portraying the economy through a series of aggregated sectors. Any differences within these sectors is lost. This may be especially important when estimating competitiveness effects as the nature of competitive interaction is likely to vary significantly within a sector.

In summary, the macro models are well suited to exploring economy-wide impacts on prices, output, fuel use and employment, and less well suited for exploring competitiveness effects and carbon leakage. The sectoral models perform well on competitiveness, but cannot address impacts on macroeconomic variables.

Let us turn to the results from these models.

2.1.2 Energy use

Recent European modelling of carbon-energy taxes shows a reduction in fuel demand and an increase in both energy and carbon productivity. The fuel use reductions were of the order of a few per cent when estimated by the COMETR project for the carbon-energy tax reforms implemented in the following seven countries: Denmark, Finland, Sweden, Germany, the Netherlands, the UK and Slovenia.

For example, by 2012, fuel demand was estimated to have been 4 per cent lower across Sweden, Denmark, UK, Netherlands, Finland and Germany, than it would have been without carbon-energy taxes (Barker, Junankar, Pollitt, & Summerton, 2009). Agnolucci estimates a fall in energy consumption as a result of British and German environmental tax reforms and found it ranged from 2 per cent in the financial sector to 4 per cent in the electrical and optical equipment sector in the UK. In Germany, it amounted to 3 per cent in the pulp, paper and printing sector (Agnolucci, 2011, p 161:4).

More narrowly, Salmons (2011) estimated the effect of the road transport Fuel Duty Escalator in the UK. This was a policy to increase the rate of excise tax in transport fuels at a rate above that of inflation. Had it been maintained at 6 per cent above inflation throughout the 2000s, he suggests, demand for transport fuels in 2010 would have fallen to a quarter below the outturn figure.

2.1.3 Greenhouse gas emissions

There is a wider range of studies reporting estimated effects on carbon emissions, some examining the effects of existing taxes and some asking what effect new taxes might have.

Among the studies of existing taxes, Prognos & IER (2004) calculated that Germany's environmental tax reform saved 6.4 million tonnes CO_2 by 2003, which is around 0.7 per cent of the 1999 emissions level. Steiner & Cludius (2010) reported emissions reductions of around 5 per cent in the transport sector. A much larger effect of tax reform is reported for Sweden: according to Hammar and Åkerfeldt (2011), greenhouse gas emissions in Sweden fell by almost 9 per cent between 1990 and 2007, by which time CO_2 emissions would have been 20 per cent higher had taxes remained at the 1990 level.

For the UK, the OECD concluded that widespread exemptions had reduced the environmental efficacy of the Climate Change Levy (an energy tax). Firms that were fully exposed to the Climate Change Levy reduced the growth in their emissions by between 5 and 26 per cent more than those that were partially exempted by being participants to Climate Change Agreements (OECD, 2010, p: 232-4).

Ex-ante calculations for the COMETR project suggested emissions savings of around 5 per cent for the tax rates implemented in the countries under review. By 2012, the researchers found, greenhouse gas emissions would be between 2 and 7 per cent lower in Denmark, Germany, Finland, Sweden, Netherlands and the UK (Barker, et al., 2009, p 182:3). The largest emissions reductions were predicted for Sweden (7 per cent) and Finland (5.5 per cent). These countries have the highest tax rates out of the five aforementioned. A similar range of figures are obtained for Spain by Labandeira and Rodríguez. Here, a hypothetical energy tax recycled in the form of reductions in Value Added Tax is estimated to cut CO_2 emissions by 2.3 per cent, SO_2 by 8.6 per cent and NO_x by 5.5 per cent (Labandeira and Rodríguez, 2007).

A more extreme scenario is tested in a piece of work focused on British Columbia. Rivers and Sawyer, (Rivers and Sawyer, 2008, p:20) chose to estimate the effect of a carbon tax rate of $150/ton CO_2e (expressed in $2003). Their results suggested an emissions cut of 36 per cent by 2020 relative to business as usual in 2020. Relative to 1990, emissions decrease by 7 per cent.

2.1.4 When tax revenues are recycled

In some countries, increases in energy or environmental taxes have been accompanied by reductions in other forms of taxation with the intention of leaving the overall tax take unchanged. This has been driven by the concept of a 'double dividend', which states that a revenue-neutral energy tax reform can improve both environmental and general macroeconomic reform. Annex A provides a discussion of the economic theory behind this concept for the interested reader.

The most common implementation of revenue recycling is to reduce employer's social security contributions or income taxes in compensation. Reductions in corporation taxes are unusual and there are no examples of reductions in indirect taxation such as Value Added Tax.

Both Denmark and the UK chose (to different extents) the same path. They both recycle the revenues from their environmental tax programmes through reduced employers' social security contributions, an approach which is not inflationary and is strongly supported in tax theory (Andersen & Speck, 2009, p 129:30 and Fullerton et al., 2010). Germany took a mixed approach – revenue recycling was split equally between reductions in employees' and employers' social security contributions (Andersen & Speck, 2009, p 129:30). It also set aside 1 per cent of energy tax revenues to promote renewables. Other countries, such as the Czech Republic, Sweden, British Columbia, and Estonia, have mainly chosen to reduce income or corporate tax rates (Andersen & Speck, 2009, p 129:30, and sources from 4). In Sweden, income tax rates were reduced in 1991 to an average of 30 per cent for low income earners and 50 per cent for high income earners. Prior to the environmental tax reform, marginal tax rates were as high as 80 per cent (Blomquist, Ekloef, and Newey, 1997). In British Columbia, the corporate tax rate was reduced to 10 per cent in 2011 from 16.5 per cent in 2001.

Both *ex ante* and *ex post* studies analysing the impact of environmental tax reform with recycling tend to find positive impacts on employment and output. This is consistent with the key message from the theoretic analysis presented in Annex A: a double dividend, though not guaranteed in every case, is certainly possible; whether or not it is actually realised depends on the circumstances of each individual reform. Evidence from experience, presented below, shows a variety of cases in which it was realised.

For instance, Truger (2008) reports that most *ex post* studies of German environmental tax reform with recycling found positive employment effects of 0.15 to 0.75 per cent. For example, Kohlhaas (2005) found positive effects from environmental tax reform on Germany's output, with one example result indicating that gross domestic product was higher by 0.45 per cent in 2003, 0.3 per cent in 2005 and 0.13 per cent in 2010, and associated positive effects on net employment (in the order of 0.25 million additional jobs).

Two ex-ante studies across Europe found both a positive effect and a negative effect respectively on output from environment tax reform as a consequence of revenue recycling. They were both part of the PETRE project. One used the Global Inter-industry Forecasting System (GINFORS) model and the second, the Energy-Environment-Economy Model of Europe (E3ME). E3ME was more optimistic, predicting positive changes in EU-27 GDP to 2020 of between 0.2 and 0.8 per cent. The GINFORS model predicted negative gross domestic product change ranging between -0.3 and -3 per cent. Both models predicted positive changes in employment and negative changes in labour productivity, again with E3ME results being more optimistic (Barker, Lutz, Meyer, Pollitt, & Speck, 2011, p:224-6). These differences are due to the model specifications; GINFORS assumes labour supply to be more restricted and E3ME less restricted, and GINFORS predicts that unilateral rises in EU energy prices reduce the EU's share in international trade (Barker et al., 2011 and Barker, Lutz, Meyer, & Pollitt, 2011).

Further analysis with the E3ME model for the COMETR project found that by 2012, all six countries in its study would experience between 0.1 and 0.5 per cent increase in gross domestic product as a result of the environmental tax reforms implemented, with Finland, Denmark and Germany enjoying the largest benefits (Barker, Junankar, et al., 2009, p 180:212).

Other *ex-ante* studies report similar positive effects on gross domestic product in the range 0.1 to 1.0 per cent. In the Czech Republic, Š□asný and Piša (2009) estimated that increased emission charges under the proposed Czech environmental tax reform Phase II (see section 4) would boost gross domestic product by 0.1 per cent. Kiuila and Markandya (2005) considered a hypothetical carbon tax in Estonia (which had been introduced within an environmental tax reform) and concluded that under all scenarios, there would be a positive impact on employment of up to 1 per cent. The effect on gross domestic product was ambiguous.

A larger effect was estimated for Spain. Modelling for Spain suggested that increased energy taxation, recycled in the form of reductions in Value Added Tax, would increase gross domestic product by 1 per cent with no significant impact on wage levels or capital returns (Labandeira and Rodríguez, 2007).

2.1.5 Competitiveness impacts

The Fourth Assessment report of the IPCC, published in 2007, summarised the findings of the literature at that time as follows (Pachauri and Reisinger 2007, p. 59):

> *'Critical uncertainties remain in the assessment of carbon leakage. Most equilibrium modelling supports the conclusion in the TAR* [third assessment report] *of economy-wide leakage from Kyoto action in the order of 5-20%, which would be less if competitive low-emissions technologies were effectively diffused.'*

Economy-wide estimates may be substantially smaller than figures for individual energy-intensive, trade exposed (EITE) sectors. Both whole economy and sectoral models have been used to estimate effects on trade, output and carbon emissions. Most of that work, reported later in this report (section 8), is from whole economy models. For reasons described earlier, these may mask some of the stronger competitiveness effects which are to be found in the most vulnerable sectors.

2.1.6 Effects on households

A major concern of raising additional revenues from carbon or energy consumption is that it is regressive i.e. the negative impact of the tax reforms, expressed as a proportion of income, are larger for low-income or disadvantaged groups than for higher income groups.

Section 5, which explores the impact of the regressiveness of the reforms explored in this study, identifies four key findings from the literature on this topic:

- first, energy taxation can be, and often is, broadly speaking regressive;
- secondly, impacts vary with household characteristics other than income, such as rural/urban location, leading to large in-decile variation of impacts;
- thirdly, regressive effects vary across different types of energy taxation;
- lastly, there are some circumstances in which energy taxation is neutral or even progressive, rather than regressive.

A summary of historic evidence, suggesting that actual energy tax reform packages (including support policies) need not be regressive, is given in box 1 below.

Box 1. **Historic evidence suggests that distributional impacts can be alleviated**

Countries have historically used various revenue recycling strategies to address regressiveness, ranging from tax exemptions and tax credits to lump-sum transfer payments. When carefully targeted and well designed, these have succeeded in addressing distributional concerns.

Broadly speaking there are two main options for addressing negative distributional effects: taxation side measures (reducing income taxes or social security contributions, however this measure would leave out the unemployed and pensioners); and redistribution of revenues through support measures (Blobel et al., 2011, p 260:6). For example, low-income households in British Columbia receive a refundable 'Climate Action Tax Credit', and since 2011 an up-to-C$200 'Northern and Rural Homeowner' benefit (Ministry of Finance British Columbia, 2011). In another case, means-tested heating benefits are offered in Germany (EEA Technical Report, 2011), entirely mitigating the impact of energy price increases on the poorest households. Section 5.2 explores the pros and cons of different measures in more detail.

When the impacts of these compensatory measures are taken into account, the question of whether energy taxes are regressive becomes more ambiguous. The PETRE project used the E3ME model to examine the impact of higher energy taxes on income distribution with recycling measures in place. This found that at an EU aggregate level the reforms would generate positive changes in real income for all socio-economic groups under consideration and under all scenarios (Pollitt & Barton, 2011). Likewise, Peter et al. (2007) reported that in Sweden, the impact of the environmental tax reform was neutralised through reduced income taxes (Blobel et al., 2011). Bach (2009) showed that although slightly regressive, the German environmental tax reform was less regressive due to revenue recycling (Blobel et al., 2011, p:248).

The general conclusion from these studies is that carbon-energy taxes are regressive, but the net effect may change once revenue recycling is taken into account.

2.1.7 Public attitudes

There is a sufficient history of environmental tax reform to show that wherever the public believes that the reform is a means of introducing new tax bases or raising revenue, it is unpopular. In this, it shares the same fate as any other tax increase. There is nothing to suggest environmental taxes are less popular than conventional taxes, and so if tax increases are needed in order to reduce a fiscal deficit, the political obstacles may be similar for environmental and conventional taxes.

Like other analyses of environmental taxes, the public attitudes literature focuses on the costs and benefits of the introduction of a tax, not on a comparison with other forms of taxation. For example, as quoted in Agnolucci (2011), a significant impediment to the introduction of new (environmental) taxes in the UK has been the attitude of the public and industry. Intense lobbying from industry resulted in a reduction in Climate Change Levy rates and the introduction of exemptions. Similar opposition to environmental tax reform was seen in Germany in 2001/02. In the Czech Republic, environmental tax reform was almost brought to a halt by public scepticism (Šauer et al. 2011), and in the countries examined in detail within this study, Poland, Hungary and Spain, interviews carried out by Vivid Economics indicate that there is often little public appetite for environmental tax reform.

In the Czech Republic, various criticisms of the implementation of the energy tax reform were raised: there was no agreement among the public administrations on its main objectives, stakeholders were not invited to participate in its creation, and businesses in particular would have liked to have been involved in its design (Šauer et al. 2011). Nearly all stakeholders (including the state administration) perceived the energy tax reform as the introduction of additional taxation or charges, with the purpose of obtaining additional revenues to fund environmental projects.

Even in Denmark, one of the pioneers of a carbon tax, communication problems were reported: stakeholders were not aware of the revenue recycling and were sceptical of the government's intentions (Danish Ecological Council 2003). In British Columbia, one of the reasons quoted for the success of the carbon tax was the fact that the increases were set in advance, removing some uncertainty (Milne et al. 2008).

Despite these difficulties, there may be more support for environmental tax reform in the future, as suggested by evidence from Germany and France, where according to a study by Égert (2011) it may be possible to agree on the introduction of a carbon tax once EU ETS allowances are auctioned rather than given away. There might be more support for energy taxation if its merits relative to alternative forms of taxation were better understood and if the choice were presented as an alternative to income or value added tax. There is some strong evidence that levels of support are much higher where the choice is presented in this form (UK Green Fiscal Commission 2009).

2.2 Hypothecation and earmarking for spending programmes

While for externality-correcting taxes hypothecation is undesirable, earmarking may have a role to play

2.2.1 Arguments for and against

When thinking about using any revenues raised from environmental or energy taxes, it is helpful to distinguish between *hypothecation* and *earmarking*. Environmental taxes can feature hypothecation, 'namely the complete funding of an area of expenditure from a single tax source' (Fabian Commission on Taxation and Citizenship 2000). Alternatively, environmental taxes can feature earmarking, which is defined as any explicit connection between a tax and a spending programme: earmarking allows that a spending programme may also receive support from other sources. In assessing hypothecation and earmarking both the type of tax and the type of spending programme in question matter.

It is also helpful to distinguish taxes used to raise revenues from those used to correct an externality. A tax whose purpose is solely revenue raising could be hypothecated or earmarked without sacrificing economic efficiency. When the revenue needs of the associated spending programme either increase or decrease, the tax rate (or the allocation of revenues) can simply be adjusted accordingly. A reason to hypothecate or earmark a tax in this way would be to improve its political legitimacy (Fabian Commission on Taxation and Citizenship 2000). Examples of taxes that are hypothecated in such a way are utility bill charges which are frequently levied to pay for feed in tariffs.

However, if the tax is levied primarily for the purpose of correcting a n externality, then hypothecation can lead to problems (Fabian Commission on Taxation and Citizenship 2000). Having set the tax rate at an efficient level (ideally linked to the social costs of the relevant externality), the amount of revenue raised may not match the needs of the spending programme. Even if it matches initially, over time the tax revenues and funding requirements may diverge. In such a situation the government can either modify the hypothecation, for example, by increasing or decreasing the proportion of tax revenues going into the spending programme,[6] or adjust the tax rate away from its externality-correcting optimum, or change the funding of the spending programme. The combination of hypothecation of revenues, appropriate funding for a spending programme and an efficient tax rate is unlikely to be attainable over time.

Depending on the type of spending programme, this problem can be solved by modifying the link between revenue and spending. For spending programmes with relatively fixed funding needs, such as an energy efficiency support fund with a fixed annual budget, the required revenue could be earmarked. Instead of committing a fixed percentage of tax revenues, the government is committing a fixed sum. Moreover, if the funding needs of the programme exceed that fixed amount, additional resources may be found from elsewhere.

Such a link between tax revenue and spending may be desirable for two reasons. First, an appropriate spending programme (such as energy efficiency) may support the objective of the original tax, for example by increasing the price elasticity of demand for energy (Jacobs 1991). Secondly it may increase the tax's political legitimacy, which in turn may increase compliance. These advantages need to be compared with the inflexibility created by the link, which may prevent appropriate changes to spending programmes, or introduce inappropriate changes to the externality-correcting tax rate.

This analysis is summarised in table 2 below.

6 As long as the spending needs of the programme do not exceed 100 per cent of the revenues raised from the tax.

Table 2. **For behavioural taxes, it is preferable to earmark rather than hypothecate funds**

Type of spending programme	TYPE OF TAX: Behavioural tax (e.g. carbon tax, congestion charge)	TYPE OF TAX: Pure revenue raising tax (e.g. VAT)
Fixed budget (e.g. energy efficiency fund)	Earmarking • Tax rate driven by tax policy goal (e.g. tax pegged to cost of externality) • Tax revenues may vary • No problem as long as revenues are larger than spending needs or there is flexibility to supplement earmarked resources with other public funds	Hypothecation • Tax rate driven by spending policy funding requirements • Tax rate may vary if tax base changes, otherwise constant
Variable budget (e.g. un-capped feed in tariff)	Neither Hypothecation nor Earmarking; linkage between tax and spending policies of this type may not be optimal • Earmarking not possible due to variable spending programme needs • Hypothecation will compromise either the spending programme (if tax rate is kept constant and aligned with its goal) or the behavioural tax (if tax rate is adjusted away from its optimal rate to meet spending needs)	Hypothecation • Tax rate driven by spending policy funding requirements • Tax rate likely to vary along with size of spending programme

Source: Vivid Economics

2.2.2 Conclusions

There is past analysis and experience of energy tax reform from across Europe, including Germany, UK, Sweden, Denmark, Czech Republic and Estonia.

Specific tax measures cause a reduction in fuel demand and an increase in both energy and carbon productivity typically of between 2 and 6 per cent and exceptionally, in Sweden, up to 30 per cent. In some countries, increases in energy or environmental taxes have been accompanied by reductions in other forms of taxation. The most common implementation of revenue recycling is to reduce employers' social security contributions or income taxes. Reductions in corporation taxes are unusual and there are no examples of reductions in indirect taxation such as Value Added Tax. Tax recycling tends to offer positive impacts on employment and output.

Despite these positive economic effects, the taxes can be unpopular. Wherever the public believes that reform is a means of introducing new tax bases or raising revenue, it is unpopular. In this, it shares the same fate as any other tax increase. There is nothing to suggest environmental taxes are inherently less popular than conventional taxes.

There might be more support for energy taxation if its merits relative to alternative forms of taxation were better understood and if the choice were presented as an alternative to income or value added tax. There is some evidence that levels of support are much higher where the choice is presented in this form.

3

Current carbon-energy taxes in Europe

Room for reform

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Current carbon-energy taxes in Europe

3

Room for reform

A review of carbon-energy taxes in Europe

This section sketches the profile of carbon energy taxation in nine EU countries.

It shows the inter- and intra- country variations in rates of carbon energy taxation. It discovers a miscellany of tax rates, with some general patterns and much variation, presenting these results in a number of ways, including as energy tax curves. The most important assumptions underlying this analysis are given in this section, while a complete list of all underlying assumptions is given in Appendix B.

Despite recent efforts at European harmonisation, perhaps most successfully achieved through the EU ETS, substantial differences in the rates of carbon-energy taxation remain both within and between countries, a situation which is not economically efficient.

3.1 What the variation in carbon tax rates across Europe reveals

An efficient structure of carbon-energy taxes is a critical part of the climate policy framework

3.1.1 The importance of high and credible carbon prices

If Europe, along with its international partners, is to achieve its goal of avoiding dangerous climate change, then it will have to persuade firms and households to emit fewer greenhouse gases. Markets operate through prices, and although there are market failures which limit the responsiveness of energy users to changes in prices, without those price signals, it will be difficult, if not impossible, to change behaviour. Carbon prices, in the form of taxes and trading are an essential part of the policy prescription, and they need to be sufficiently high and sufficiently stable to promote reaction from the market.

Europe's chances of succeeding will be higher if it can keep the costs of action down, encouraging least cost actions through competitive markets. This implies the same or similar carbon-energy taxation across users, uses and fuels (after taking into account non-carbon externalities). Without a common set of signals, various costs of the following nature will be incurred:

- too much effort in some sectors and not enough in others;
- inappropriate investment in the supply and use of some forms of energy instead of others;
- carbon and economic leakage between countries as some countries introduce incentives out of step with others.

Where differences in carbon-energy tax rates exist and persist, they may misdirect investment towards fuels or uses that are relatively under-taxed. This will prevent some low cost abatement options from being implemented and push up the overall costs of reaching European and member states' emission targets. Significant differences in tax rates may also lead to inappropriate investments, which are economic in the current taxation structure, but cease to be once the tax structure fully reflects the costs of energy use. A similar effect can occur between countries, where arbitrary tax differences may encourage costly relocations of output that deliver no cost savings to society. It is therefore crucial to set energy taxes on a path towards gradual convergence to the same implicit carbon tax rates.

The European Union has targeted 2020 as the year for achieving a significant milestone in emissions reduction and has outlined challenging ambitions beyond that date. The economic scaffolding to support changes to the economy's assets by and beyond 2020 is needed well in advance, including appropriate price signals. In order to find out whether this scaffolding is currently in place, we need to ask:

- Is the coverage of price signals sufficiently broad? and
- Are they uniform?

3.1.2 Methodology

This section presents analysis of carbon-energy taxes and subsidies in nine countries, using the most recent tax, emissions and energy use data.[7] The countries examined are France, Germany, Greece, Hungary, Italy, Poland, Portugal, Spain, and the UK. They represent diversity by location, size, economic composition, wealth, hydrocarbon assets and fiscal position.

All national carbon-energy taxes are included except those applying to international shipping and aviation, as well as subsidies affecting marginal incentives. We exclude taxes that are applied at different rates at the sub-national level. Carbon-energy taxes include the EU ETS and departures from standard rates of Value Added Tax.

The steps taken were as follows:

- the taxes and subsidies were identified from tax review sources, in particular the European Commission's Excise Duty Tables (European Commission 2011g), and the OECD's Inventory of estimated budgetary support and tax expenditures for fossil fuels (OECD 2011a). A number of national sources were used to supplement these reviews;
- the tax and subsidy rates are converted from their initial units, such as €/kWh, to €/tCO_2 using standard mass/volume/density conversion factors, as well as implied emission intensities from IEA energy use and emission data (IEA 2011a, IEA 2011b), for each country and energy type;
- the tax base was matched to classifications used when reporting emissions statistics;
- total emissions from each base were estimated from these compendia of emissions statistics;
- total revenue (or subsidy cost) was estimated approximately by multiplying the tax rate by the total carbon dioxide associated with the tax base.

The data were collected and analysed at market prices and exchange rates. Parts of the results vary when analysed using purchasing power parity (PPP) exchange rates, generally showing up higher tax rates for Poland, Hungary, Greece and Portugal, as well as, to a smaller extent, for Spain. PPP exchange rates also imply lower rates in Germany, France and Italy, while rates in the UK remain broadly unaffected.

The taxes were classified into sectors. All residential and transport taxes were assigned to one of those categories, and all others were assigned to business users, which encompasses industrial, commerce and public users.

7 Tax data from 2011, with individual rates updated to take account of recent changes. Emission and energy use data for 2008.

There are a number of caveats to this analysis. A full list of all caveats is given in Appendix B. The most important assumptions and caveats are set out below:

- all energy consumed in the following four IEA categories is assumed to be consumed in installations covered by the EU ETS: Iron & Steel; Chemical and Petrochemicals; Non-Metallic Minerals; and Paper, Pulp and Print;
- approximately 70 per cent of the energy used in the IEA category Food & Tobacco is assumed to be consumed by installations covered by the EU ETS;
- approximately 10 per cent of the energy used in the IEA category Commercial and Public Services is assumed to be consumed by installations covered by the EU ETS;
- electricity producers and refiners are assumed to pass 100 per cent of the additional costs imposed on them by the EU ETS on to consumers;
- the EU ETS allowance price is taken as the average spot price between 25.01.2011 and 24.01.2012, which is calculated as €11.74;
- PPP and market exchange rates are taken as the average for the calendar year 2011;
- fuel used in domestic commercial aviation is assumed to be tax exempt;
- fuel duties are implicitly treated as carbon taxes although it is recognised that, in the case of transport fuels in particular, there are a range of other externalities that will be important and that justify higher tax rates on these products;
- biofuels are not covered, due to lack of available emission data.

3.2 Results

A miscellany of tax practices with too little common structure is an inadequate basis for efficient and effective climate policy

3.2.1 Structure of this sub-section

This section is divided into seven parts:

- the headline results;
- the analysis of taxation of residential energy use;
- the taxation of industrial, commercial and public energy use: 'business use', in brief;
- transport;
- country portfolios of taxation presented as energy tax curves;
- a comparison of energy taxation practice with fiscal balances and liabilities;
- conclusions.

3.2.2 Headline results

Carbon-energy tax rates vary greatly across sectors, between fuels and between countries. Low rates of tax are commonly found for specific inputs to energy-intensive trade-exposed sectors such as steel and many offer low rates of tax to households.

Throughout this section, carbon-energy tax rates are compared on a per tonne of carbon dioxide basis. On this basis, carbon-energy tax rates are not uniform in any of the countries examined. Instead, they vary by fuel type, by user and even type of use. The users are classified into residents, large and small business and several modes of transport. In places, special categories have been designated for individual sectors, such as for agriculture, or according to use, such as heat or chemical and metallurgical process reagents.

The EU ETS is the only fiscal instrument to be applied uniformly across Europe, with a single universal rate and coverage. Excise duties vary substantially nationally, and there are considerable targeted exceptions from excise duties and from Value Added Tax, frequently used only to direct subsidies to favoured groups of users.

Within the excise duty and Value Added Tax variations, there are some patterns to be seen across countries, but these are dwarfed by the particular characteristics that pervade the tax schedules of individual countries. Altogether, there is a chaotic picture of variation across Europe.

Using market exchange rates, the average tax rate in each country ranges from €35/tCO_2 in Poland to double that figure, €78/tCO_2 in Italy. Portugal and the UK also have figures above €70/tCO_2. Transport taxation is an influential driver of the rank. While Germany and Italy have relatively high tax rates across all sectors and rank highly, Poland and Spain rank low in aggregate because of their low rates of excise duty on transport fuels. When their residential and business tax rates are examined, they are mid-ranking. Meanwhile, the UK and Greece are pulled up the rankings by their high rates of tax on transport. The UK is by far the most generous to residential users, directing a substantial implicit subsidy[8] towards them to achieve an effective negative tax rate, €-31/tCO_2. Greece takes the prize for the lightest taxation of business at €5/tCO_2.

Table 3. **Carbon-energy tax rates at market exchange rates, 2011, €/tCO_2**

Country	Mean	Rank	Residential	Transport	Industry, public and commerce
France	66	=4	12	149	15
Germany	66	=4	34	199	23
Greece	58	5	5	213	5
Hungary	44	7	(4)	144	13
Italy	78	1	70	179	24
Poland	35	8	9	126	18
Portugal	72	2	10	151	15
Spain	56	6	20	115	17
UK	71	3	(31)	248	26

Note: *(x) indicates a negative number.*

Source: *Vivid Economics*

8 Household energy use in the UK benefits from a reduced VAT rate (5 per cent as opposed to the generally prevailing rate of 20 per cent). By taxing household energy use at a quarter of the full rate, the UK tax system makes domestic energy use significantly cheaper relative to other goods subject to the full VAT rate. This acts as an implicit subsidy (of 15 per cent of the pre-VAT price) on energy consumption.

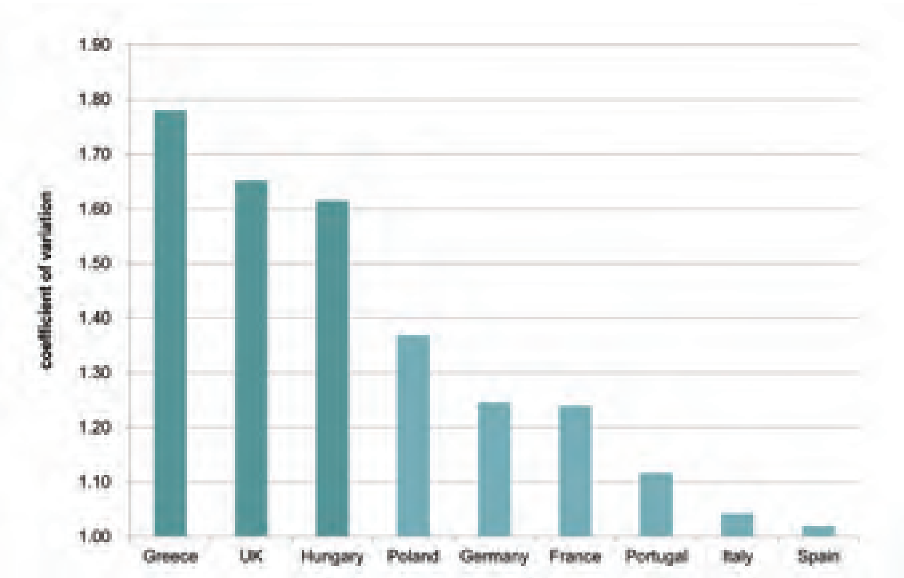
There are three overarching patterns to be seen. The first is the singling out of surface transport energy use for a much higher rate of excise duty (it is almost exempt from the EU ETS). The tax rates on surface transport energy are between 6 and 47 times higher than the tax rates on residential and business use. The second is the higher taxation of electricity than natural gas. On average, electricity used by households is taxed more heavily by €17/tCO_2, with a range of €2 to €31/tCO_2 across the countries. For industrial users the average amount by which electricity is taxed more than natural gas is lower, at €10/tCO_2, though the range is wider, from zero to €52/tCO_2. The third is the heavier taxation of gasoline than diesel, with gasoline more heavily taxed by €92/tCO_2 on average across the sample.

The variety arises mainly from inconsistency in the tax rates and subsidies applied to residential energy use and business energy use. The average difference between the two is €16/tCO_2. In five out of the nine countries examined, the difference is small, less than five euros, whereas in the remaining four, the average difference is €32/tCO_2.

Transport taxes are equally inconsistent. The range from highest to lowest diesel tax is €122/tCO_2, and the range from highest to lowest petrol tax is €110/tCO_2. Furthermore, as highlighted by the European Commission (for example European Commission, 2011b) there is considerable variability of tax rates within countries: in Greece, the country with the largest petrol/diesel spread, petrol faces a tax €145/tCO_2 higher than diesel. Even in the country with the smallest spread, the UK, the difference is still €43/tCO_2 (with petrol tax higher than diesel tax). This differential appears when the per litre rates are translated into carbon terms because diesel has a higher carbon content.

Across the panel of nine countries, the variation of rates within a country can be measured by the coefficient of variation.[9] By this measure, Greece has by far the largest variation, which is nearly twice the level of variation found in Spain: the country with the most consistent set of rates. In this characteristic, Poland, Germany, France, Portugal and Italy are all like Spain, being relatively more consistent in their taxation, whereas the UK and Hungary are more like Greece. This is shown in figure 2 below.

Figure 2. **Greece, the UK, Hungary and Poland all have significantly more dispersed energy tax rates**



Source: *Vivid Economics*

3.2.3 Residential energy use

The tax raised from residential users is just over one twentieth of all energy taxes even though residential energy use accounts for a quarter of produced emissions. In comparison, business use raises one sixth of revenues and accounts for just under a half of produced emissions.

Germany has the highest rates of taxation, with €58/tCO_2 for electricity and €27.4/tCO_2 for natural gas. This large difference comes about partly because of the EU ETS component of €11.7/tCO_2 on electricity, but also because the excise tax is 70 per cent higher on electricity €46.5/tCO_2 than €27.4/tCO_2 on gas.

9 The coefficient of variation is the standard deviation divided by the mean. This accounts for the fact that distributions with a larger mean will naturally have a larger absolute standard deviation.

After Germany, the next highest in terms of rates is Italy. It deploys four pieces of energy taxation: the EU ETS, excise duty, a municipal surcharge (on electricity) and variations in Value Added Tax. Again, electricity is taxed more heavily than natural gas, at €73/tCO_2 compared to €55/tCO_2, most of the difference accounted for by the EU ETS on electricity. It taxes residential fuel oil much more highly, at €143/tCO_2, similar to the rates on road transport fuels. Two unusual details in Italy's tax schedule are a rising block tariff[10] of excise duty and a 10 per cent reduction in Value Added Tax on the first tranche of household natural gas consumption.

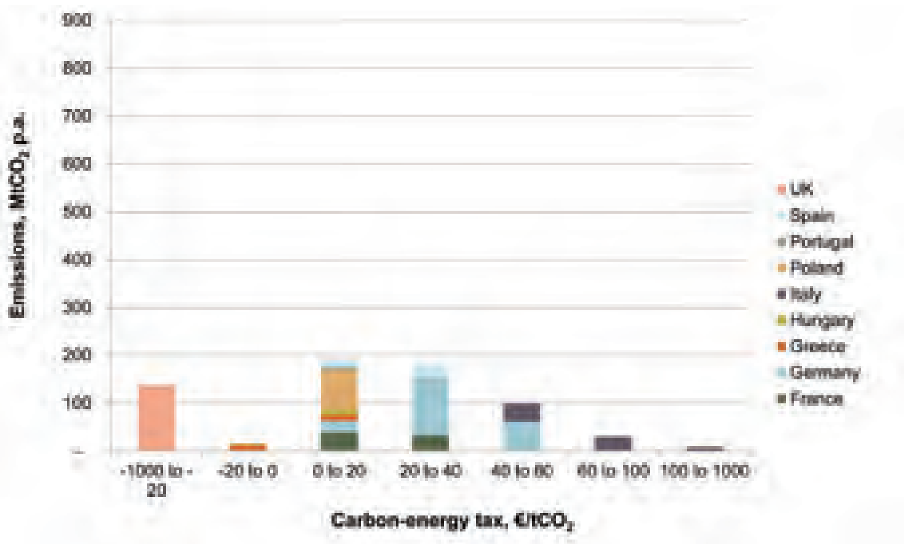
In the mid-level of tax rates is Spain. Spain raises no energy tax on natural gas but has two components on electricity, the EU ETS and an excise duty, totalling €29/tCO_2. It is unusual in applying a higher excise tax on electricity for residential use €16.3/tCO_2 than it does for business use €11.7/tCO_2. This is not consistent with the pattern for natural gas: residential natural gas is exempt from excise duty but certain types of business use are charged €21/tCO_2.

There is then a group of countries with low energy taxes or subsidies. Poland levies no taxes on heating fuels except fuel oil, at €4.9/tCO_2. Notably, coal, responsible for 21 mtCO_2 p.a. of emissions, is exempt.[11] Electricity is treated differently, with an excise tax of €7.8/tCO_2, a low rate compared with the countries discussed above.

Although Poland's tax rates are low, Hungary goes further by applying no excise taxes on residential use. This leaves the EU ETS as the only policy pricing component on electricity. In fact, Hungary goes even further by subsidising electricity use by electricity sector workers to the tune of €-0.14/kWh, although this only relates to a very small proportion of total energy consumption. However, Hungary does not have the lowest rates. That honour is taken by the UK, by some distance, because of the partial exemptions from Value Added Tax which it bestows upon residential energy. These are worth €45/tCO_2 for electricity, although this is partly offset by the impact of the EU ETS, and €31/tCO_2 for natural gas.

Altogether, the most commonly applied tax rates lie between zero and €40/tCO_2 as shown in figure 3. The exceptions at either end are supplied by Italy (fuel oil) and the UK (electricity and natural gas). Germany is notable for the scale of its emissions in total, and France for its low level of emissions for a country of its size. Residential emissions per capita are shown in figure 4 below. France is once again notable for its low emissions given its GDP per capita. Portugal and Spain also have very low per capita residential emissions, perhaps due to lower heating needs and a relatively clean electricity supply.

Figure 3. **The bulk of residential energy emissions are taxed at between €20 and €40 per tCO_2 although there is substantial variation**

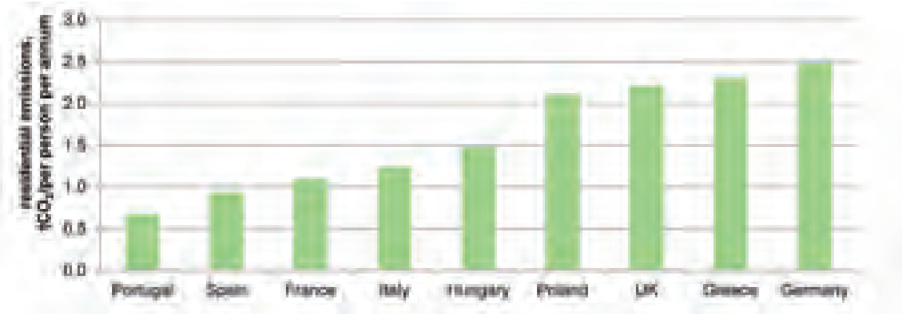


Source: *Vivid Economics*

10 In a rising block tariff, the rate (or tax) charged increases in a step-wise fashion as consumption increases. An example would be a tax on electricity where the first 500 kWh are free of tax, the next 1,500 kWh attract €10/MWh of tax, the next 3,000 kWh €20/MWh, and any consumption above that €40/MWh.

11 This was the case when this analysis was conducted. Poland has now introduced an excise tax on coal of €0.29/GJ.

Figure 4. **CO_2 emissions per capita: Portuguese, Spanish and French households emit close to or less than one tonne of CO_2 per person per annum**

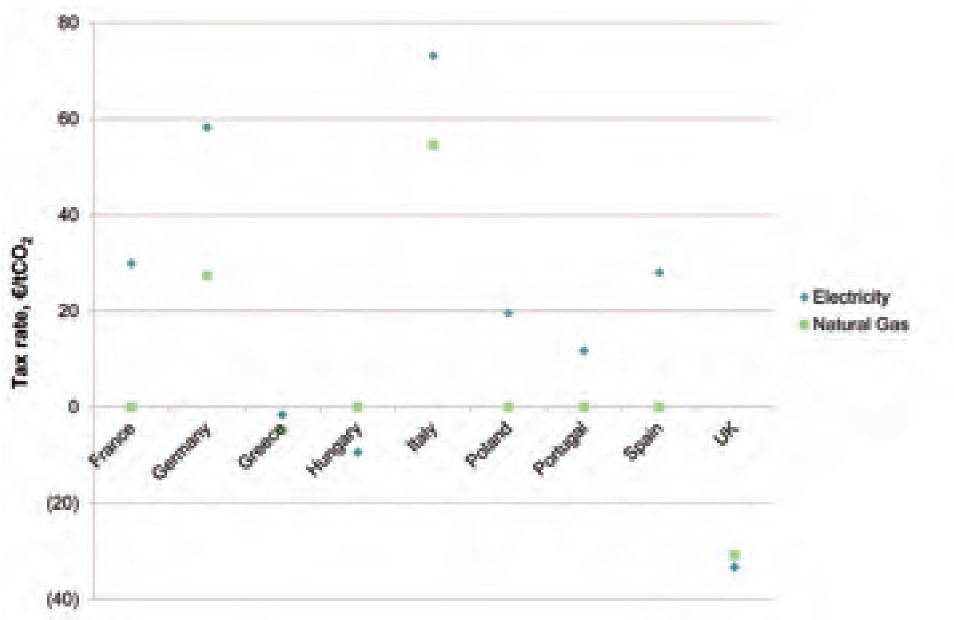


Note: *Residential emissions include residential fuel combustion and emissions from electricity consumed in households but not personal transport use.*

Source: *Vivid Economics*

As has been seen, the rates of tax not only vary between countries but also within them, by fuel type. Generally, per tonne of CO_2, the tax rate on electricity is higher than the rate on natural gas. The average difference is around €17/tCO_2, and varies from €+31/tCO_2 (a higher rate on electricity) in Germany to €-9tCO_2 (a higher rate on natural gas) in Hungary. Low rates on electricity are associated with VAT reductions. Low rates on natural gas are due to full exemption, which is quite common, and found in Spain, France, Hungary, Poland, Portugal and Greece. The UK is the only country to have a substantial negative tax rate on natural gas, and the only country to subsidise both electricity and natural gas.

Figure 5. **Residential energy tax rates: across Europe, residential electricity is taxed significantly more highly than natural gas**



Source: *Vivid Economics*

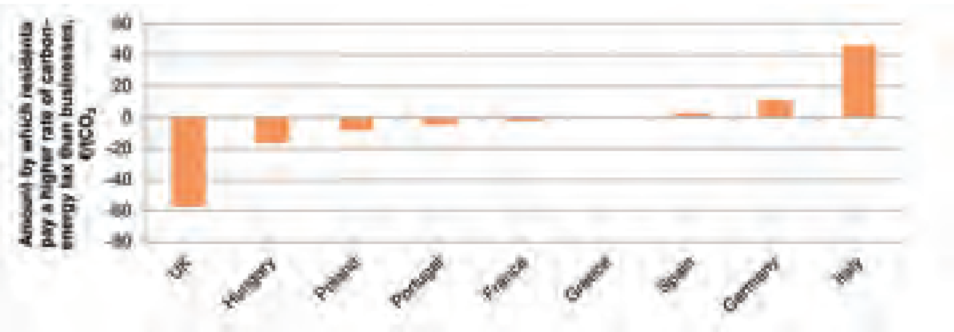
3.2.4 Industrial, commercial and public energy use

Overall the energy tax rates paid by some German businesses, particularly non-manufacturing, are similar to those paid by its residents. However, the tax rates paid by manufacturing businesses are significantly lower due to a number of important exemptions and refunds. Taking most of these exemptions and refunds into account, energy taxes on German manufacturing are broadly in line or slightly below the business tax rates found throughout the rest of our sample.

Due to the complicated nature of some of the refunds and exemptions provided, we have not been able to include all of them in our analysis of energy tax rates.[12] However, it is possible to estimate their approximate impact by comparing the aggregate size of the tax expenditures with the aggregate revenue of the relevant taxes: they constitute between 0 and 29 per cent of the revenue here considered.[13] Average tax rates for manufacturing businesses may therefore be lower still than shown here.

Spain, France, Portugal and Greece tax residential and business energy use approximately equally. The same cannot be said of Italy. Italy taxes its businesses much less heavily than its citizens - similar to Germany but in a more pronounced fashion. Italy's business rates average €24/tCO_2, which compares to residential rates averaging €70/tCO_2. The UK exhibits the reverse pattern, with industrial rates averaging €26/tCO_2 and residential rates of €-31/tCO_2. It is joined in this pattern by Hungary and Poland. These differences are shown in figure 6.

Figure 6. **Residential versus business taxes: while residents in Italy face far higher carbon-energy taxes than business, the reverse is true in the UK**



Source: *Vivid Economics*

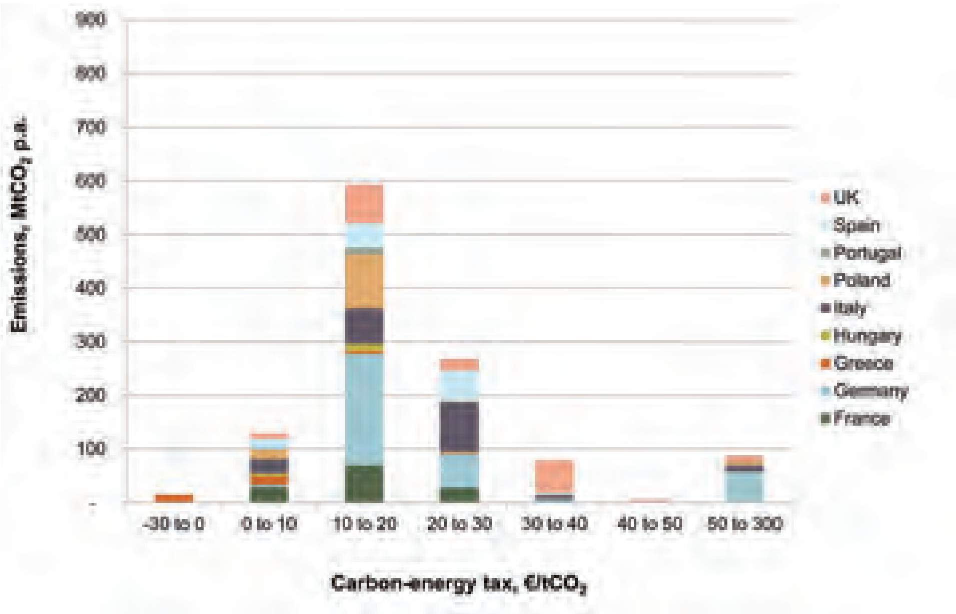
Despite these differences, business energy tax rates are more tightly grouped around the range €5 to 35 euro/tCO_2 than residential tax rates. That is largely because the UK and Italy do not behave as outliers, as they do for residential. Indeed, no country operates a policy of subsidies (reduced Value Added Tax) for business energy use, and this fact removes the tail of very low rates.

This miscellany of rates is clearly visible when all the individual tax bands are arranged alongside one another, as in figure 7. Germany's high rates on non-manufacturing businesses stand out (as they do for residential taxes), as do France's low rates on some types of energy.

12 We have included the reduced electricity tax in accordance with § 9b StromStG, and the exemption from energy taxes for certain industrial processes in accordance with §§ 37, 51 EnergieStG; we have also included the Spitzenausgleich in accordance with § 10 StromStG, assuming that all manufacturing businesses make use of it, and ignoring the Sockelbetrag. We have not included the energy tax exemption for fuels used in CHP in accordance with §§ 37, 53 EnergieStG.

13 We have not included exemptions for fuel used in CHP (€2.3 billion, Bundesministerium der Finanzen 2011) in our analysis. However, it is unclear what proportion of that exemption accrues to the electricity generating sector (which is generally tax exempt and treated as such in our analysis; this exemption, to the extent that it applies to the electricity sector, is therefore at least partly and implicitly taken into account), and what proportion accrues to industrial CHP plants. The range of tax expenditures for industry that we have not considered in our analysis is therefore between €0 and €2.3 billion. Our analysis shows that the revenue from relevant taxes on industrial and commercial energy use in Germany in 2008 was approximately €8 billion.

Figure 7. **There is less variation in carbon-energy tax rates in industrial, commercial and public energy use than in residential use**

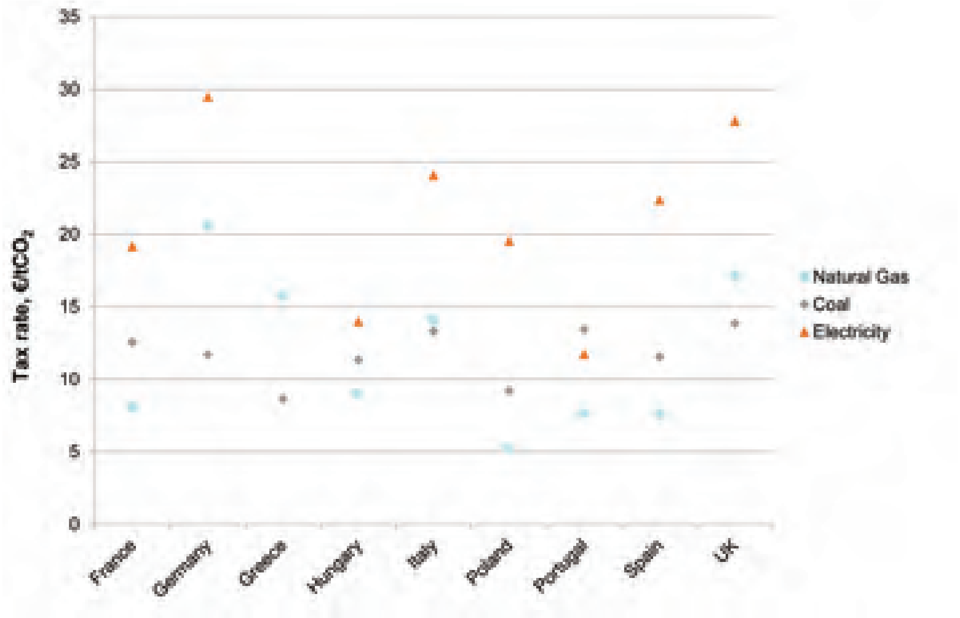


Source: *Vivid Economics*

Although the dispersion of rates is much less than is found in the residential sector, the inconsistency across fuels is most striking. As with the residential sector, electricity is more heavily taxed per tonne of CO_2 than natural gas, this time in every country except Greece. The average difference is that electricity is taxed around 40 per cent more or €8/tCO_2. For example, Poland has no excise duty on natural gas but raises €8/tCO_2 on electricity. Similarly penalising electricity consumption, France imposes a rate of €18/tCO_2 on electricity, but only €6/tCO_2 on natural gas. It is not alone in favouring coal with a zero rate for use in industrial processes. Per tonne of CO_2, coal is taxed more heavily than natural gas, except in Germany, the UK and Greece.

Germany, again, levies some of the highest rates (subject to the caveat concerning various exemptions outlined above), with excise taxes for industrial heating with natural gas of €20.5/tCO_2 and electricity (for companies where the Spitzensteuerausgleich does not apply), €35/tCO_2. Meanwhile, it favours coal with zero taxation of coal and coke in the metals sector and very low rates outside it. Figure 8 nevertheless shows positive tax rates for coal in all nine economies due to the EU ETS.

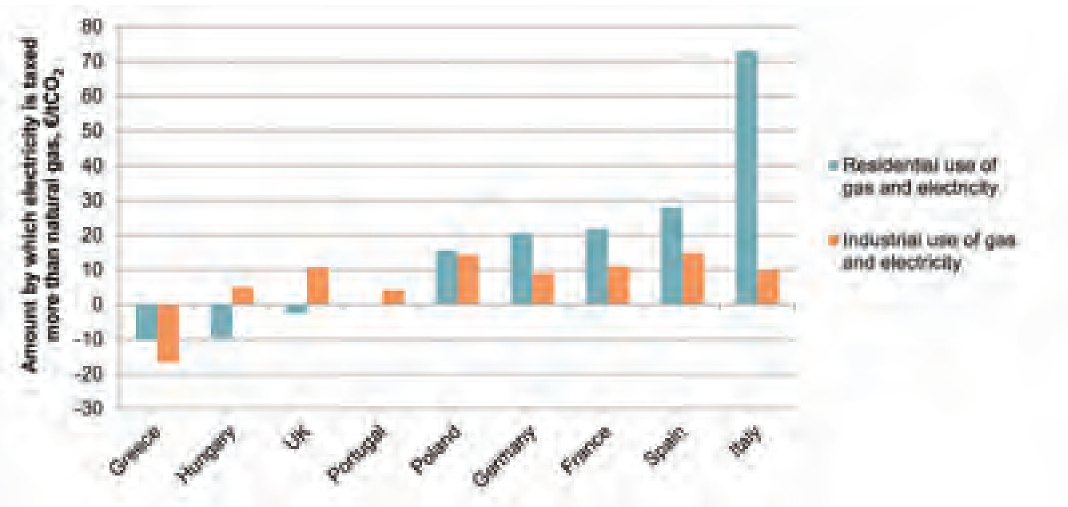
Figure 8. **Industrial energy tax rates: electricity consumption by industrial, commercial and public users is typically taxed more heavily per tCO_2 than gas consumption**



Source: *Vivid Economics*

Germany, France and Spain all favour natural gas: they have relatively large differentials between electricity and natural gas in residential use, and somewhat smaller differentials in industrial use. The results are presented in figure 9. The extent to which Italy favours natural gas vis-à-vis electricity in residential use is particularly striking.

Figure 9. **Taxes on electricity versus taxes on natural gas: the difference between implied CO_2 tax rates on electricity and gas consumption is greatest in Italy, Spain, France and Germany**



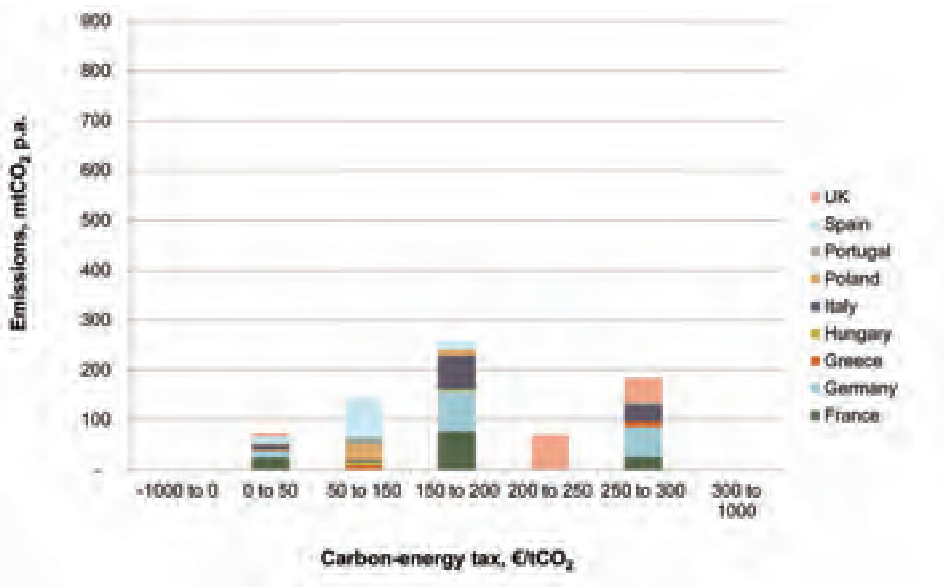
Source: *Vivid Economics*

3.2.5 Transport energy use

Transport energy use accounts for 28 per cent of produced emissions in the sample of nine countries and 77 per cent of fiscal revenues from carbon-energy taxes.

There is a wide range of tax rates applied to transport fuels, from zero, for example for the use of natural gas in France, to €280/tCO_2 for motor gasoline in the UK. The spread can be seen in figure 10.

Figure 10. **Most emissions from transport fuel use are taxed at between €150 and €200 per tCO_2**



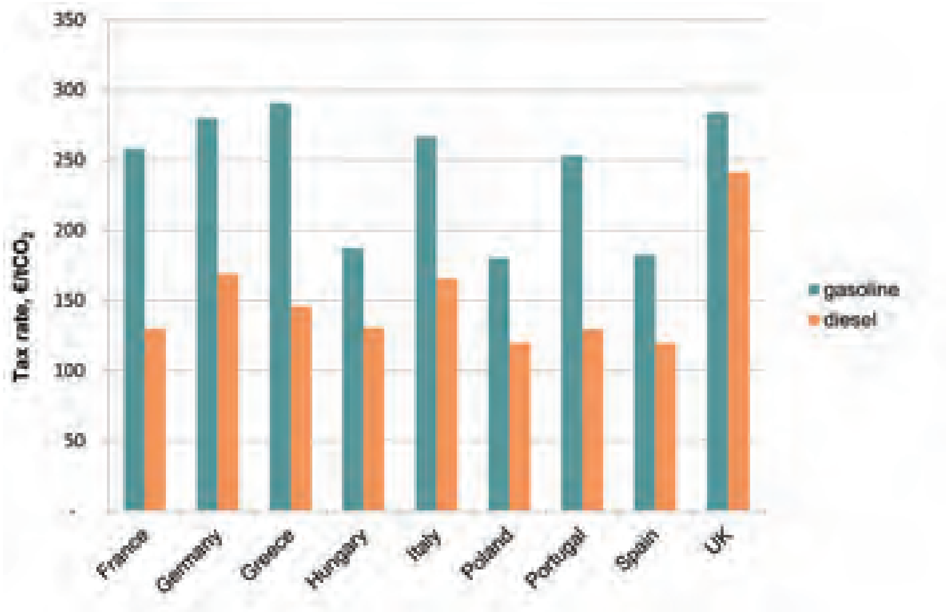
Source: *Vivid Economics*

Generally, the taxes vary by fuel, in descending order from gasoline, through diesel and LPG down to natural gas. Road fuels are taxed heavily while aviation and rail fuels are typically not taxed at all (or taxed very lightly). There are significant differences both within countries, between the average tax rate on diesel and gasoline, and across countries, between the rate on petrol in one country and another, and between the rate on diesel in one country and another.

The spread between diesel and petrol rates within each country varies considerably throughout the sample, from a low of €43/tCO_2 within the UK to a maximum of €145/tCO_2 within Greece. With regard to petrol taxes, the sample is split into two groups: a low tax group, comprising Hungary, Poland and Spain, with an average of €183/tCO_2; and a high tax group, comprising France, Germany, Greece, Italy, Portugal and the UK, with an average of €272/tCO_2.

The rate at which diesel is taxed ranges from a low of €119/tCO_2 in Spain to a high of €241/tCO_2 in the UK. There are no clear groups with regards to diesel taxation, though the UK is an upwards outlier. Excluding the UK, the range of diesel taxes narrows considerably: the second highest diesel tax is €169/tCO_2 in Germany. This brings the cross-country diesel spread down to €50/tCO_2 (between Germany and Spain), compared to a much larger cross-country petrol spread of €111/tCO_2 (between Greece and Poland). This information is summarised in figure 11 below.

Figure 11. **Diesel taxes versus gasoline taxes: the UK has the smallest differential between the two**



Source: *Vivid Economics*

3.2.6 Energy tax curves

The entire tax schedule for a country can be presented as an energy tax curve, in which the tax revenue for each piece of the tax base is represented as a rectangle. The larger the rectangle, the greater the revenue. The height of the rectangle indicates the implied CO_2 tax rate and the length the amount of energy taxed, measured in tonnes of CO_2 emissions. These rectangles are placed in ascending height order, to build up a curve. The profile of the tax curve is shown in the charts below both with and without the EU ETS, so that it is clear how much the EU ETS contributes.

A country which taxes energy uniformly per unit of carbon dioxide would have a flat energy tax curve: a single rectangle stretching across the horizontal axis. No countries have this arrangement: they all have something more complex instead. The complexity comes in two ways. First, the number of steps in the schedule shows the number of discrete tax rates that are employed. The more steps there are, the more complex the tax rules become. The variation in height along the schedule shows how unevenly spread across energy use is the burden of taxation. The larger the variation the greater the differences in marginal value from consuming energy in an individual use or sector by virtue simply of the tax schedule. Complexity drives administrative costs and differences in marginal value generate inefficiency in the pattern of energy use and associated emissions, with choices being made about which forms of energy to use and how much effort to put into economising emissions.

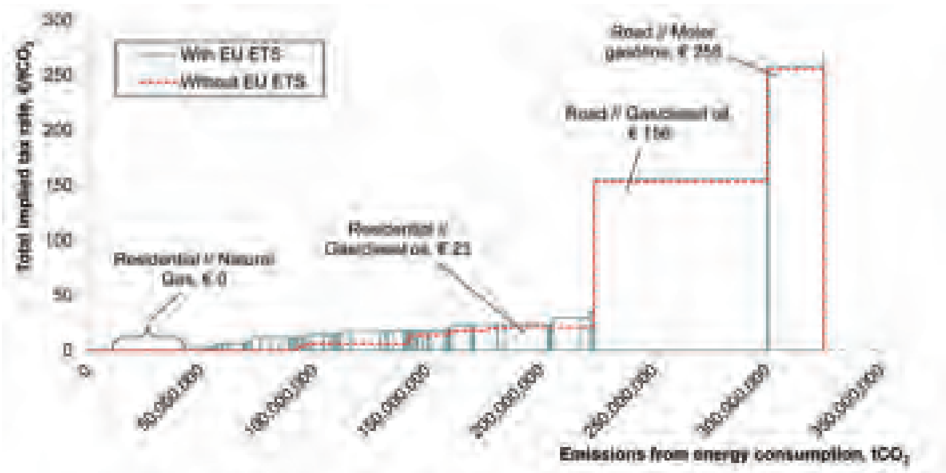
The gasoline-diesel differential is a good example of how differences in rates impose costs in the economy. In this case, the costs are imposed on the oil refining sector, where low tax rates on diesel have encouraged dieselisation of the light vehicle fleet, requiring billions of euros of investment in refinery processes to get more middle distillates out of each input barrel of crude (Cuthbert 2009).

The EU ETS plays an important role. It is the sole policy price signal on around half of the emissions outside the transport sector in these three countries. Even with it, because of the limits of its coverage to large combustion installations, natural gas consumed by households remains entirely free from tax and other policy pricing mechanisms in these three jurisdictions.

On the following pages are the energy tax curves for each of the nine countries analysed: France, Germany, Greece, Hungary, Italy, Poland, Portugal, Spain and the United Kingdom. A broad pattern is visible across all nine curves: a block of low, negative or zero-taxed energy consumption followed, moving to the right along the schedule, by gradually rising tax rates for business and residential use, and then much higher tax rates for transport fuels. There are around half a dozen different tax rates applied to business and residential use, and usually at least three for the principal transport fuels. The higher tax rates for petrol stand out.

The first schedule is for France, figure 12. It is immediately clear how much of the area of the curve, the revenue, is supplied by transport fuels and how much is given up by the zero rate of tax on natural gas. The dominance of diesel as a transport fuel is also shown up, as is the considerable tax advantage from which it benefits relative to petrol.

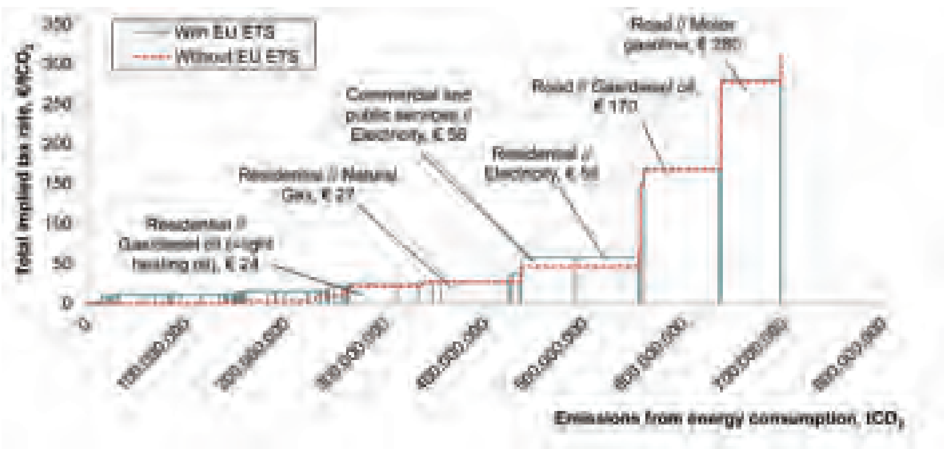
Figure 12. **Energy tax curve for France**



Source: *Vivid Economics, IEA, European Commission*

The next energy tax curve, figure 13, shows the energy tax structure of Germany. Unlike most other countries surveyed, transport fuels make up a comparatively small fraction of total emissions in Germany. Nevertheless, as in most other countries, they face considerably higher tax rates and make significant contributions to total energy tax revenue. Exemptions for industry are visible towards the left of this curve, where most industrial emissions face zero or low energy taxes, and where the EU ETS provides the only price signal.

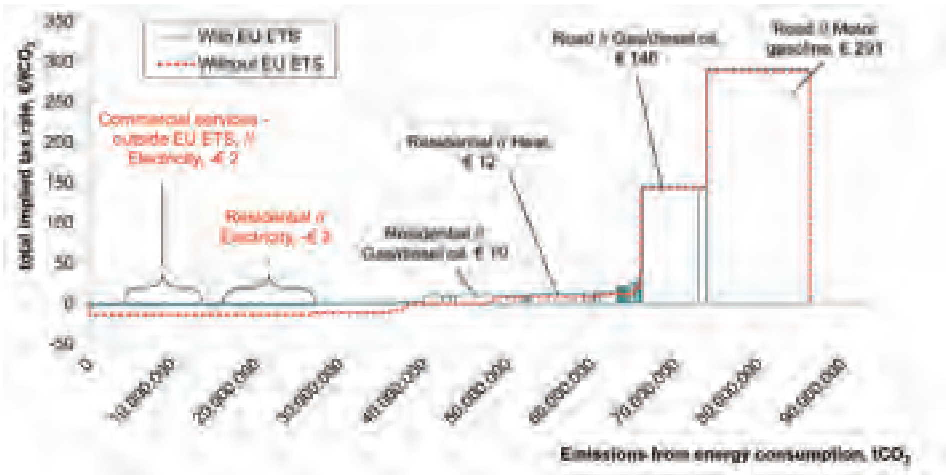
Figure 13. **Energy tax curve for Germany**



Source: *Vivid Economics, IEA, European Commission*

Greece, shown in figure 14, has strongly diverging carbon energy tax rates. While its tax rates on petrol are the highest in our sample, and provide the majority of all revenues from energy taxation in Greece, more than a third of all emissions benefit from a negative tax rate (indicating implicit subsidies).

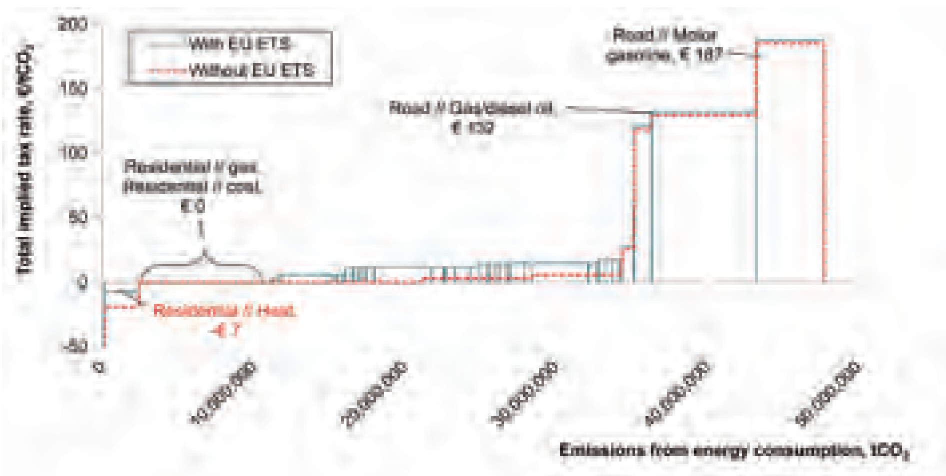
Figure 14. **Energy tax curve for Greece**



Source: *Vivid Economics, IEA, European Commission*

In Hungary, similar to Greece, it is immediately clear how dominant the position of transport fuel taxation is in terms of revenue raised, and how large a potential is left untapped by the exemption of domestic coal and gas. The remainder of the tax schedule is relatively flat and low, with most of the price signal for non-transport emissions coming from the EU ETS. This is shown in figure 15.

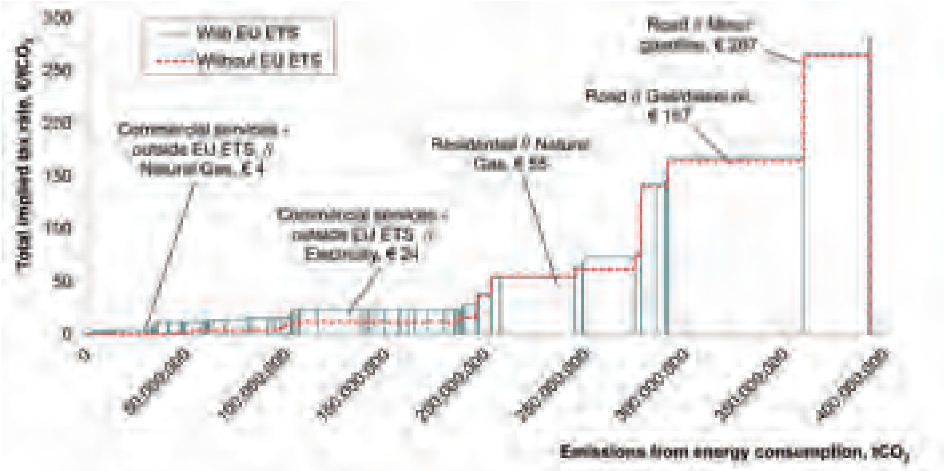
Figure 15. **Energy tax curve for Hungary**



Source: *Vivid Economics, IEA, European Commission*

Italy's energy tax curve, shown in figure 16, presents a relatively smooth picture compared to some of the other countries. This reflects the existence of exemptions and (implicit) subsidies in the transport sector, which reduce the step between transport and non-transport taxation. It also reflects the unusually high rates that Italy levies on some of its residents, particularly with respect to natural gas. Comparatively little energy consumption and emissions remain entirely untaxed.

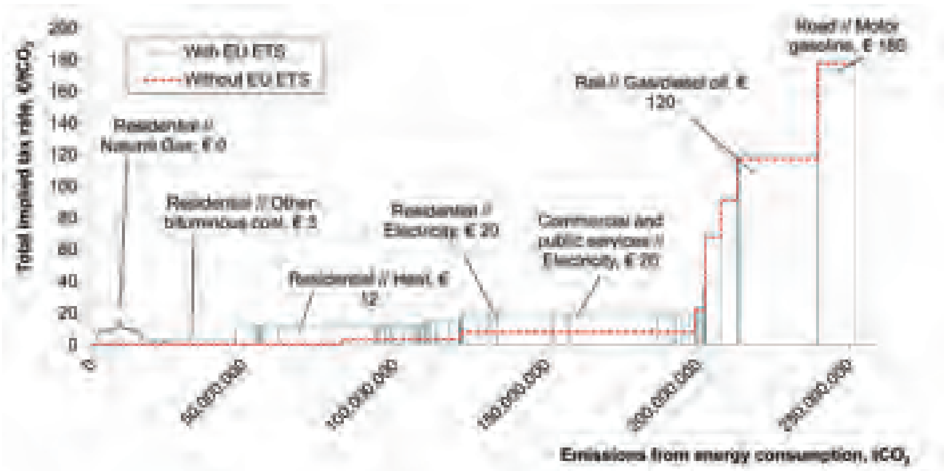
Figure 16. **Energy tax curve for Italy**



Source: *Vivid Economics, IEA, European Commission*

Poland's energy tax curve, figure 17, shows that transport emissions constitute a relatively small fraction of Poland's overall emissions. In this way it is similar to Germany. Nevertheless, it is immediately clear how much of the area of the curve, the revenue, is supplied by transport fuels, and how much is given up by the zero rate of tax on natural gas. The differences in taxation across residential electricity, heat and natural gas consumption are also immediately revealed.

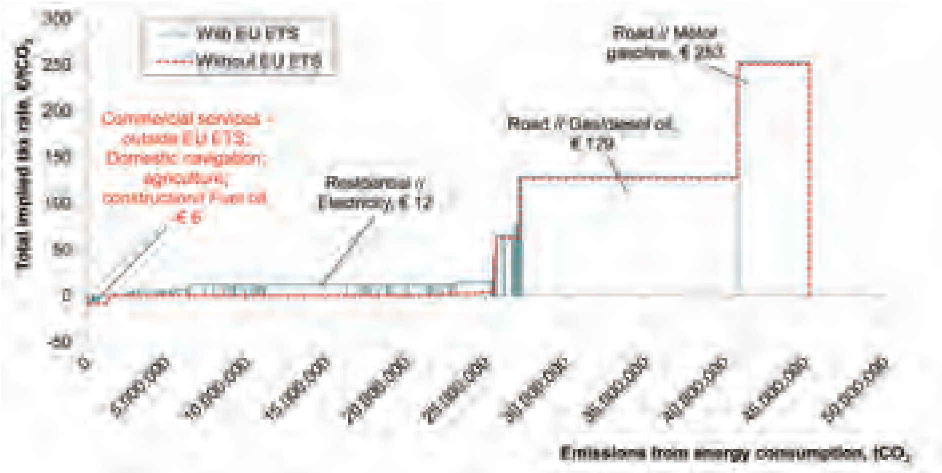
Figure 17. **Energy tax curve for Poland**



Source: *Vivid Economics, IEA, European Commission*

Energy taxation in Portugal is almost entirely concentrated on transport fuels. The Portuguese energy tax curve, shown in figure 18, is dominated by the rectangles representing diesel and petrol used in road transport. While most emissions face a positive price signal, outside transport this is nearly entirely due to the EU ETS.

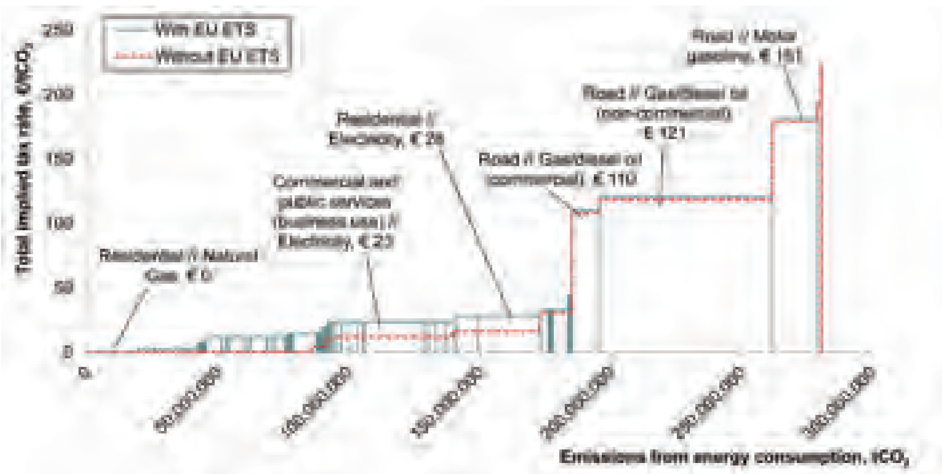
Figure 18. **Energy tax curve for Portugal**



Source: *Vivid Economics, IEA, European Commission*

The energy tax curve for Spain, shown in figure 19, is similar to that of Portugal, although Spain has a more complex system with a larger number of tax levels outside transport. Nevertheless, approximately 30 per cent of Spain's emissions face no domestic taxation, and approximately half of those are not covered by the EU ETS either. Electricity tax is an exception to this pattern, both on business and residential use.

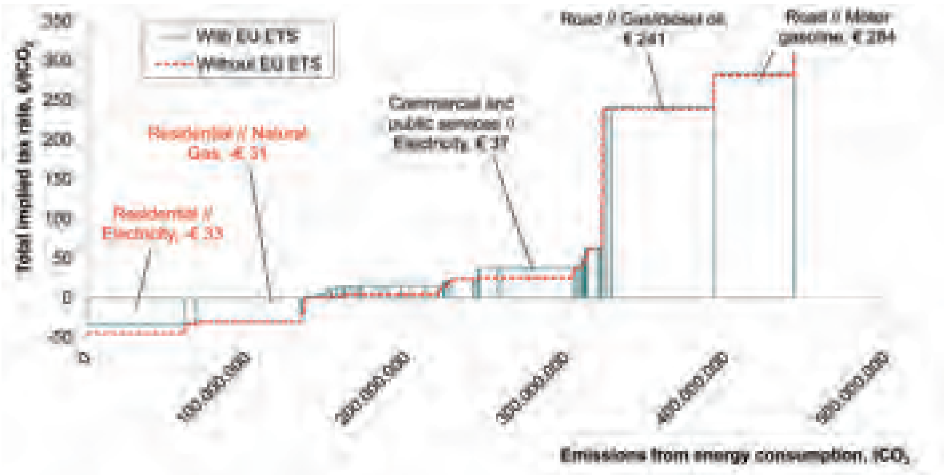
Figure 19. **Energy tax curve for Spain**



Source: *Vivid Economics, IEA, European Commission*

Energy taxation in the United Kingdom, shown in figure 20, is characterised by a particularly large range of different rates. While taxes on transport fuels are among the highest in our sample (and indeed throughout the EU) residential energy use is heavily (implicitly) subsidised, resulting in substantially negative tax rates for more than a quarter of all emissions.

Figure 20. **Energy tax curve for the United Kingdom**



Source: *Vivid Economics, IEA, European Commission*

Table 4 below gives a statistical summary of the findings, showing both the levels and the dispersion of tax rates in the nine countries investigated. The country with the highest average carbon-energy tax rate according to market exchange rates is Italy, at €78. Measured at purchasing power parity (PPP), Portugal has the highest average, at €87. The most dispersed carbon energy tax system, as measured by the coefficient of variation, can be found in Greece. Spain has the least dispersed system of carbon energy taxation, closely followed by Italy.

Table 4. **Carbon-energy tax rates at market and PPP exchange rates, 2011, €/tCO_2**

Country	Mean (Market FX)	Mean (PPP)	Coefficient of variation
Italy	78	74	1.04
Portugal	72	87	1.12
United Kingdom	71	71	1.65
France	66	58	1.24
Germany	66	62	1.25
Greece	58	63	1.78
Spain	56	60	1.02
Hungary	44	71	1.62
Poland	35	57	1.40

Note: *Coefficient of variation is equal to standard deviation divided by the mean.*

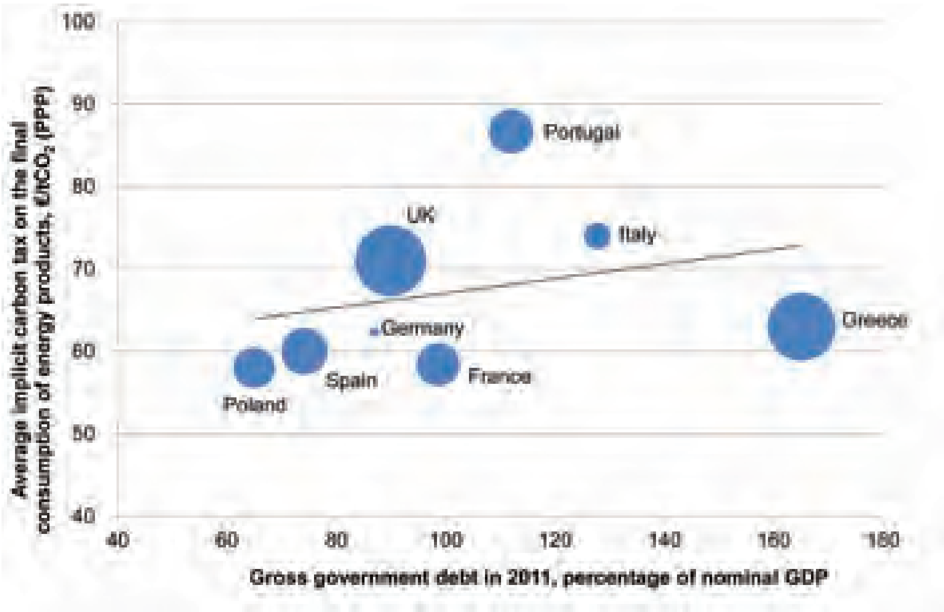
Source: *Vivid Economics, Oanda (market exchange rates) Eurostat (PPP exchange rates)*

3.2.7 Comparison with fiscal positions

Recently, it seems that countries with higher deficits and higher gross debt, across this small sample of only nine countries, have tended to have higher carbon-energy tax rates, but the relationship is weak, as figure 21 indicates. Portugal, Italy and Greece carry more debt and have higher tax rates than Poland, Spain and France.

However, Germany, which is fiscally almost in balance, has the same tax rates as Greece. There are certainly other factors at play here, and perhaps fiscal health has not been a strong influence on energy tax rate-making, but if that conclusion tells us anything, it is that there is reason to look thoroughly at the opportunities for carbon-energy tax reform, which is the subject of the remainder of this report.

Figure 21. **Implicit carbon taxes and fiscal health: there is no clear relationship between the two**



Note: The size of the bubble reflects the government deficit as a percentage of gross domestic product, 2011.

Source: Vivid Economics

3.2.8 Conclusions

This review of tax schedules across nine countries produces some firm findings:

- it is universally held that road transport fuels are treated quite differently to other uses of energy, reflecting the greater externalities associated with their use;
- countries have had no difficulty in sustaining different levels of taxation between residential and business use, and appear not to adhere to principles of optimal taxation,[14]
- quite different levels of energy taxation apply across borders within Europe, even to energy-intensive business activities, despite the potential for unwelcome competitiveness effects between firms as well as the potential for tax arbitrage between countries;
- collectively, those countries in greatest need of fiscal injection do not seem to have chosen to set higher carbon-energy tax rates;
- there is surprising variation in rates by fuel type, even within the same sector. Most countries allow this variation to persist, even though it may distort economic behaviour. The two conspicuous examples are coal, which often receives tax exemptions, and natural gas, which is taxed more lightly than electricity.

14 Which would suggest that production inputs should not be taxed for the sake of raising revenue, and that tax rates should reflect externalities.

4

Options for national tax reform

Proposals and modelling results

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Options for national tax reform

Proposals and modelling results

4

Potential energy tax reforms in Poland, Hungary and Spain

This section considers the opportunities for member states to use energy taxes as a means to reduce government deficits, and how this is less painful than the use of higher direct or indirect taxes.

Building on the proposed revision to the EU Energy Tax Directive, it develops three case studies – Poland, Hungary and Spain – to illustrate the potential of energy tax reform. These three countries span a variety of size, location, and economic structure, while all requiring various degrees of fiscal tightening. Covering these three countries may therefore yield useful lessons for a number of member states, even though circumstances and policy needs differ from member state to member state. Tax packages raising an additional 1.0 to 1.5 per cent of GDP by 2020 are modelled and compared with alternative packages of direct and indirect taxes that raise the same amount of revenue. In each case, the modelling analysis shows that the energy tax reforms have a smaller detrimental impact on economic output. The energy tax reform package leads to national emission reductions of up to 3 per cent by 2020, whereas alternative tax options have a negligible impact on emissions.

The tax reform packages are described in detail in this section, including energy tax curves comparing pre- and post-reform tax structures. A complete description of the three national reform packages, including tax rates for every year between 2013 and 2020, is given in Appendix C.

4.1 Introduction

This section describes the macroeconomic and environmental impacts of a package of illustrative energy tax reforms in Spain, Hungary and Poland. The main objective here is to compare an illustrative energy tax package with common alternatives that raise the same revenue, to see which is 'best'. The chosen package is purely illustrative and each country may wish to consider other designs according to national circumstances. Three pieces of evidence inform the composition of the energy tax package.

The first is the discrepancy in carbon tax rates within each country, shown in section 3. Intra (and indeed, inter-) country variation in carbon energy tax rates leads to higher costs of emissions reduction. Where carbon tax rates are low, relatively low cost abatement opportunities may be ignored, while high carbon tax rates may induce very costly abatement.

The second is the proposed revised EU Energy Tax Directive. This proposal (European Commission 2011d) seeks to harmonise inter- and intra- European energy tax rates. It has two main aspects:

- The establishment of minimum tax rates for various energy products in the EU, with the minima being the sum of two elements, one the CO_2 content and the other the energy content. The principle of the latter is already reflected in the current Energy Tax Directive although the proposal envisages a minimum rate of €9.6/GJ for all motor fuels, to apply from 2018, whereas for heating fuels[15] the proposed rate is €0.15/GJ to apply from 2013. The proposed new CO_2 element is €20/tCO_2 and applies from 2013, except for nine member states (including Poland and Hungary) which may postpone the inclusion of the CO_2 element until January 2021. Combustion emissions from installations within the EU ETS are exempt from the carbon element and residential energy consumption can be entirely exempted from both minima.
- A requirement that the relativities established between the different *minimum* rates are reflected in the *actual* rates. That is, since the proposed minimum transport diesel rate is 8.3 per cent higher than minimum petrol rate (€390/1,000 litres compared to €360/1,000 litres), actual diesel rates should also be 8.3 per cent higher than petrol rates, even if they are above the €360 or €390/1,000 litres minima. This is required with respect to heating fuels by 2013 and for motor fuels by 2023.

Table 5. **The proposed EU Energy Tax Directive would increase the minima for all energy uses and product**

Energy use	Product	Unit	Current minima	Proposed future minima	Year minima must be reached
Transport	Petrol	€/1,000l	359	360	2018
	Diesel (Gas oil)	€/1,000l	330	390	2018
	Kerosene	€/1,000l	330	392	2018
	LPG	€/1,000kg	125	500	2018
	Natural gas	€ per GJ	2.6	10.7	2018
Heating	Diesel (Gas oil)	€ per 1,000l	21	57.37	2013
	Heavy fuel oil	€ per 1,000kg	15	67.84	2013
	Kerosene	€ per 1,000l	0	56.27	2013
	LPG	€ per 1000kg	0	64.86	2013
	Natural gas	€ per GJ	0.15	1.27	2013
	Coal and coke	€ per GJ	0.15	2.04	2013
All	Electricity	€ per MWh	0.5	0.54	2013

Source: European Commission (2011) http://ec.europa.eu/taxation_customs/resources/documents/taxation/minima_explained_en.pdf

15 And some exceptional motor fuel uses.

The third is comments received through consultation with stakeholders who allowed the national circumstances of each country to be taken into account.

For each country, first we present the comparison between the energy tax package and the alternatives. For the interested reader there are more details on the impact of the energy tax package, including a break-down of the impacts across the different elements within the overall (indicative) package. Given the importance of the potential distributional impacts from energy tax reforms, these are covered separately in section 5.

The modelling is conducted with Cambridge Econometrics' E3ME model. This is a macroeconomic model especially built to capture interactions between the economy and the energy system within European countries and across the continent as a whole. The relationships within the model are determined through econometric analysis of historic trends. This is in contrast to the family of Computable General Equilibrium (CGE) models in which such relationships are assumed from first principles. Further details of the model and a discussion of its strengths and weaknesses are presented in Appendix A.

4.2 Spain

Energy taxes might deliver more than €10bn per annum of revenue by 2020 with a smaller impact on GDP than other types of tax

4.2.1 A package of energy tax reforms

The illustrative Spanish energy tax package has been drawn up to illustrate how carbon-energy tax reform might be implemented. It has three main elements.[16]

Increases in tax on transport fuels (particularly diesel). As discussed in section 3, diesel transport fuel accounts for more than 25 per cent of Spain's total emissions from energy consumption but is taxed (on a per tonne of CO_2 basis) at two thirds of the rate of petrol. The package makes the nominal tax rate on non-commercial diesel equal to that on petrol in 2013. There follows a more gradual increase in diesel rates beyond this date, so that, by 2018, the relationship between the diesel and petrol rate reflects the minima in the Energy Tax Directive (ETD), achieving compliance with the requirement in the ETD five years ahead of schedule. The package also includes a phased abolition of the reduced rate of diesel tax for commercial diesel transport use by 2018, as well as removal of exemption for railway diesel and the reimbursement of duty for agricultural use by 2020. Finally, it includes gradual increases in taxes on other transport fuels such as LPG and natural gas, bringing rates in line with the proposed ETD. The real value of tax on unleaded petrol is not changed.

Introduction or increase in taxes on residential energy consumption to bring them in line with rates for non-residential use. Residential natural gas and coal use account for around 3 per cent and 0.2 per cent of total emissions in Spain and are not subject to any taxation. The package introduces taxes on residential consumption of coal and natural gas – both starting at €0.15/GJ in 2013, and increasing to €2.04/GJ for coal and €1.27/GJ for natural gas by 2020. This brings the tax rate on these emissions in line with the ETD minima for non-residential energy use.[17] The introduction of these taxes is more gradual than proposed in the Energy Tax Directive for non-residential energy use. This gentler introduction gives households more time to adjust their behaviour. The package does not include any changes to the real value of taxes on residential electricity consumption.

Increases in taxes on non-residential energy use in line with the minima proposed in EU Energy Tax Directive. Current tax rates on non-residential energy consumption are, in some instances, lower than the minima proposed in the EU Energy Tax Directive. The final element of the package delivers compliance with these minima through increases in the tax rates on natural gas, LPG, heavy fuel oil and coal in 2013. All users of natural gas and LPG experience higher levels of taxation, especially installations outside the EU ETS. Among users of coal and heavy fuel oil, only installations outside the EU ETS face a higher tax rate. The package does not involve any increase in the real value of taxation on non-residential electricity consumption.

Additionally, tax rates are adjusted annually (indexed to inflation) to maintain their real value.

The resulting tax rates for the most important fuels and usages are shown in table 6 below. The tax rates for all fuel and usage combinations are shown in Appendix C.

16 All values cited in the three paragraphs below are in 2011 prices.

17 For installation outside the EU ETS.

Table 6. **A possible profile of revised energy taxes in Spain**

Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1,000l)	425	425	425	425	425	425	425	425	425
Transport diesel (€/1,000l)	331	425	432	440	447	451	462	462	462
Transport diesel for commercial purposes (€/1,000l)	330	352	374	396	418	440	462	462	462
Agricultural diesel net of reimbursement (€/1000l)	0	9.84	19.7	29.5	39.4	49.2	59.0	68.9	78.7
OTHER FUEL USE									
Gas, domestic heating,€/GJ	0	0.16	0.32	0.48	0.64	0.79	0.95	1.11	1.27
Gas, installations outside the EU ETS, €/GJ	0	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Gas installations inside the EU ETS, €/GJ*	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Electricity, domestic, €/MWh**	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Electricity, business use, €/MWh**	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8

Note: *2011 prices. Proposal also includes indexing to account for inflation in each year.*

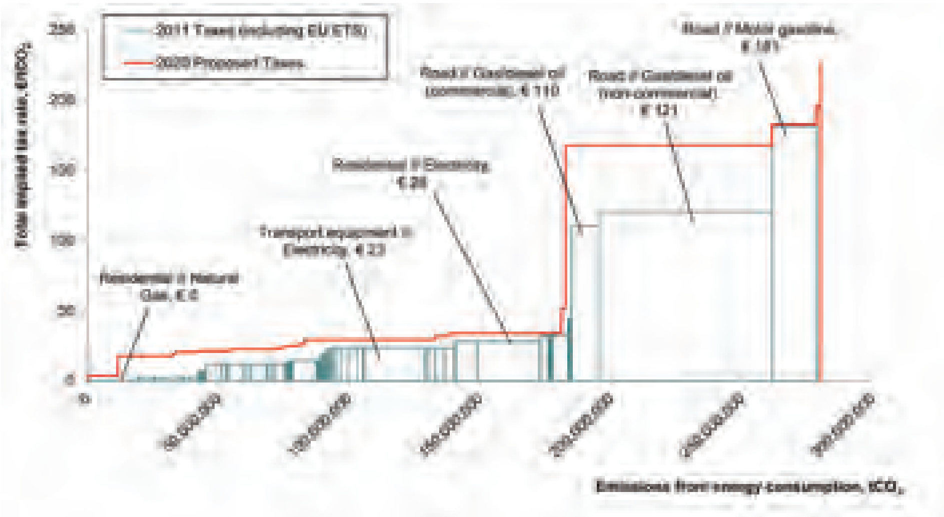
** Gas used within installation inside the EU ETS for industrial/commercial use as defined under Article 8 of the Energy Tax Directive would continue to be taxed at €1.15/GJ, subject to annual indexation.*

*** Tax is levied at 5.113% of electricity price before VAT, which in 2008 came on average to 5.3 €/MWh for domestic electricity use, and 3.8 €/MWh for business electricity use.*

Source: *Vivid Economics*

The proposed tax package can also be displayed as an energy tax curve, similar to the curves analysing the existing carbon-energy tax system in section 3.2.6. Compared to the existing tax system, the proposed reform package covers a larger proportion of all emissions, and significantly reduces the difference between petrol and diesel taxation. This is shown in figure 22.

Figure 22. **The proposed package of reforms increases the average implied carbon tax on energy consumption in Spain from €56/tCO_2 to €76/tCO_2**



Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6/tCO_2 (2011 prices) by 2020, in line with European Commission assumptions. Labelled tax rates refer to existing implied CO_2 rates.*

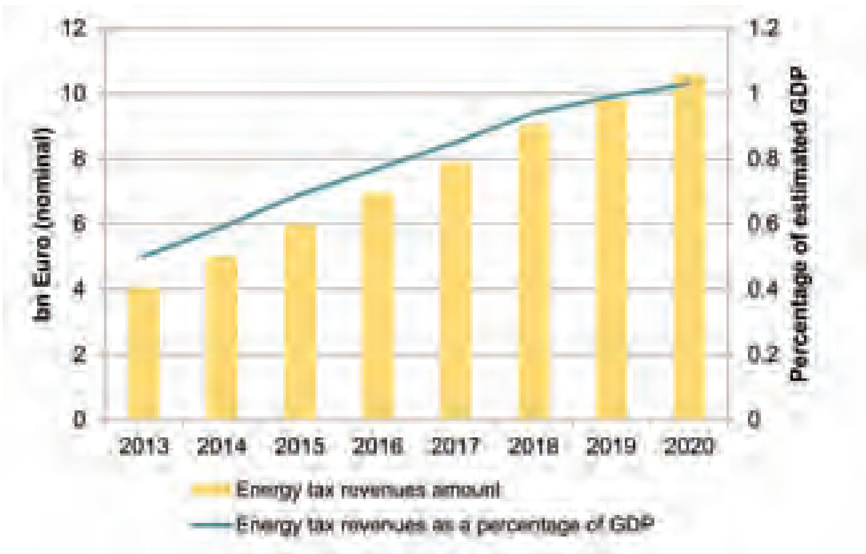
Source: *Vivid Economics based on IEA (2011) and European Commission (2011e)*

Moving on to the amount of revenue that can be expected from this reform package, figure 23 presents the modelling estimates for how much this package might raise in each year to 2020. The increase in revenue is smooth over the entire period, reflecting a gradual phasing in of most changes.

The revenue raised could make a substantial contribution to fiscal consolidation in Spain. The OECD gives Spain's budget deficit for 2011 as 6.2 per cent of GDP (OECD 2011b). The reform package could reduce this deficit by more than 8 per cent by 2013, rising to a reduction of 16 per cent in 2020. Taking into account other fiscal consolidation policies, which the OECD predicts to bring down the deficit to 3 per cent by 2013, the reform package could reduce the remaining deficit by 33 per cent, bringing it down to 2 per cent by 2020.

Appendix C provides the full detail of the package and also shows how it would alter the implied carbon energy tax rates in Spain.

Figure 23. **Spain: in 2013, the energy tax package could deliver €4 billion of revenues rising to €10 billion by 2020**



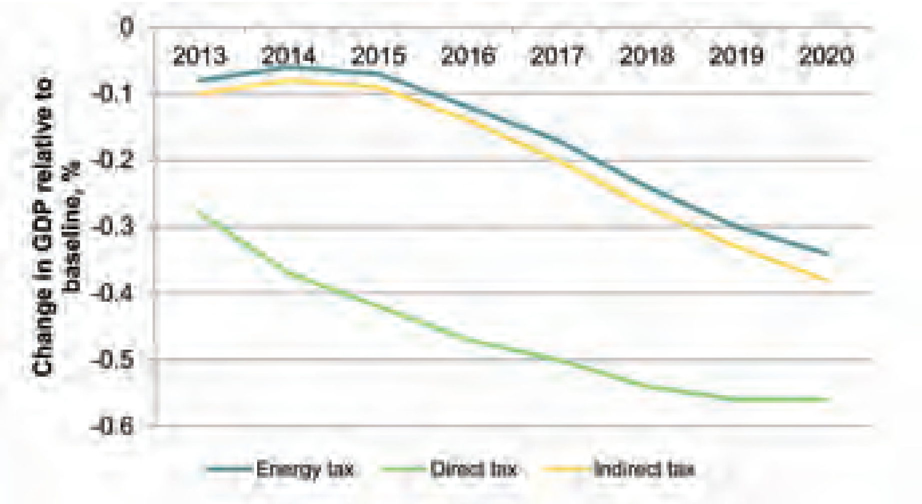
Source: *Cambridge Econometrics E3ME model*

4.2.2 Comparison with alternative revenue raising approaches

The E3ME model is used to compare the macroeconomic impact of the energy tax package described above with the alternatives of increased indirect or direct taxes. Indirect taxes are modelled as an increase in VAT rates while, following the definition provided by Eurostat, direct taxes relate to the taxes on income and wealth (including capital taxes). The model has been calibrated so that each option delivers the same tax revenues in each year in the period 2013 to 2020.

Figure 24 shows the comparative impact of these proposals on GDP. The energy tax package has the least detrimental impact on GDP, with GDP being -0.3 per cent lower in 2020 than under the baseline of no tax increases; indirect tax rises cause slightly larger reductions in GDP while direct tax increases cause a drop in GDP that is almost twice as great.

Figure 24. **Spain: the energy tax package has a smaller impact on GDP than either a package of direct or indirect tax increases that raise the same amount of revenue**



Source: Cambridge Econometrics E3ME model

The three tax packages have dissimilar impacts on GDP, while removing the same amount of money from the economy, for several reasons.

First, both energy and indirect tax increases push up prices, causing a reduction in spending. However, Spain is disproportionately more reliant on energy imports than it is on other imported goods/services, so a greater proportion of the drop in spending from energy taxes is accounted for by a decline in imports than is the case for the indirect tax increase.[18] This implies a smaller decline in GDP as less of the fall in consumer spending is experienced by Spanish producers. Further, in the case of the energy tax package, some of the money previously spent on imported energy is diverted to domestically produced goods and services,[19] further offsetting the decline in GDP. These factors more than offset the fact that the energy tax is expected to lead to a larger fall in exports than the indirect tax increase (0.16 per cent compared with 0.05 per cent in 2020).

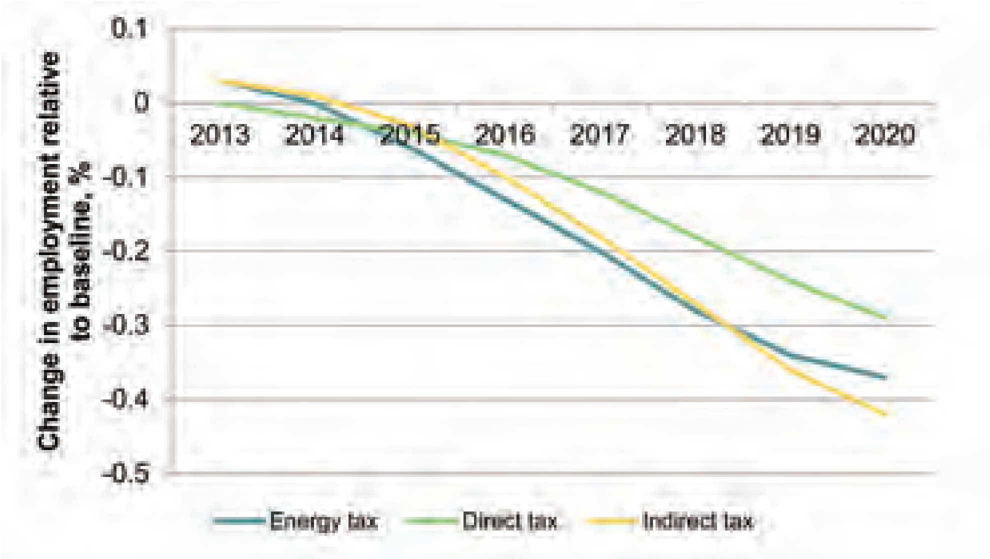
Energy and indirect taxes differ from direct taxes in the way that the model anticipates effects on the labour market. Specifically, based on estimated relationships, the change in prices following indirect tax increases are quickly matched by increases in nominal wages, leaving real wages largely unchanged. By contrast, and in line with empirical estimates (Azémar and Desbordes 2010) upon an increase in direct taxes on wages, only around 50 per cent of the initial decline in post-tax wages is offset by higher pre-tax wages. This proportion rises over time. The consequence is that direct taxes lead to a more significant decline in real wages than indirect/energy taxes. This in turn leads to larger declines in consumption, with the fall in consumption a little less than twice as great in 2020 under the direct tax package compared to the energy tax package. This leads to a significantly more negative impact on GDP. This in turn is exacerbated by the fact that although indirect taxes typically have an aggregate negative impact on investment, this is less severe than for direct taxes because there is an offsetting factor: indirect taxes make investment relatively cheaper than consumption.

Turning to employment, the E3ME model suggests the following impacts to 2020.

18 Over the ten year period imports decline by almost 50 per cent more under the energy tax than under the indirect tax.

19 By 2020, the indirect tax increase is expected to reduce domestic consumption by 0.76% relative to the baseline; the energy tax package results in a fall in consumption of -0.64 per cent.

Figure 25. **Spain: in 2020, the decline in employment from the indirect tax rise is expected to be the greatest**

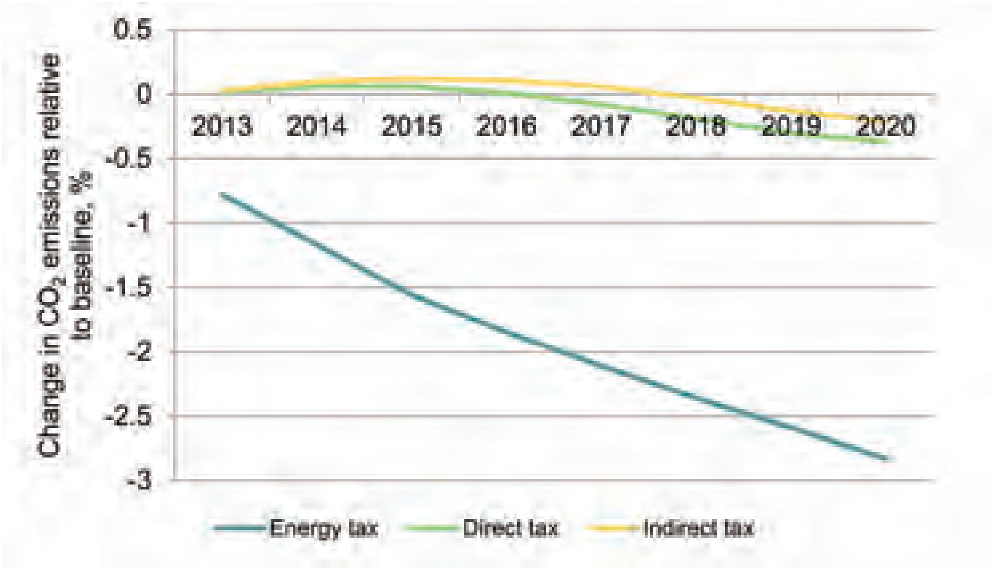


Source: *Cambridge Econometrics E3ME model*

The figure shows that the packages are expected to have broadly similar impacts on employment to 2015, at which point the direct tax package leads to smaller falls in employment. This is again explained by the differing effects of the tax rises on the labour market. In particular, since the model anticipates that only 50 per cent of the decline in post-tax incomes is offset by higher nominal wage demands, whereas all of the increase in prices from indirect and energy tax rises is offset by higher nominal wages, labour is relatively cheaper under the direct tax package, and so more is demanded. Hence, even though the GDP declines are the greatest from this tax package, it has the least damaging impact on employment, with the energy tax reform package being second best and better than the indirect tax package.

Finally, and as would be expected, the energy tax package has a much greater impact on fuel consumption and hence CO_2 emissions than either the direct or indirect tax package. The results for CO_2 emissions are shown in figure 26. The figure shows that the energy tax package leads to an immediate fall in CO_2 emissions of 0.75 per cent relative to the baseline in 2013, largely as a consequence of the higher taxes on transport diesel and non-residential energy use. Further declines in emissions are achieved throughout the period such that emissions are more than 2.5 per cent lower than in the baseline by 2020. By contrast, the direct and indirect taxes result in only small declines in emissions (less than 0.5 per cent compared to the baseline by 2020) as a result of the overall decline in economic activity caused by these tax packages. Indeed, in the early years of the period they are expected to mildly increase emissions as the reduction in real incomes experienced by households causes a reduction in household investment and old, inefficient equipment is used for longer.

Figure 26. **Spain: the energy tax package results in a greater emissions reduction than the direct and indirect tax packages**



Source: *Cambridge Econometrics E3ME model*

4.2.3 Further details on the illustrative energy tax package

This sub-section provides further details of the modelled impacts of the energy tax reform package while the next sub-section breaks down these impacts across the different elements of the package.

Key results are shown in table 7. Although they are provided here for the interested reader, both subsections can be omitted without any loss of continuity in the overall argument.

Table 7. **The energy tax package causes a small decline in GDP and employment but raises more than €10bn by 2020 and causes Spanish CO_2 emissions to fall by more than 2.8 per cent**

Variable	Unit	Change by 2020	Percentage change relative to baseline
GDP	m€, 2011 prices	-4,850	-0.34
Employment	Thousands of jobs	-79	-0.37
Consumption	m€, 2011 prices	-4,994	-0.64
Investment	m€, 2011 prices	-450	-0.11
Exports	m€, 2011 prices	-777	-0.16
Imports	m€, 2011 prices	-1,372	-0.26
CO2 emissions	Thousand tonnes	-9,523	-2.83
Total fuel consumption for energy use	Thousand tonnes of oil equivalent (toe)	-3,594	-3.29
Tax revenues	m€, nominal prices	10,584	1% of 2020 GDP

Source: *Cambridge Econometrics E3ME model*

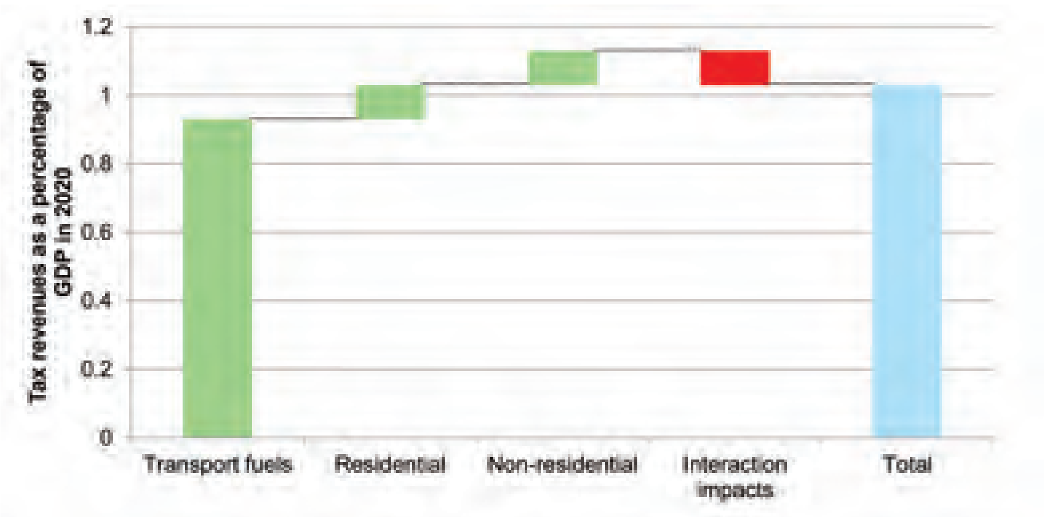
The table shows an overall decline in GDP of just over 0.3 per cent (relative to the baseline), which comprises several factors. First, higher energy prices cause a reduction in residential consumption. Second, they cause exports to fall as higher costs impair the competitiveness of some firms. The residential consumption effect is much stronger than the export effect both in absolute terms (the reduction in residential consumption is almost €5,000m per annum by 2020, while the reduction in exports is just over €775m per annum) and in relative terms (consumption is -0.64 per cent lower than in the baseline in 2020, while exports only fall by -0.16 per cent[20]). Indeed, although exports fall, imports fall by more as the higher energy taxes reduce the amount of energy imported from overseas, a factor that is exacerbated by a general fall in economic activity that also depresses imports. The net trade balance increases by around €600m by 2020. Finally, there is an impact on investment. At the start of the period, there is a switch from consumption to investment, including energy efficiency investment; over time this effect is more than offset by the decline in other economic activity, causing firms to cut back on investment.

The model also indicates the sectoral breakdown of changes in output. As might be expected, given that much of the increase in taxes within the package are placed on gas and transport fuels, the distribution, land transport and gas supply sectors are the three sectors that see the largest falls in output. The output in the distribution and land transport sectors falls by up to 1 per cent by 2020 (relative to the baseline), while the gas supply sector sees output declines (relative to the baseline) of almost 4 per cent in 2016, although this narrows to close to 1.5 per cent by 2020. Motor vehicle manufacturing also sees output declines of between half and three quarters of one per cent compared to the baseline over the second half of the decade. There are also some sectors that experience small output increases as a result of the package, including the textiles, clothing and leather sector as shifts in relative prices mean that consumers buy more output from these sectors.

4.2.4 Impacts of the different elements of the energy tax package

The overall impacts of the illustrative energy tax package can be further decomposed into the separate elements. This suggests that the greatest revenue raising opportunity is likely to come from increasing taxes on transport fuels: the proposed increases in transport fuels in our package contribute both the largest amount of taxation revenue – amounting to more than 0.9 per cent of expected GDP in 2020 – and correspondingly the largest proportion of emissions reductions.[21]

Figure 27. **Spain: the taxes on transport fuels are responsible for the bulk of the tax revenues raised**

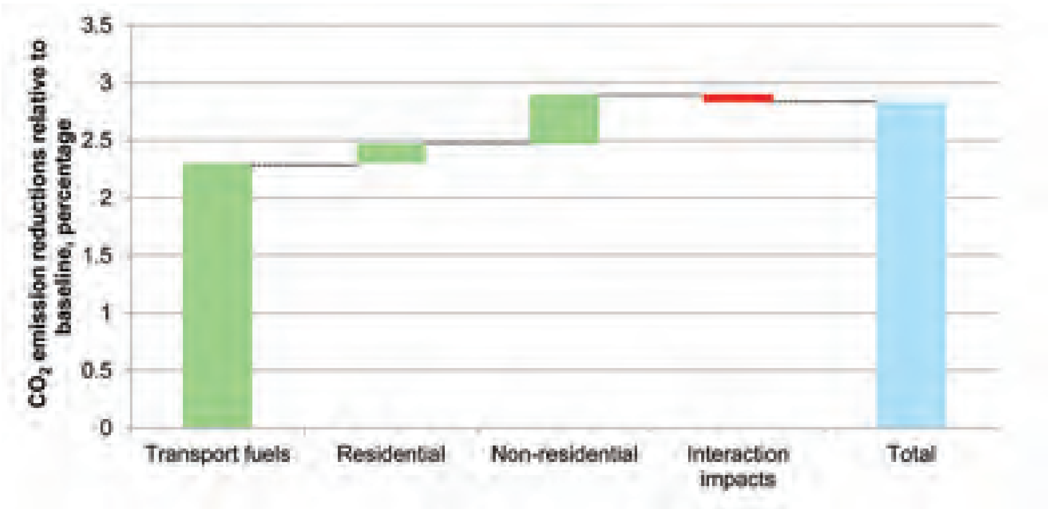


Note: The interaction impacts account for the fact that when the whole tax package is introduced, the overall revenues

20 Although, as discussed in section 2, macroeconomic models like E3ME may not capture the decline in exports and competitiveness that might be experienced in specific product markets as a consequence of higher energy taxes.

21 It should be noted that the E3ME model assumes that there are no cross-price effects between diesel and petrol i.e. higher diesel prices do not lead to a switch to petrol consumption. This is consistent with the findings from the literature review reported by (Dahl 2011) who cites papers that found very little evidence across 23 countries that there was significant cross price elasticity of demand between diesel and petrol or vice versa.

Figure 28. **Spain: the increased taxes on transport fuels deliver the greatest proportion of the emission reductions**

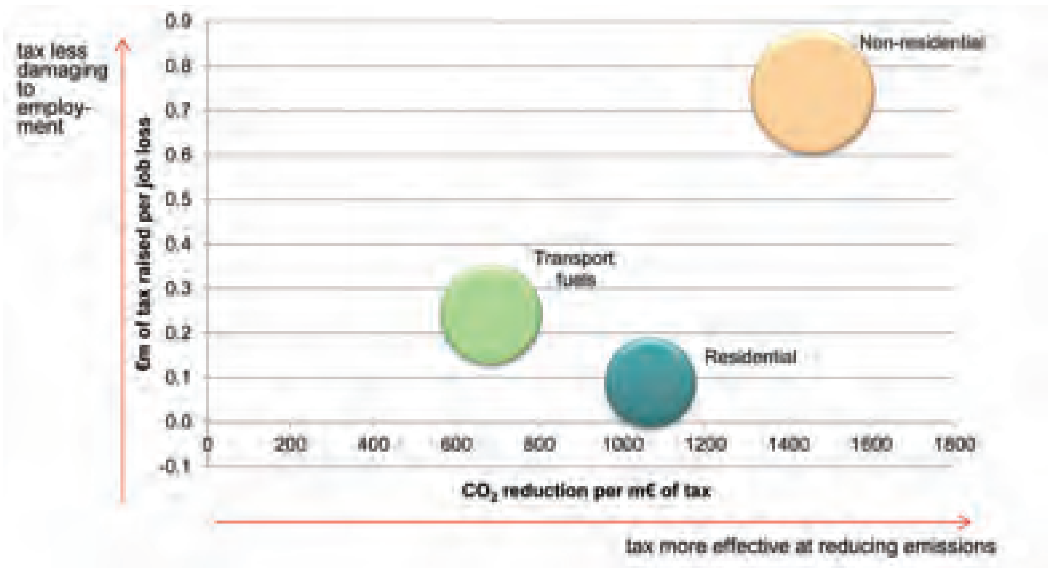


Note: *The interaction impacts account for the fact that when the whole tax package is introduced, the overall emissions reductions are slightly lower than the sum of the emissions reduction were each element of the package to be introduced in isolation.*

Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

It is also possible to show how efficient the elements of the tax package are both in terms of delivering emission reductions for each euro of tax raised and also in terms of the number of jobs lost/reduction in GDP for every euro of tax revenue raised. This is shown below in figure 29 where each 'bubble' represents an element of the tax package. The further to the right the bubble is, the more emissions reductions are delivered for each euro of tax revenue raised; the higher up the bubble is, the more tax revenues are raised for each job that is lost. Similarly, the larger the bubble the more tax revenues are raised for each euro of GDP that is lost. Therefore, the further to the top-right and the larger the bubble, the more attractive that element of the tax package might be.

Figure 29. **Spain: the increased taxes on industry deliver more emissions reduction and are less damaging to employment and output than the other elements of the package**



Note: *Bubble size proportional to tax revenues raised per €m of GDP decline i.e. a larger bubble implies a smaller decline in GDP.*

Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

The results suggest that although the non-residential taxes contribute the smallest amount of revenue in our package, per euro of tax raised they may be the most attractive. They both deliver more emission reductions for each euro of tax raised and allow more tax to be raised for every job lost or euro of GDP decline. The Spanish energy tax package reduces employment by 4.9 jobs for every million euros of tax revenues raised in 2020. The emissions effectiveness is a consequence of the relatively emissions intensive mix of fuels used by the non-domestic sector compared to the economy as a whole. The economic effectiveness can be explained by the contribution of consumption in overall GDP and the labour intensity of many of the sectors that rely on consumer spending. This means that taxes that have a negative impact on consumption are likely to have a larger negative impact on overall GDP and employment. As residential energy taxes are fully passed through to the prices paid by final consumers whereas only a proportion of the increase in taxes on transport fuels and non-residential energy taxes fall on final consumers, the former has a greater effect on employment and GDP than the latter.

This latter effect is exaggerated in the E3ME model as data constraints lead to an assumption that all profits are saved rather than, for instance, used to finance investment or paid out as dividends. Therefore the impact of a decline in profits on GDP and employment is not fully captured. Although this is regrettable, it is probable that the direction of the results is correct, for instance, it is acknowledged that the savings rates of companies are higher than those of consumers (a factor which is partly responsible for the current economic challenges seen in Europe). In addition, changes in wealth associated with retention of profits or dividend payments tend to accrue to high-income/wealthy individuals whose consumption patterns are less responsive to changes in income, or to pension funds where changes in value (and hence to the wealth of households) do not have much impact on household saving and spending.[22] Finally, the assumption appropriately captures multinationals that repatriate their profits.[23]

4.2.5 Conclusions

In Spain, energy taxes are likely to raise revenue more benignly than direct or indirect taxes and bring an environmental dividend.

The findings are:

- It is possible to raise substantial tax revenues from reforms to energy taxes. The illustrative package examined here could deliver more than €10 billion per annum by 2020, equivalent to more 1 per cent of projected Spanish GDP.
- Crucially, if the same amount of money was raised through either direct or indirect taxes then it would be likely to have a more detrimental macroeconomic impact. While, by 2020, the energy tax package we consider is expected to reduce GDP by a little more than 0.3 per cent relative to the baseline; indirect taxes might reduce GDP by a further 0.04 per cent of GDP and direct taxes are expected to cause GDP to decline by more than 0.5 per cent relative to the baseline.
- At the same time, the energy tax reform could lead to a significant improvement in emissions performance that would not be delivered by direct or indirect taxes. In the package we consider energy taxes could deliver national CO_2 emission reductions of more than 2.5 per cent per annum by 2020, while the other forms of taxation have a negligible impact on emissions.
- Taking into account the proposed Energy Tax Directive, as well as the desirability of setting appropriate (relative) price signals, the clearest opportunities for increasing taxes relate to the taxing of transport fuels and, especially, closer alignment of petrol and diesel rates and the gradual removal of subsidies for commercial diesel use. These would also deliver the greatest emission savings. However, although the greatest amount of additional tax revenues comes from transport fuels, per euro of tax revenue raised, taxes on non-residential energy use appear to have both the least detrimental impact on GDP and employment and deliver the greatest emissions savings.

22 For instance, the Federal Reserve Board assumes that the long run marginal propensity to consume from a change in wealth is only 3.8 per cent i.e. 96.2 per cent of the value of the wealth change is saved. See (Buiter 2008).

23 Taking account of these factors, sensitivity analysis by Cambridge Econometrics suggests that an alternative treatment of profits would lead to differences in GDP impacts of no more than 0.05 percentage points.

4.3 Poland

4.3.1 Polish energy tax package

The illustrative package of Polish energy tax reforms consists of the same three elements as the Spanish package, although the precise reforms reflect specific national circumstances.

Transport taxes. Transport diesel consumption (excluding diesel used in the agriculture sector) accounts for 10 per cent of Poland's emissions from energy use but is taxed, on a per tonne of CO_2 basis, at around two thirds of the rate of petrol. Therefore the package involves steady increases in the excise duty rate on diesel so that Poland is on track to meet the required relationship between the minima rates in the ETD by 2023. This requires faster increases in transport diesel tax rates than needed for compliance with the minima in the Directive in 2018. The package also includes steady increases in tax rates on LPG and natural gas to meet the minima in the ETD by 2018, as well as the phasing out of subsidies on agricultural diesel. Rebates not linked to energy consumption would be provided for diesel for agricultural use for distributional reasons while preserving the marginal incentive to reduce energy consumption/emissions. The package does not include changes in the tax rate on petrol.

Residential energy taxes. Residential consumption of gas and coal accounts for almost 12 per cent of Poland's emissions from energy consumption but is not subject to tax. Coal is particularly prevalent among households, accounting for almost 75 per cent of energy emissions from the residential sector and almost 9 per cent of total Polish emissions from energy use. The package progressively introduces taxes on residential coal and gas consumption so that they move towards the minima in the ETD for installations outside the EU ETS. In Poland, such installations have until 2021 to comply with the CO_2 minima. The residential coal tax rises from €0 /GJ[24] to €1.81/GJ by 2020 and the natural gas tax rises from €0/GJ to €1.13/GJ by 2020 (2011 prices).

Non-residential energy taxes. Finally, the package increases taxes on non-residential energy consumption so that the minima are either reached or on track to be reached. This takes into account the exemptions Poland has with respect to the CO_2 element of the taxes for non-transport fuels until 2021. There are steady increases in the tax rate for heavy fuel oil, LPG, gas and coal for installations outside the EU ETS, but no changes in the tax rates on fuel use for installations within the EU ETS.

It shares with the Spanish package an automatic indexation of the tax rates to preserve their value in 2011 prices and has the same focus on taxation of emissions outside the EU ETS.

A numerical summary of these proposals is given in table 8 below, focussing on the development of the most important tax rates. A complete table covering all fuels and usages is included in Appendix A.

Table 8. **A possible profile of revised energy taxes in Poland, euros, 2011 prices**

Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1000l)	422	422	422	422	422	422	422	422	422
Transport diesel (€/1000l)	327	339	351	363	375	387	399	411	423
OTHER FUEL USE									
Coal, domestic, €/GJ*	0	0.23	0.45	0.68	0.91	1.13	1.36	1.59	1.81
Coal, installations outside the EU ETS, €/GJ*	0	0.23	0.45	0.68	0.91	1.13	1.36	1.59	1.81
Coal, installations inside the EU ETS, €/GJ*	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Electricity, domestic, €/MWh	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Electricity, business use, €/MWh	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1

Note: *2011 prices. Proposal also includes indexing to account for inflation in each year.*

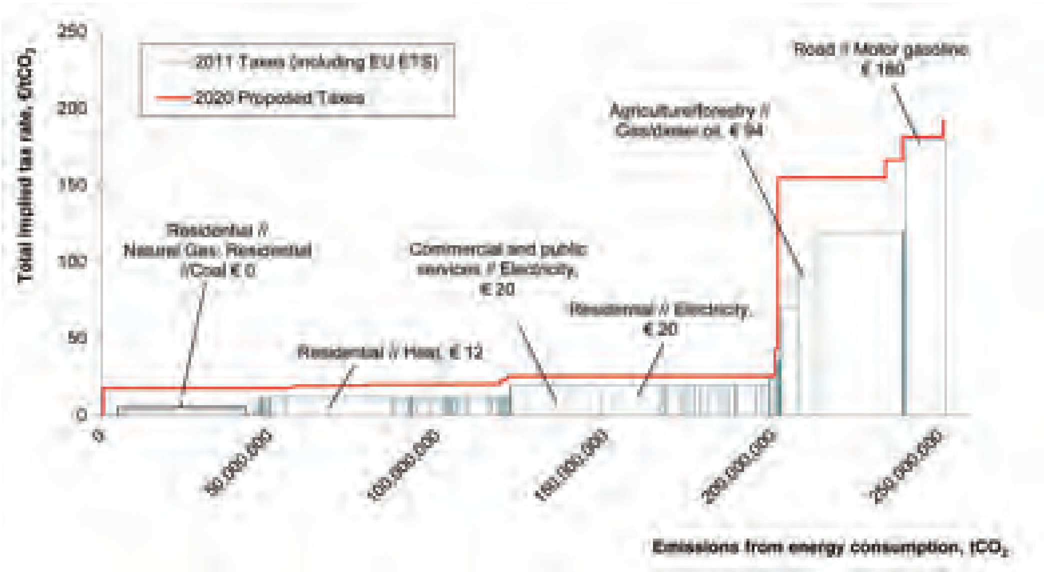
* *This modelling was undertaken before the recent introduction of a coal tax in Poland was introduced. The 'current' coal tax rate is therefore given as 0 (as was used in the model), even though Poland is now levying a tax of €0.29/GJ on coal.*

Source: *Vivid Economics*

24 This modelling was undertaken before the recently introduced coal tax in Poland was announced. The 'current' tax rate on coal used in the model is hence €0/GJ, even though Poland now levies a tax of €0.29/GJ on both residential and business use of coal.

Figure 30 illustrates how the illustrative package of reforms alters the profile of energy taxes in Poland by 2020. It increases the real implied carbon tax rate on energy consumption, using current consumption weights, by around 36 per cent. There would be a more uniform implied carbon tax rate on all non-transport energy uses, and less variation in the implied carbon tax rates on transport fuels. The difference in implied tax rates on transport and non-transport energy uses would grow.

Figure 30. **The proposed package of reforms may increase the average implied carbon tax on energy consumption in Poland from €35/tCO_2 to €50/tCO_2**

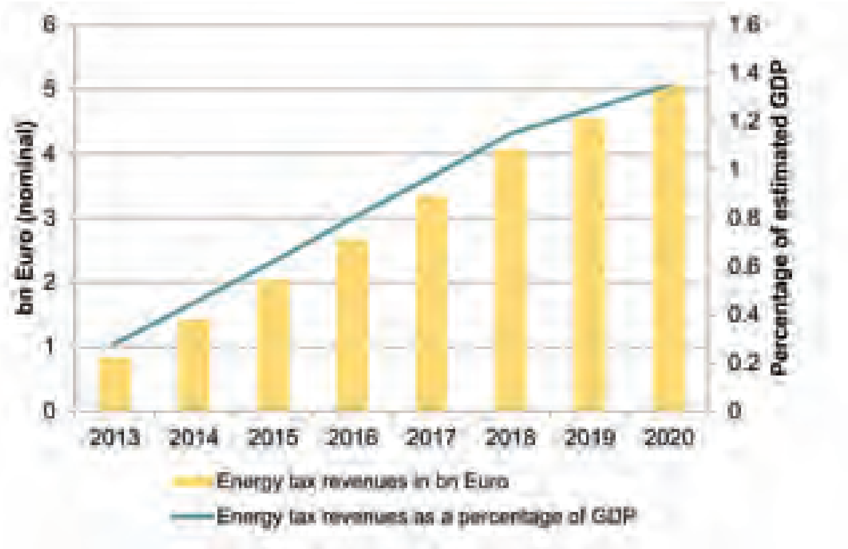


Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6/tCO2 (2011 prices) by 2020, in line with European Commission assumptions.*

Source: *Vivid Economics based on IEA (2011) and European Commission (2011e)*

Figure 31 below illustrates the revenue raising potential of this illustrative package. In the context of fiscal consolidation, the package could make a substantial contribution in Poland. According to the OECD, Poland's budget deficit for 2011 is 5.4 per cent of GDP (OECD 2011b). In the short run, the reform package provides only a modest reduction (reducing the deficit by 4 per cent by 2013) due to its phased introduction. However, in the medium run (by 2020), it could reduce the deficit by more than a quarter (taking the 2011 deficit as the base). Taking into account other fiscal consolidation policies, which the OECD predicts to bring down the deficit to 2 per cent by 2013, the reform package could nearly eliminate the deficit by 2020, reducing it by 68 per cent to 0.4 per cent of GDP.

Figure 31. **Poland: the illustrative energy tax package could raise more than €5bn of revenue by 2020**



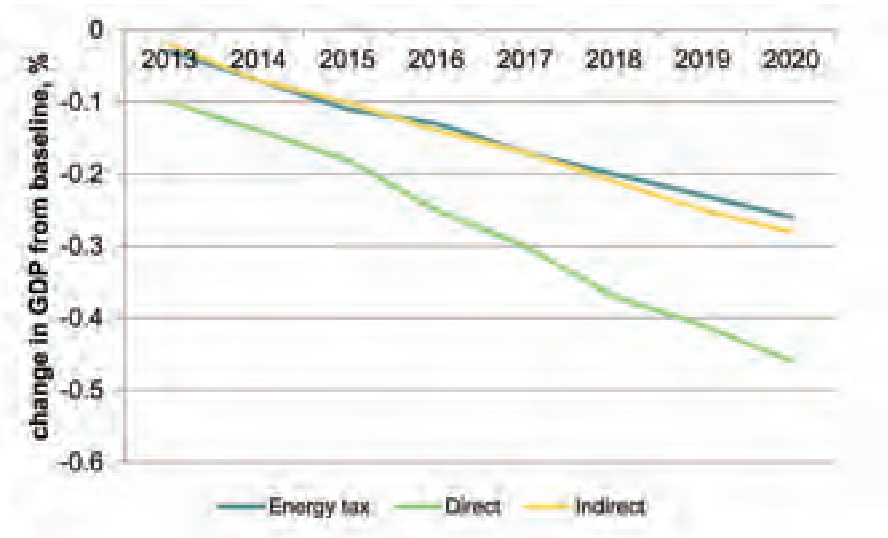
Source: Cambridge Econometrics E3ME model

4.3.2 Comparison with alternative tax packages

This subsection compares the results from the E3ME model on the macroeconomic impact of the above energy tax package with alternatives of either direct taxes[25] or indirect taxes (Value Added Tax). The model has been calibrated so that each of these alternatives delivers the same tax revenues in each year between 2013 and 2020.

Figure 32 shows that both the energy package and indirect tax are expected to lead to relatively similar, and small, declines in GDP (0.25-0.3 per cent lower than the baseline by 2020) but that direct taxes may cause a larger decline in GDP of close to 0.45 per cent of GDP by 2020.

Figure 32. **Poland: indirect and energy taxes have very similar impacts on GDP; direct taxes cause more significant declines in GDP**



Source: Cambridge Econometrics E3ME model

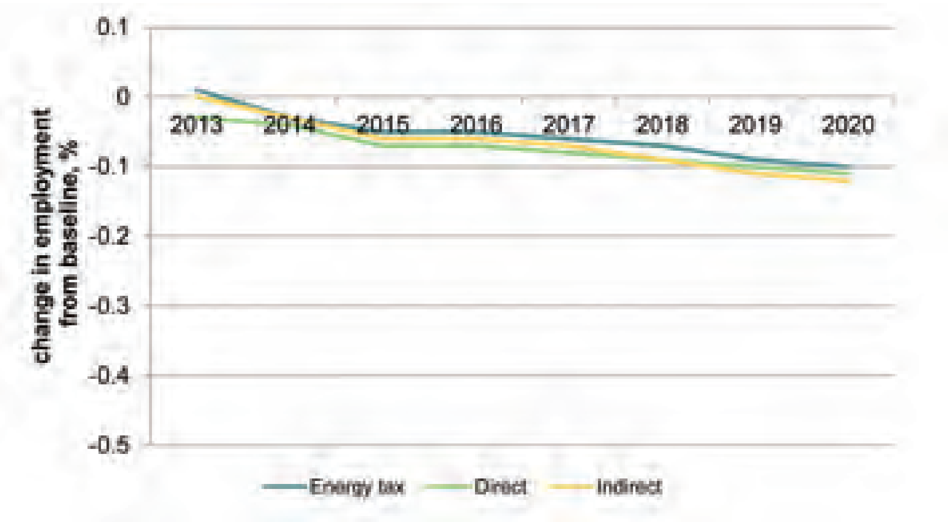
25 Defined, as in the case of the Spanish results, as taxes on income and wealth including income taxes and capital taxes.

The difference between the indirect and energy tax package, on the one hand, and the direct tax package, on the other, has the same origin as the Spanish results. Both the energy tax package and the indirect tax packages result in higher prices. The model predicts that this leads to a broadly equivalent adjustment in nominal wages, allowing real consumption to stay close to its previous levels. By contrast, the wage response to the direct tax increase is assumed to counteract only 50 per cent of the initial decline in post-tax incomes. This results in a greater decline in consumption: the reduction in consumption from the baseline by 2020 is more than twice as great under the direct tax increase as opposed to the energy tax increase (€1,802m compared with €842m).

The indirect tax and energy tax package both reduce GDP by broadly the same amount. This is in contrast to the Spanish results where the energy tax reforms have a smaller impact on GDP. This difference is explained by the fact that in Spain the energy tax package suppresses imports by around 50 per cent more than the indirect tax over the ten year period. By contrast, in Poland the energy tax package causes a smaller fall in imports than the indirect tax. This is because Poland supplies a lot more of its own energy than Spain.

The modelled employment impacts of the energy tax package and the two alternatives are very similar: each leads to around a 0.1 per cent decline in employment. The direct tax has a similar impact on employment to the other packages, despite its worse GDP impact, because the smaller adjustment in nominal wages to declines in post-tax income results in labour becoming relatively cheaper than under the other options. By 2020, employment losses from the indirect tax are slightly greater than in the other two options, reflecting the relatively greater damage suffered by the labour-intensive service sectors under the indirect tax package.

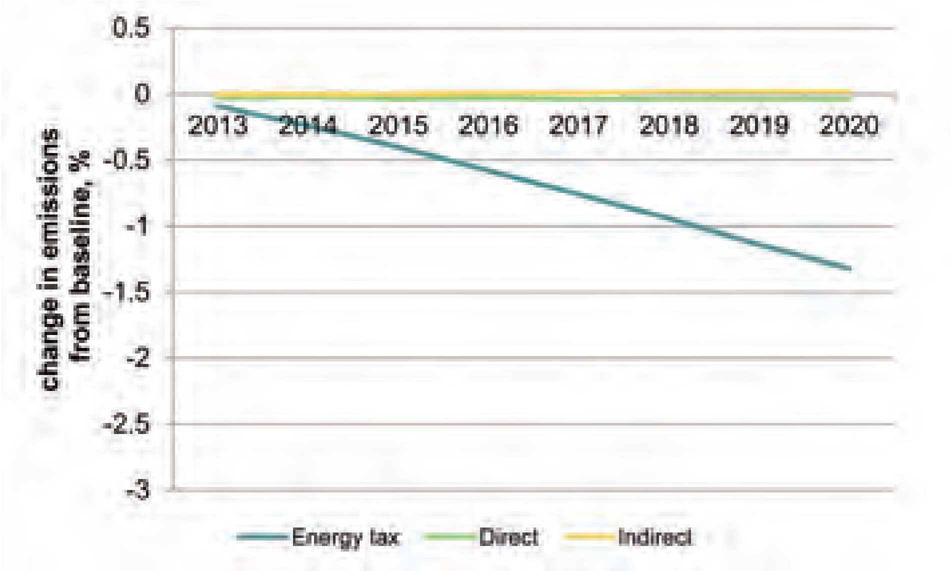
Figure 33. **Poland: all of the tax packages are expected to lead to similar declines in employment**



Source: *Cambridge Econometrics E3ME model*

Finally, the energy tax package delivers a significantly superior environmental performance. While there is essentially no change in fuel use and emissions under the direct and indirect taxes, they decline by more than 1.6 per cent and 1.3 per cent respectively with the energy tax package. Figure 34 illustrates the difference between the options for CO_2 emissions.

Figure 34. **Poland: the energy taxes reduce emissions by more than 1 per cent while the direct and indirect taxes have no material impact**



Source: Cambridge Econometrics E3ME model

4.3.3 Further details on the energy tax package

This sub-section provides further details of the impacts of the illustrative energy tax reform package that we model while the following sub-section breaks down these impacts across the different elements of the package. Although they are provided for the interested reader, both subsections can be omitted without any loss of continuity in the overall argument.

Table 9 below shows the key modelling results for the illustrative package of Polish energy tax reforms.

Table 9. **The energy tax package causes a small decline in GDP and employment but raises taxes equivalent to almost 1.4 per cent of expected 2020 GDP while reducing Polish CO_2 emissions to fall by 1.3 per cent**

Variable	Unit	Change by 2020	Percentage change relative to baseline
GDP	m€, 2011 prices	-1,038	-0.26
Employment	Thousands of jobs	-15	-0.10
Consumption	m€, 2011 prices	-842	-0.34
Investment	m€, 2011 prices	-253	-0.21
Exports	m€, 2011 prices	-25	-0.01
Imports	m€, 2011 prices	-82	-0.04
CO2 emissions	Thousand tonnes	-4,302	-1.32
Total fuel consumption for energy use	Thousand tonnes of oil equivalent (toe)	-1,184	-1.62
Tax revenues	m€, nominal prices	5,065	1.35% of 2020 GDP

Source: Cambridge Econometrics E3ME model

As reported above, the modelling shows GDP in 2020 being 0.26 per cent lower than in the baseline. As with the Spanish results, the reduction in GDP is largely driven by lower consumption which falls by proportionally more. There are significantly smaller negative impacts on GDP through investment and exports. The investment effect comes about because future investment returns are linked to GDP.[26] The export effect can be interpreted as a small decline in industrial competitiveness.[27] The decline in investment by 2020 is only 30 per cent of the decline in consumption while the decline in exports is equal to only 3 per cent of the decline in consumption. Indeed, the net trade balance adjusts as the higher energy prices and lower economic activity result in a fall in (primarily energy) imports, which is more than three times greater in 2020 than the decline in exports.

Although the expected dynamics are similar to those for Spain, the modelling indicates that, for this package of reforms, each euro of energy tax raised in Poland leads to a slightly smaller decline in GDP and consumption than in Spain. This is because in Spain, where the package of energy taxes is weighted further towards higher taxes on transport fuels, some of the sectors that tend to be adversely affected by the energy taxes are also large employers, for example, the distribution sector. In these sectors, the decline in employment has a larger knock-on effect on the rest of the economy. By contrast, the sectors that are adversely affected by the package of energy taxes in Poland are not such large employers and so the decline in output and employment in these sectors has lower impact.

Figure 33 showed that the illustrative energy tax package might result in a reduction in employment in 2020 of 0.1 per cent relative to the baseline, this is equivalent to around 15,000 jobs. As with GDP, each euro of tax raised in the Polish package leads to a smaller reduction in employment than in the Spanish package: the Spanish energy tax package reduces employment by 4.9 jobs for every euro million of tax revenues raised in 2020, in Poland the equivalent figure is 2.9. The smaller employment impact in Poland compared to Spain has the same explanation as the GDP results.

At the same time, the energy tax package reduces Polish fuel consumption by 1.6 per cent and, as shown in figure 34, carbon dioxide emissions by 1.3 per cent. It is noteworthy that compared to Spain:

- The package results in limited changes in fuel consumption. The Polish tax package raises tax revenues equivalent to 1.35 per cent of GDP in 2020 and causes a reduction in fuel consumption of 1.6 per cent in 2020. By contrast, Spain's energy tax package only raises 1 per cent of expected 2020 GDP but reduces fuel consumption by 3.3 per cent by 2020. This is because Spain's energy tax package is heavily weighted towards higher taxes on transport fuel which, in the long term (as fleets are upgraded) leads to a greater demand response than higher taxation of residential fuel consumption.
- Each unit of reduced fuel consumption in Poland leads to a greater reduction in emissions. In Spain the ratio of CO_2 reduction per tonne of oil equivalent of fuel consumption is 0.72 tCO_2/toe; in Poland it is 1.09 tCO_2/toe. This reflects Poland's carbon-intensive fuel mix as well as a greater proportion of the energy tax package in Poland being applied to residential and non-residential energy use (rather than transport fuels) which use more carbon intensive fuels.

Overall, the former impact is slightly more important. Consequently, in the Polish package, CO_2 emissions fall by 745 tonnes per annum for every euro million of tax revenues raised in 2020, while in Spain the figure is 845 tonnes per annum.

The model shows a change in the pattern of sectoral output broadly in line with expectations. Coal and fuel manufacture are the only sectors to experience output declines (relative to the baseline) of greater than 1 per cent in any year between 2011 and 2020.

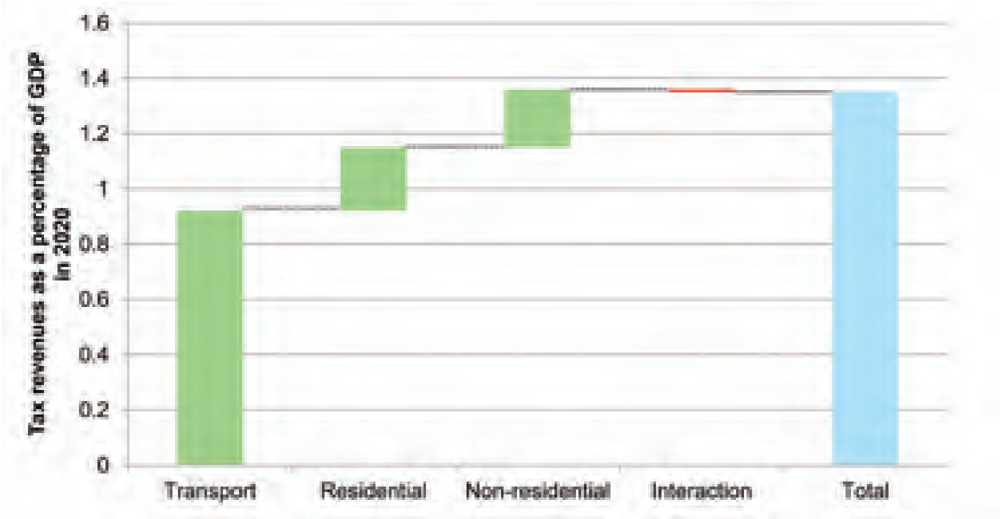
4.3.4 Impacts of the elements of the energy tax package

Figure 35 and figure 36 show the composition of the elements of the indicative energy tax package, first in terms of their revenue raising contribution (in 2020, as a percentage of 2020 GDP) and then in terms of their contribution to emissions reductions.

26 The E3ME model for Poland does not capture the possible increase in business investment resulting from a switch from consumption to investment as a result of higher consumer prices e.g. greater energy efficiency investment. This is because the time-series of data available are too short to estimate reliable model parameters.

27 Although, as discussed in section 2 and Appendix A, macroeconomic models like E3ME do not capture the decline in exports and competitiveness that might be experienced in specific product markets as a consequence of higher energy taxes.

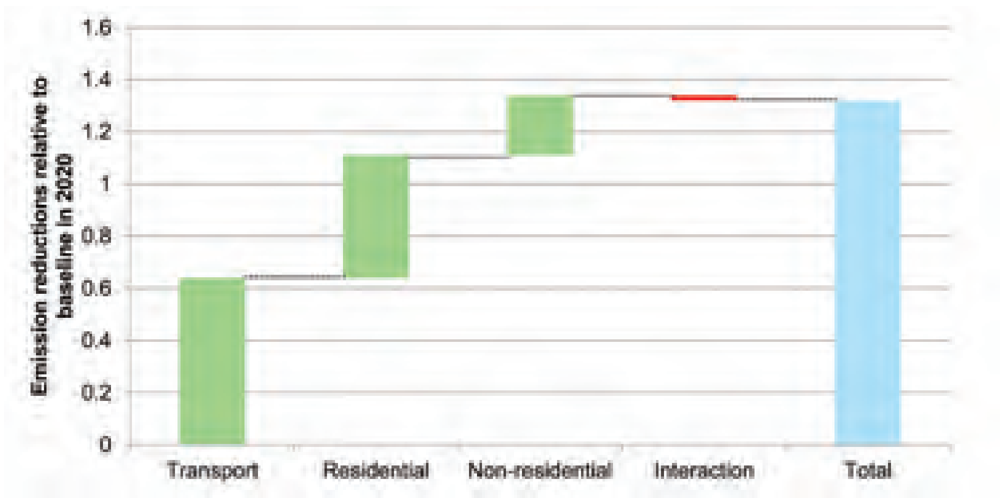
Figure 35. **Poland: taxes on transport fuels raise the greatest amounts of revenue in the package**



Note: *The interaction impacts account for the fact that when the whole tax package is introduced, the overall revenues raised are slightly lower than the sum of the revenues raised when each element of the package is introduced in isolation.*

Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

Figure 36. **Poland: the taxes on residential energy consumption make the greatest contribution to emissions reduction**



Note: *The interaction impacts account for the fact that when the whole tax package is introduced, the overall emissions reductions are slightly lower than the sum of the emissions reduction were each element of the package to be introduced in isolation.*

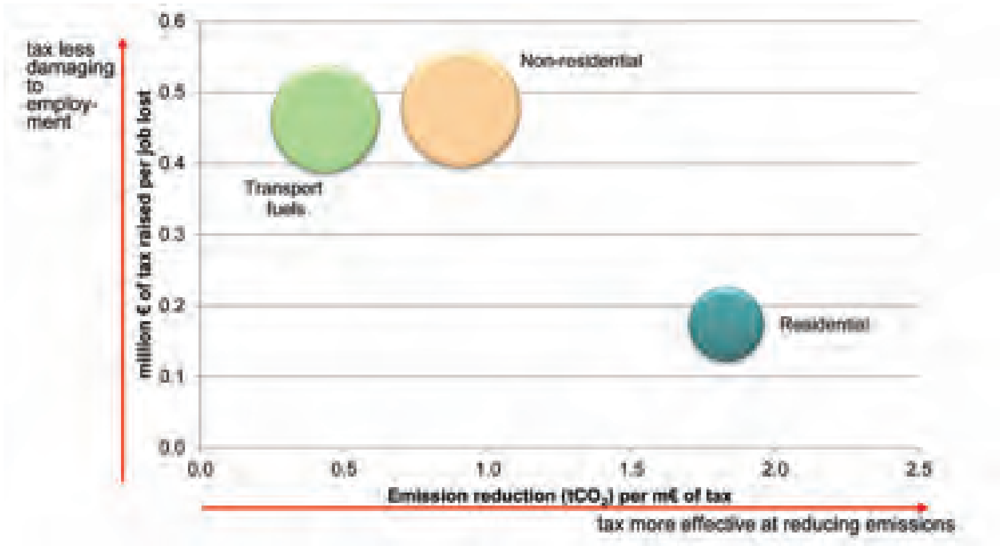
Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

These results suggest that changes to transport fuel taxation make the greatest contribution to revenue. In the package they raise revenues equivalent to more than 0.9 per cent of GDP in 2020 and around 68 per cent of the total revenue increase from the package. This reflects both the substantial increases in the nominal tax rate applied to diesel, around 30 per cent, on a tax base that is responsible for more than 10 per cent of total Polish emissions. However, both the residential and non-residential taxes are also capable of making an appreciable contribution to tax receipts. In this example, they are responsible for raising taxes equal to around 0.2 per cent of 2020 GDP – in both cases, although the absolute increase in tax rates is relatively small, the tax base is relatively wide.

The contribution of elements of the package to emissions reduction is notably different from their contribution to tax revenues. In the modelled example, residential energy taxes account for over 35 per cent of the emissions reductions achieved by the package despite contributing less than 20 per cent of the tax revenues. Likewise, the non-residential taxes make a relatively greater contribution to emission reductions than they do to revenue raising. In both cases, this is explained by the relatively carbon intensive nature of the energy used for these purposes relative to transport fuels as well as the fact that the existing prices for energy used for these purposes is lower, meaning that the same absolute increase in prices/taxes represents a greater percentage change in prices.

This effect is also captured in the 'bubble chart', figure 37. As in the equivalent chart for Spain, the bubbles show how the elements of the package compare in terms of emissions reduced per euro of tax raised (increasing to the right); tax raised per decline in employment (increasing up the chart); and the tax raised for each million euros of GDP loss shown by the bubble size (revenue per GDP loss increasing with bubble size). A larger bubble further to the top-right is more attractive.

Figure 37. **Poland: residential energy taxes are the most effective at reducing emissions but also cause more employment losses for every euro of tax revenue**



Note: Bubble size proportional to tax revenues raised per €m of GDP decline i.e. a larger bubble implies a smaller decline in GDP.

Source: Vivid Economics based on Cambridge Econometrics E3ME model

The chart suggests that residential energy taxes are the most effective at reducing emissions, but, because they have a large impact on residential consumption, they are also the element of the tax package that has the most adverse impact on GDP and employment per euro of tax raised. The relative unattractiveness of residential energy taxes is explained by the significant negative impact residential energy taxes have on consumption, the largest component of GDP. As with the Spanish results this effect is exaggerated by the assumption in the E3ME model that all profits are saved and hence changes (declines) in profits have no impact on consumption or investment. However, for the reasons stated previously, the direction of the results is still likely to be valid. The relative attractiveness of residential energy taxes from an emissions perspective reflects the high emissions intensity of residential energy consumption. Non-residential energy taxation and transport fuel taxation are broadly equal in terms of their employment impact although non-residential energy taxes lead to slightly greater falls in GDP. Non-residential energy taxes also generate more emissions savings per euro of revenue raised than transport fuel taxes as a result of the more emissions intensive energy mix in the affected sectors.

4.3.5 Conclusions

Carbon-energy taxes could raise substantial additional revenue in Poland at no greater cost to output than equivalent direct or indirect taxes.

The findings for Poland share many similarities with those for Spain, although there are some differences.

- It is possible to raise substantial tax revenues from reforms to energy taxes. A package of increases in transport fuel taxation, the introduction and increase in residential energy taxation and higher taxes on business energy use might deliver tax revenues of more than €5 billion per annum by 2020, equivalent to 1.3-1.4 per cent of projected Polish GDP in that year.
- Direct or indirect taxes could be used to raise the same amount of revenue as the energy tax package, but, the modelling suggests, would have an equally or more detrimental impact on economic activity. In the package we look at, both energy taxes and indirect taxes are expected to reduce GDP by 0.25-0.3 per cent below the baseline by 2020 while the impact from direct taxes would be closer to 0.5 per cent. All three taxes are expected to have similar impacts on employment.
- As well as delivering an equivalent or more benign macroeconomic impact than other taxes, the modelling shows that energy taxes would reduce Polish fuel consumption and emissions. The package of energy tax reforms is expected to reduce carbon dioxide emissions by 1.3 per cent, while the direct and indirect taxes have a negligible impact.
- There is an important trade-off between different types of energy tax increases in Poland. Higher taxes on transport fuels and non-residential energy consumption would be less economically detrimental than taxes on residential energy consumption, but they are also a less cost effective way of reducing emissions.

4.4 Hungary

4.4.1 Hungarian energy tax package

The illustrative Hungarian energy tax package breaks down into the same three elements as for Poland and Spain.

Transport fuels. Transport diesel consumption accounts for 14 per cent of Hungary's emissions from energy use but is taxed, on a per tonne of CO_2 basis, at around two thirds of the rate of petrol. Given Hungary's role as a transit country, the package steadily increases diesel transport fuel taxation in a way that is consistent with the proposals in the ETD, so that Hungary is on track to meet the requirement that the diesel rate exceeds the petrol rate by the margin required under the ETD by 2023. It also includes an immediate removal, in 2013, of the recently-introduced reduced rate for commercial diesel. The tax exemption for railway diesel would be abolished, and a phased increase would take it up from €0 in 2013 to the full prevailing transport diesel rate in 2020. The package also steadily increases taxes on natural gas and LPG for transport fuels so that these move towards the minima in the ETD.

Residential energy taxation. Residential energy consumption (except for non-subsidised electricity consumption) accounts for almost 23 per cent of Hungary's emissions from energy consumption but is either not taxed or subsidised. Easily the most important of these sources of emissions is residential gas consumption which alone accounts for 16 per cent of Hungary's emissions from energy consumption. Therefore, in addition to the already scheduled removal of subsidies for residential gas consumption in 2012, the package introduces and steadily increases tax rates on the residential consumption of gas and coal so that they move towards the rates that the ETD requires for non-residential consumption for installations outside of the EU ETS. This implies an increase to €1.16/GJ for gas and €1.85/GJ for coal by 2020 (2011 prices). The lower VAT rate on district heating, an implicit subsidy, would be removed in 2017, halfway through the period during which increases in the real rates of tax on domestic coal and gas would be phased in. This reform on the taxation side should be accompanied by additional support measures for poor households, to prevent fuel switching away from natural gas and district heating towards unconventional cheaper fuels such as wood or waste, which can lead to serious health impacts.

Non-residential energy taxation. The package steadily increases non-residential energy tax rates when they are below the minima identified in the proposed ETD, taking into account that the ETD allows Hungary a longer period to adopt the carbon dioxide element of the minima. This implies increases in the tax rates for coal, LPG, heavy fuel oil and gas for installations outside the EU ETS but no increases in taxes for installations within the EU ETS.

In the same way as for Spain and Poland, the package includes automatic indexation of these rates to preserve their real value. It focuses the increase in taxes on emissions outside the EU ETS in order to generate genuinely pan-European emissions reductions.

Table 10 outlines the impact of this proposal on the energy tax rates in Hungary, with tax rates given in euros.

Table 10. **A possible profile of revised energy taxes in Hungary, euro, 2011 prices**

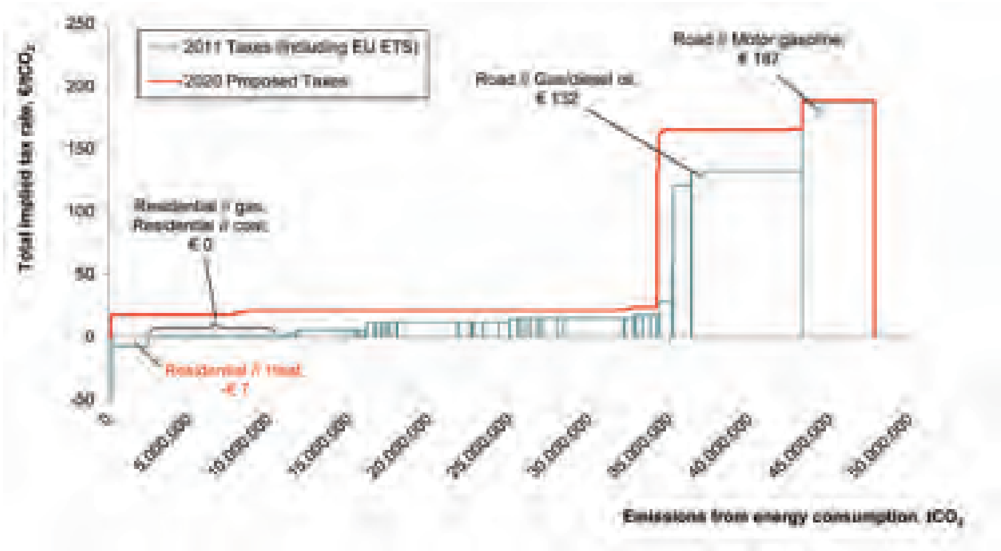
Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1,000l)	438	438	438	438	438	438	438	438	438
Transport diesel (€/1,000l)	362	372	383	393	403	414	424	434	445
Transport diesel for commercial purposes (€/1,000l)	362	372	383	393	403	414	424	434	445
Transport diesel used in railways (€/1,000l)	0	56	111	167	222	278	334	389	445
OTHER FUEL USE									
Gas, domestic heating,€/GJ	0 - subsidies removed	0.14	0.28	0.42	0.56	0.71	0.85	0.99	1.13
Gas, installations outside the EU ETS, €/GJ	0.32	0.43	0.53	0.64	0.74	0.85	0.95	1.06	1.16
Gas installations inside the EU ETS, €/GJ	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Electricity, domestic, €/MWh	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
Electricity, business use, €/MWh	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
District heating, VAT rate, %	5%	5%	5%	5%	5%	25%	25%	25%	25%

Note: 2011 prices. Proposal also includes indexing to account for inflation in each year.

Source: Vivid Economics

Figure 38 illustrates how the illustrative package of reforms alters the profile of energy taxes in Hungary by 2020. By 2020, the implied carbon tax rate on energy consumption would increase by around 45 per cent (using latest available data on energy consumption as weights). There would be much less variation in the implied carbon tax rates within transport and non-transport energy use, although there would be a larger gap between the tax rates prevailing on these different energy uses.

Figure 38. **The proposed package of reforms would increase the average implied carbon tax on energy consumption in Hungary from €44/tCO_2 to €63/tCO_2**

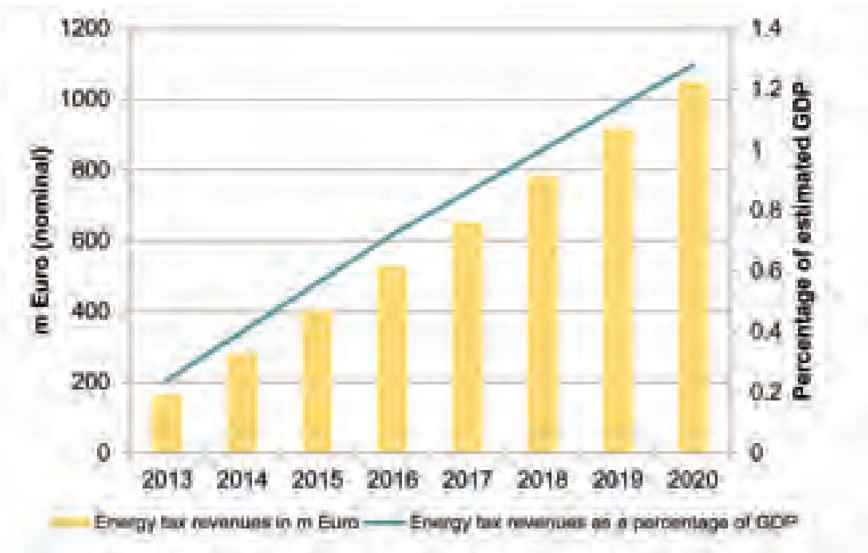


Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6tCO2 (2011 prices) by 2020, in line with European Commission assumptions.*

Source: *Vivid Economics*

Figure 39 shows that a package of reforms on this basis could generate more than €1 billion of revenues by 2020. This package could make a substantial contribution to deficit reduction in Hungary. According to the Ministry for National Economy, Hungary's budget deficit for 2011 (excluding one-off items) is 2.4 per cent of GDP (Hungarian Ministry for National Economy 2012). In the short run, the reform package provides only a modest reduction (reducing the deficit by 8 per cent by 2013) due to its phased introduction. However, in the medium run (by 2020), it could reduce the deficit by more than half (taking the 2011 deficit as the base), bringing it close to 1 per cent of GDP.

Figure 39. **Hungary: an illustrative package of energy tax reforms in Hungary could raise more than €1 billion per annum by 2020**



Source: *Cambridge Econometrics E3ME model*

Hungarian experts also identified a series of other reforms to the fiscal framework that could contribute to emissions reductions. These include reform of, and greater stringency in the application of, tax treatment of the purchase and use of company cars. In particular, it has been estimated that tax evasion and tax avoidance, by declaring private cars as company cars or cars for company usage, has led to forgone revenue of up to 5 per cent of GDP (Lukács 2011). This has not been investigated in detail, because the project focuses explicitly on taxes on fuel combustion. Nonetheless, complementary reforms such as these could stimulate both emissions reductions and reduce fiscal deficits.

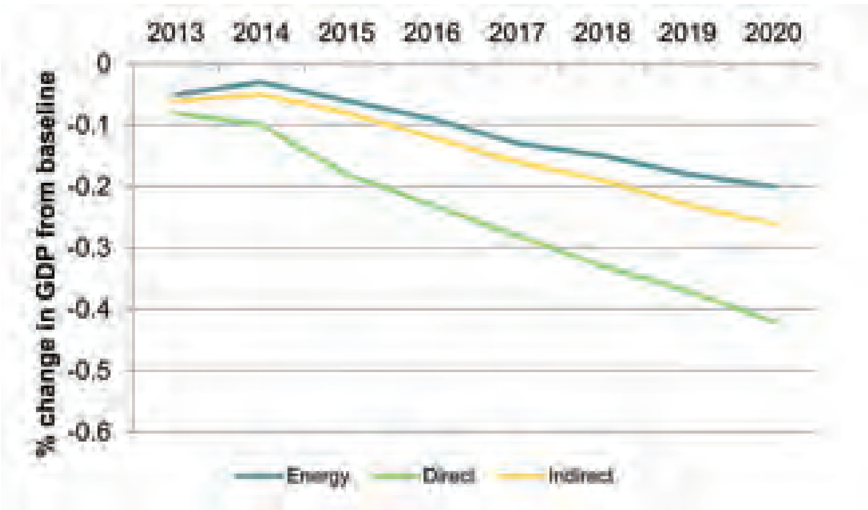
A second reform that could contribute to revenue raising and emission reduction is the reform of the "diesel fuel saving allowance". This allowance gives truck drivers the right to declare "fuel savings" revenue (i.e. money intended to be spent on fuel, but not spent due to more fuel efficient driving or a more fuel efficient vehicle) as salary free of any taxes and social security contributions. It is estimated that a volume of approximately 30 per cent of total diesel sales in Hungary, or nearly €200 million, is declared as tax free income in this way. The main reason for this are outdated fuel consumption norms for trucks, which are much higher than current real consumption.

4.4.2 Comparison with other taxes

This subsection considers the relative macroeconomic impacts if direct or indirect energy taxes were used to raise the same amount of revenue as the illustrative energy tax package might deliver.

As shown in figure 40, in Hungary the energy tax package has a less detrimental impact than either indirect or direct tax increases. By 2020, our energy tax package reduces GDP by 0.2 per cent relative to the baseline while the indirect tax package has around a 0.25 per cent impact and the direct taxes a 0.5 per cent impact.

Figure 40. **Hungary: the model suggests that the energy tax package in Hungary would have a less detrimental impact on GDP than either direct or indirect taxes**



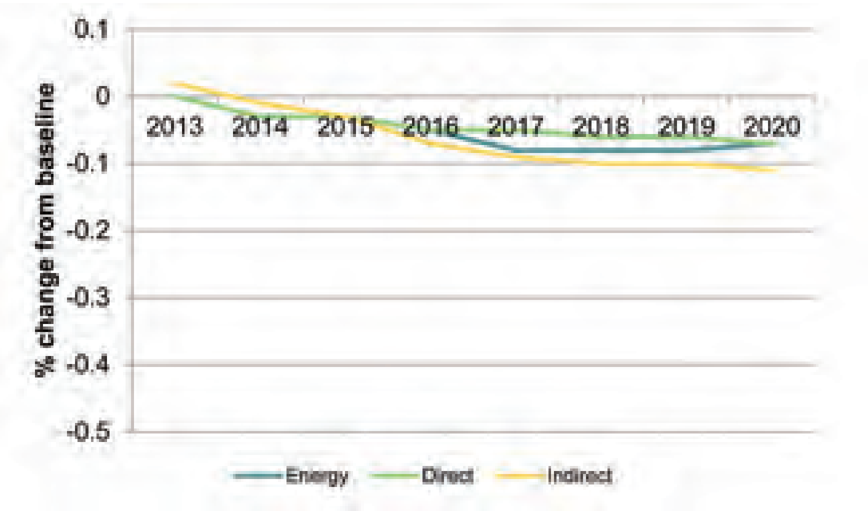
Source: *Cambridge Econometrics E3ME model*

The poor GDP performance of the direct tax package predicted by the model is explained by the same reason as in Poland and Hungary: in line with empirical evidence there is an assumption that only around half of the initial decline in post-tax incomes is offset by nominal wage increases. This decreases consumer spending power, and drags down consumption. Consumption, which is easily the single largest component of GDP, falls by around 1 per cent in the direct tax package by 2020. By contrast, under the indirect and energy tax packages, the model anticipates there will be a larger response to nominal wages, keeping consumer spending more buoyant: the fall in consumption is only around half as severe as in the direct tax package.

The slightly more benign performance of energy taxes over indirect taxes is a result of energy taxes causing somewhat smaller declines in investment and consumption. This is because consumer prices fully adjust to the change in indirect taxation leading to a corresponding fall in real incomes and hence in consumption and household investment. By contrast, some of the energy tax package is not passed through to final consumers, leading to smaller falls in real income and hence smaller reductions in consumption. This effect is magnified by the assumption in E3ME that the decline in company profits from absorbing energy tax increases would not have any impact on GDP.

Figure 41 shows the impact of the taxes on employment levels. It shows that while all three tax packages might lead to modest falls in employment, typically of no more than 0.1 per cent, the direct and energy taxes have similar impacts while the indirect tax is expected to be slightly worse. The small magnitude of the impact on employment under all three tax scenarios is the consequence of the large proportion of public sector employment in Hungary, and an assumption that public sector employment is less sensitive to changes in GDP than private sector employment.

Figure 41. **Hungary: the indirect tax package is expected to lead to the largest fall in employment**

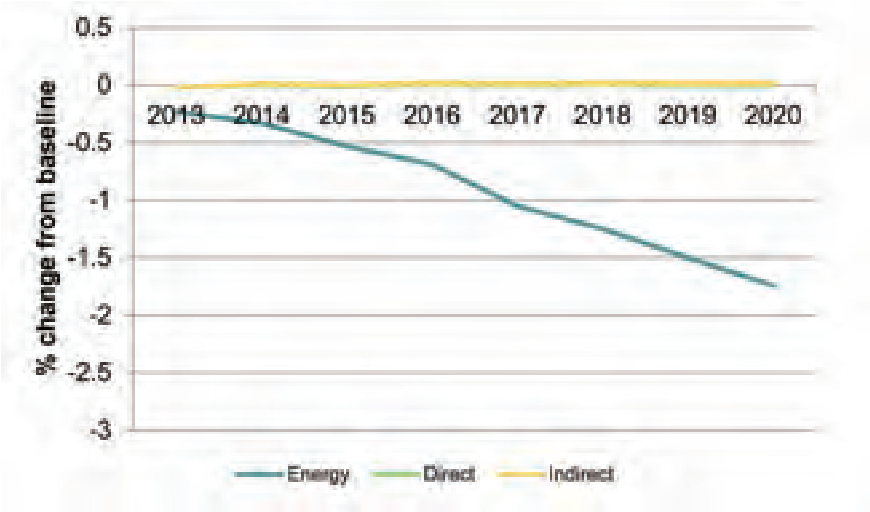


Source: *Cambridge Econometrics E3ME model*

In the model, an increase in direct taxes has a less negative impact on employment than an increase in energy and indirect taxes. This is because with a direct tax increase a smaller proportion of the initial decline in incomes following the tax increase is subsequently offset by higher nominal wages. This makes labour relatively cheaper in the direct tax package, which helps to counteract the negative shock to GDP. In turn, energy taxes perform relatively better than indirect taxes as the burden of indirect taxes falls disproportionately on labour intensive sectors such as retailing. For instance, in the indirect tax package, the output of the retail sector is expected to fall by -0.41 per cent compared to the baseline by 2020 while, in the energy tax package, output in the retail sector is only expected to fall by -0.03 per cent.

Finally, in line with expectations, the energy tax package delivers significant reduction in fuel use and carbon dioxide emissions which are not matched by either the direct or indirect tax packages. Figure 42 below shows that the emissions reductions, relative to the baseline, increase steadily over the period amounting to almost 2 per cent by 2020. By contrast, there is a negligible impact from either the direct or indirect tax package.

Figure 42. **Hungary: the energy tax package delivers emissions reductions to around 1.8 per cent while there is no discernible impact on emissions from either the direct or indirect taxes**



Source: *Cambridge Econometrics E3ME model*

4.4.3 Further details on the energy tax package

This sub-section goes into more detail on the possible impacts of the illustrative energy tax package while the following sub-section examines the different elements of the energy tax package. They can be omitted without any loss of continuity but provide further information on the possible impacts of energy taxes and the key trade-offs policy makers will need to consider when considering energy tax packages.

Table 11 below shows the key modelling results for the illustrative package of reforms.

Table 11. **The energy tax package causes a small fall in GDP and employment but raises taxes equivalent to almost 1.3 per cent of expected 2020 GDP, also reducing CO_2 emissions by about 1.7 per cent**

Variable	Unit	Change by 2020	Percentage change relative to baseline
GDP	m€, 2011 prices	-239	-0.20
Employment	Thousands of jobs	-3	-0.07
Consumption	m€, 2011 prices	-303	-0.46
Investment	m€, 2011 prices	-65	-0.16
Exports	m€, 2011 prices	-13	-0.01
Imports	m€, 2011 prices	-142	-0.08
CO2 emissions	Thousand tonnes	-252	-1.74
Total fuel consumption for energy use	Thousand tonnes of oil equivalent (toe)	-330	-1.64
Tax revenues	m€, nominal prices	1,048	1.3% of 2020 GDP

Source: *Cambridge Econometrics E3ME model*

As shown in figure 40, the energy tax package results in a modest decline in GDP of 0.2 per cent by 2020. The changes in the macroeconomic aggregates underpinning this change in GDP follow a similar pattern to those for Spain and Poland. The higher energy prices lead to a decline in GDP that is driven by an absolute and proportionately larger fall in consumption. There is a somewhat smaller fall in investment (both in absolute and proportionate terms), as businesses react to diminished economic activity by cutting back their investment.[28] These factors are partly offset by an increase in the net trade position of the country: higher energy prices and lower economic activity cause a reduction in the import of energy (and other) goods that is more than ten times greater, in 2020, than the decline in exports associated with a decline in competitiveness.[29]

The model suggests that the loss in GDP and consumption per euro of tax revenue in Hungary is notably lower than in either Poland or Spain. Indeed, the loss in GDP for each euro of tax revenue raised is only two thirds of that in Spain. This is partly explained by Hungary's reliance on imported energy which means that the decline in consumption, exports and investment is mitigated by a decline in imports. Indeed, over the eight year period modelled, the energy tax package is predicted to lead to a decline in imports that is 43 per cent of the decline in consumption, investment and exports. By contrast, the same figure in Spain is 28 per cent and in Poland is 5 per cent.

The sectoral breakdown of the decline in economic activity from the illustrative package aligns with expectations. The only sectors to see output fall by more than 0.5 per cent relative to the baseline in any year are coal production and gas supply. The output of these sectors is between 0.3 and 3.6 per cent lower than in the baseline in each year to 2020. Most other sectors see changes in output that range from -0.1 per cent to +0.1 per cent in any one year.

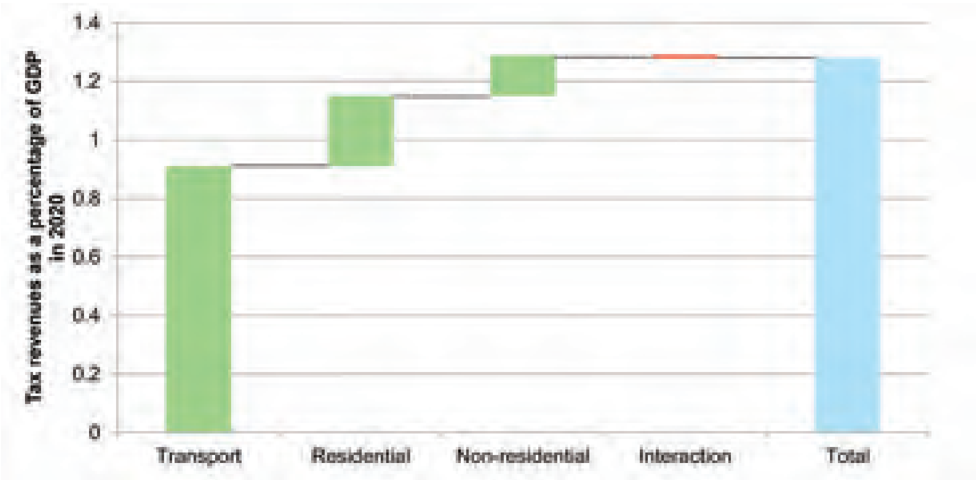
The decline in employment of -0.07 per cent shown in figure 41 is equivalent to a reduction in employment of just over 3,000 jobs by 2020. The modelled Hungarian energy tax package results in fewer jobs lost per euro of tax raised than in Spain but slightly more than in Poland.

Finally, the illustrative energy tax package is predicted to result in a significant decline in fuel consumption and CO_2 emissions, as shown in figure 42. The former falls by almost 1.6 per cent and the latter by 1.3 per cent by 2020.

4.4.4 Different elements of tax package

Higher taxes on transport fuels could make the largest contributions to revenue raising: in the package that we consider, by 2020, this element alone could raise tax revenues equivalent to more than 0.9 per cent of expected 2020 GDP. This is around 70 per cent of the total revenues raised in the package. The residential energy element of the packages raises revenue amounting to almost 0.25 per cent of 2020 GDP. Taxes on non-residential energy use raise revenues equal to 0.14 per cent of GDP by 2020.

Figure 43. **Hungary: transport taxes raise the bulk of the revenues in the tax package**



Note: The interaction impacts account for the fact that when it is assumed that the whole tax package is introduced, the overall revenues raised are slightly lower than the sum of the revenues raised when each element of the package is introduced in isolation.

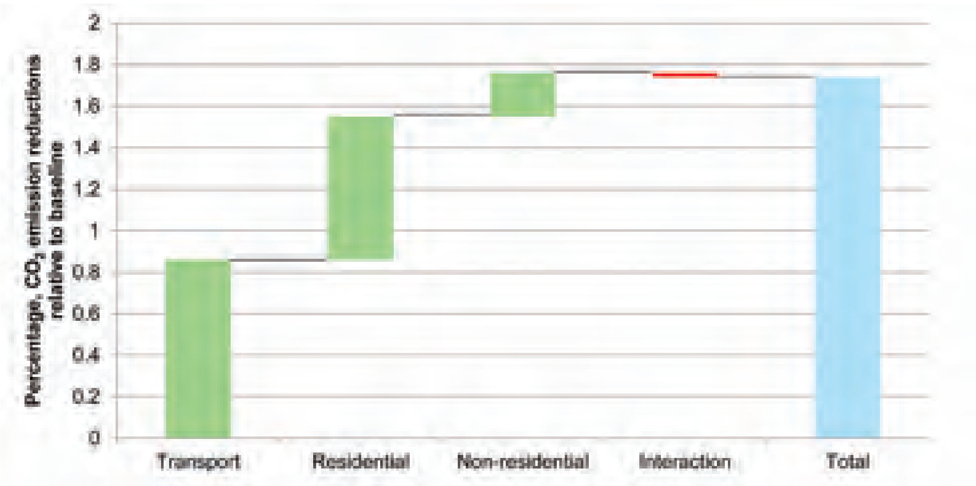
Source: Vivid Economics based on Cambridge Econometrics E3ME model

28 As with Poland, the E3ME model for Hungary does not capture the possible increase in business investment resulting from a switch from consumption to investment as a result of higher consumer prices e.g. greater energy efficiency investment. This is because the time-series of data available are too short to estimate reliable model parameters.

29 Although, as discussed in section 2, macroeconomic models like E3ME do not capture the decline in exports and competitiveness that might be experienced in specific product markets as a consequence of higher energy taxes.

The contributions that each element of the illustrative package makes to emissions reductions are quite different to the contributions they make to tax revenues. In particular, taxes on residential energy consumption deliver almost half of the emissions reductions of the overall package, despite accounting for less than 20 per cent of the revenues raised. These reductions indicate the significant (low-cost) opportunities to reduce emissions in Hungarian households coupled with the fact that domestic energy prices for gas, especially, are relatively low meaning that every additional euro of tax implies a relatively large percentage change in price which, in turn, drives larger changes in behaviour.

Figure 44. **Hungary: the taxes on residential energy consumption are expected to deliver emissions reductions of almost 0.7 per cent per annum by 2020 – almost half of the total reductions achieved**

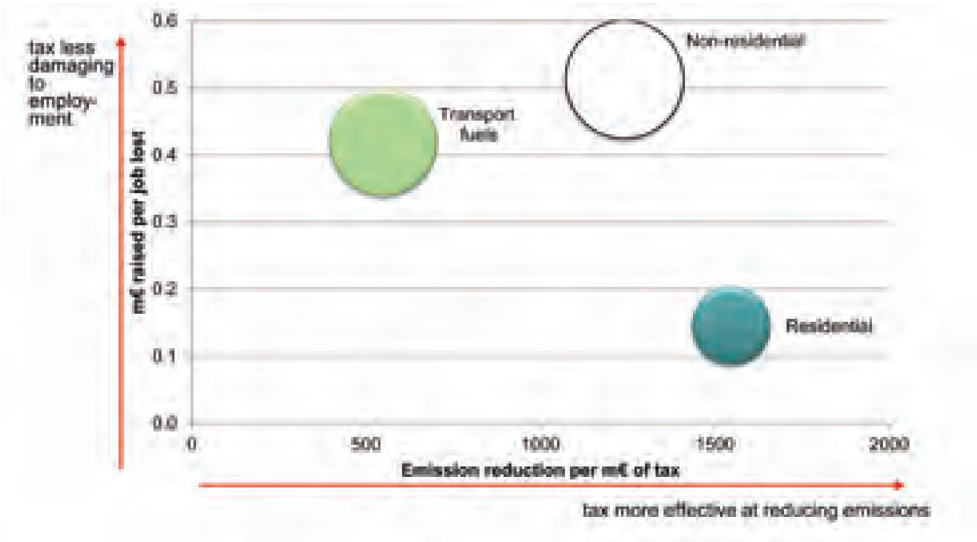


Note: *The interaction impacts account for the fact that when it is assumed that the whole tax package is introduced, the overall emission reductions are slightly lower than the sum of the emissions reduction when each element of the package is introduced in isolation.*

Source: *Vivid Economics*

The relative effectiveness of residential energy taxes is captured in the 'bubble chart', figure 45. As with the equivalent charts for Spain and Poland it shows emission reductions (increasing to the right), revenue raised per decline in employment (increasing up the chart) and tax raised for each million euros GDP loss (larger bubble indicates smaller GDP losses per unit of revenue).

Figure 45. **Hungary: residential energy taxes generate the most emissions reduction but also have the most detrimental impact on employment, per euro of tax raised**



Note: *Bubble size proportional to tax revenues raised per €m of GDP decline i.e. a larger bubble implies a smaller decline in GDP. Non-residential energy taxes are modelled to lead to a small increase in GDP, reflected in no shading.*

One notable result from the figure is that the non-residential energy taxes within the package not only reduce emissions but also lead to a very small positive increase in GDP (around 0.01 per cent per annum). The modelling suggests a modest improvement in efficiency in industry that leads to greater indigenous production and fewer imports. The increase in GDP is very slight and there is the same caveat as with the Spanish and Polish results, namely that the E3ME model does not feed back a reduction in firm profits into lower investment and/or a fall in consumption from reduced wealth/ dividend pay-outs. The figure also highlights a trade-off between residential consumption taxes and taxes on transport fuels. The former are effective at reducing emissions due to the large abatement potential in the sector but, due to their large adverse effect on consumption, have a damaging impact on employment and GDP. By contrast, higher taxes on transport fuels, where there is less abatement opportunity, generate fewer emission savings per euro raised but also cause less damage to employment and GDP.

4.4.5 Conclusions

The key conclusion from the modelling analysis is that there is scope to raise significant revenues from a package of energy tax reforms in Hungary: the illustrative package discussed above might raise tax revenues equal to more than 1.2 per cent of GDP by 2020. Further, such a tax package is likely to have a no more adverse impact on the economy than alternative packages of indirect and direct tax increases raising the same amount of revenue. Indeed, the tax package may well have a more benign impact than the alternatives: the modelling analysis suggests that while the direct and indirect tax package is expected to reduce GDP below the baseline by 0.42 per cent or 0.26 per cent respectively, the energy tax package is expected to cause a decline in GDP of 0.2 per cent. At the same time, it can deliver emissions savings of more than 1.7 per cent relative to the baseline while the other tax packages have no impact on emissions. Further conclusions include the following.

– The energy tax package in Hungary appears to be even more attractive than in either Spain or Poland. The significant reduction in imports that accompanies the packages means that the GDP reduction per euro of revenue raised is smaller than in either of these other two countries. At the same time, the package also delivers more or similar emissions savings per euro of revenue raised than in either of the other countries.

– As with Spain and Poland, there are important differences between the elements of energy tax reform in Hungary. The greatest revenue potential comes from the higher taxation on transport diesel which, by 2020, could alone raise tax revenues equivalent to more than 0.9 per cent of expected 2020 GDP. However, this is less effective at reducing emissions than either residential or non-residential energy taxes. Meanwhile, the largest mitigation potential appears to be from residential energy taxes but with a more adverse economic effect than other forms of energy taxation. Taxes on non-residential energy consumption may be less economically damaging than residential energy taxes and have an intermediate emissions saving potential, but the scope for raising substantial revenues from these taxes (while maintaining a coherent overall package) is limited.

5

Distributional aspects of carbon energy tax reform

Impacts and their mitigation

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5

Distributional aspects of carbon energy tax reform

Impacts and their mitigation

Regressive impacts from energy and other taxes, and their mitigation

It is widely recognised that energy taxes can have a disproportionate impact on the poorest households. This issue is of social and political concern.

This section consists of two parts. The first part investigates the distributional impacts from energy tax reform. It consists of a brief literature review, followed by an overview of modelling results from the three national reform proposals outlined in section 4. The second part assesses policies which might address these impacts.

It shows that by redistributing a modest fraction of total revenues as compensation, the socially undesirable regressive effects of carbon-energy taxes can be substantially alleviated. Although it does not explore options for individual countries, it does show that even simple compensation arrangements, such as a reduction in national insurance contributions, can beneficially dilute the impact of carbon-energy taxes. This indicates that more sophisticated approaches could be quite successful in addressing social policy concerns.

5.1 Distributional impacts of reform options

Literature review and modelling evidence

The academic literature suggests that the distributional impacts of an energy tax are broadly regressive. This means that the tax burden as a percentage of household income is higher on poor households than on rich households. Throughout the discussion the impacts are of interest not only when they fall differentially across the rich and poor, but also between employed and non-employed, rural and urban members of the population and so on. Each of these inequalities brings its own political difficulties, some of which may be more difficult to address through compensating measures than others.

The finding of regressivity is qualified in two ways: first, given the fiscal situation, governments face a question of *which* tax to raise, not a question of whether to raise a tax or not. Taking this perspective, energy tax reform becomes attractive from a distributional point of view: the poorest groups fare better under energy tax reform than they do under direct or indirect taxes, given certain assumptions. Secondly, it is possible to address these impacts with well-designed compensation measures; a number of policy measures for dealing with these impacts already exist, such as the a 'lakhatási támogatás' (housing benefit or support) in Hungary, the 'bono social' in Spain, and various social assistance programmes in Poland. These are discussed in section 5.1.5 below. A more conceptual analysis of such measures is given in the second half of this section (section 5.2, 'Dealing with distributional impacts').

5.1.1 The academic literature suggests that energy taxation is regressive

There is considerable evidence that energy taxes can have regressive effects. A recent report published by the European Environment Agency (EEA) states that 'in contrast to taxes on labour, energy taxes have generally been found to have regressive implications'(European Environmental Agency 2011). This is corroborated by comparative studies such as Ekins and Speck (2011) or Peter et al. (2007). The former conclude that their 'study confirms the generally regressive effect of energy and CO_2 taxes on households' (Ekins and Speck 2011). There is further evidence on this from country-specific studies: Wier et al. (2005), writing about Denmark, find that 'CO_2 taxes imposed on energy consumption in households, as well as in industry, do in fact tend to be regressive'; Bruha and Scasny (2004), conducting an ex-ante analysis of energy tax reform in the Czech Republic, point out that 'since energies satisfy basic needs, it is not surprising that there are significant regressive impacts'; and Poltimäe and Võrk (2009) studying Estonia find that 'since 2008, the [environmental] taxes are less progressive, because of the new electricity excise and increased taxes on gas'.

However, while impacts are broadly regressive, there is variability within any given income group. For example, rural households are usually more affected by higher energy taxes than their income would suggest (Regeringskansliet 2004), while urban households are less affected. Dresner and Ekins (2006) point out that 'the variation *between* the income deciles is less than the variation *within* the deciles' [emphasis added].

Furthermore, the broadly regressive impacts of energy taxation taken as a whole hide considerable variation across sub-types of energy taxes: 'fuel taxation is progressive, while heat, gas and coal taxations are rather regressive. These two effects counter-balance' (Bruha and Scasny 2004). Modelling undertaken for the Productivity and Environmental Tax Reform in Europe (PETRE) project showed that taxes on residential energy consumption are regressive, whilst taxes on transport fuels are neither regressive nor progressive, imposing relatively smaller burdens on the poor and the rich, and a relatively larger burden on the middle quintile (Ekins and Speck 2011).

Finally, under certain circumstances the distributional impacts of energy taxes can be neutral or even progressive. This is particularly the case for transport fuel taxation outside developed countries but it is not confined to them: using data for the US, Metcalf, Hassett, & Mathur (2011) show that, when ranking households by a proxy for lifetime income rather than by current annual income, 'carbon pricing is at most mildly regressive and may in fact be progressive'. The possibility that environmental taxes may have progressive impacts has also been identified in Poland (Kiuila and Sleszynski 2003).

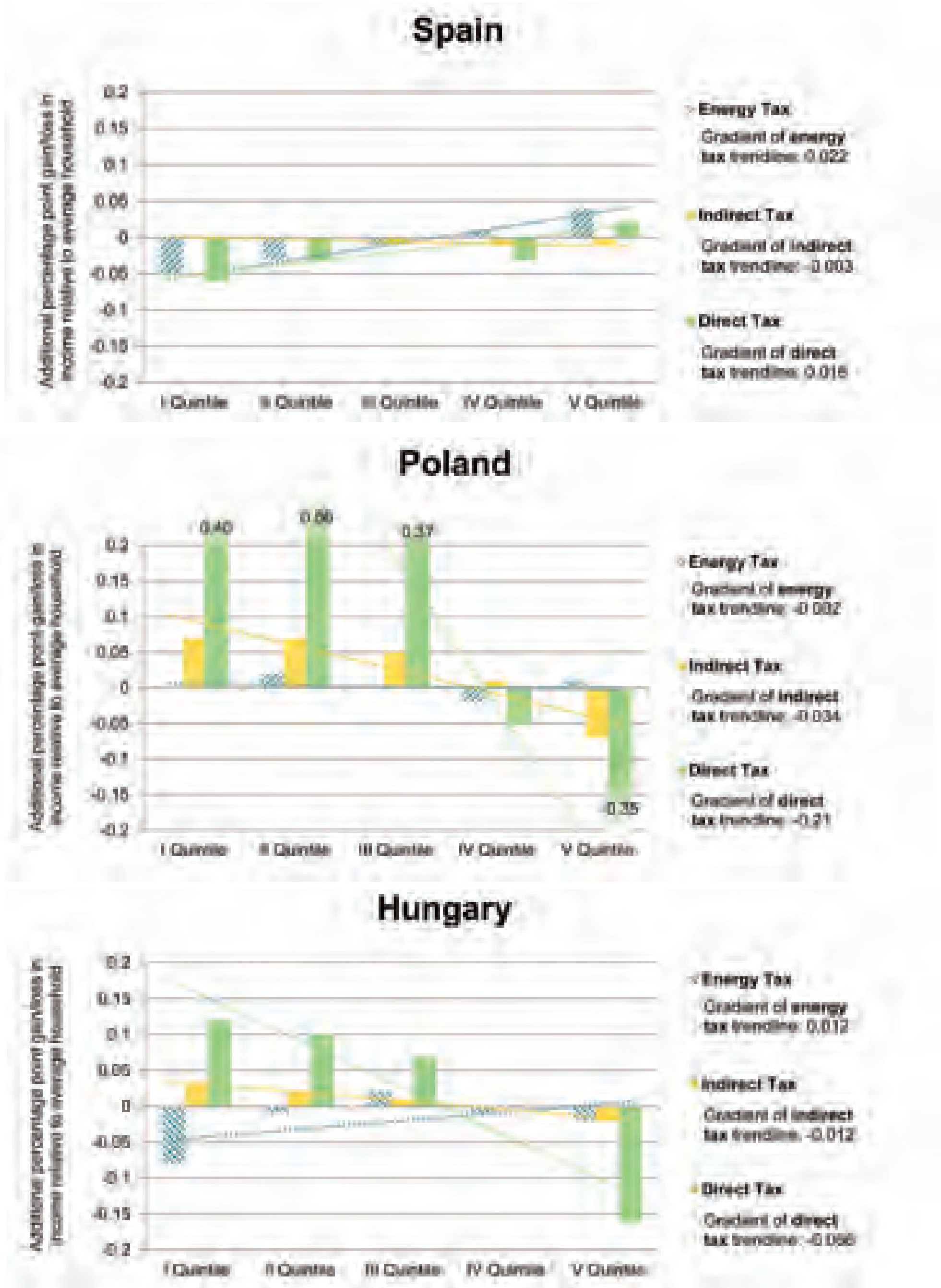
In sum, four findings stand out: first, energy taxation can be, and often is, broadly speaking regressive; secondly, impacts vary with household characteristics other than income, such as rural/urban location, leading to larger in-decile than across-decile variation of impacts; thirdly, regressive effects vary across different types of energy taxation; lastly, there are circumstances in which energy taxation is neutral or even progressive, rather than regressive.

5.1.2 Modelling evidence from the E3ME model

The results obtained from country-specific modelling performed for this study corroborate the results of the literature review. Compared to an indirect tax (e.g. VAT) or direct taxes (on capital or income) raising the same amount of revenue, energy taxation is shown to be the most regressive option in all three countries investigated. With energy taxes, the percentage loss of household income is usually the biggest for the poorest quintile, and smaller or equal for the richer quintiles. This is not the case for indirect tax (progressive in Spain, Poland and Hungary) and direct taxes (progressive in Poland and Hungary, less regressive than energy taxes in Spain). However, while energy taxation is indeed more regressive than the other two alternatives, in Poland it is nonetheless broadly neutral across income, and in both Spain and Hungary it is only mildly regressive.

These results are shown in figure 46 below where the regressiveness is indicated by the gradient of the line. An upward sloping line indicates that the tax is regressive, the steeper the slope the more regressive the tax. By contrast, a downward sloping line indicates that the tax has a progressive impact.

Figure 46. **Different social groups' change in income relative to the average household's change in income, comparing energy tax with VAT and a direct tax on income, all raising similar revenue**



Note: *The first quintile contains the poorest 20 per cent of all households, the fifth quintile the richest 20 per cent.*

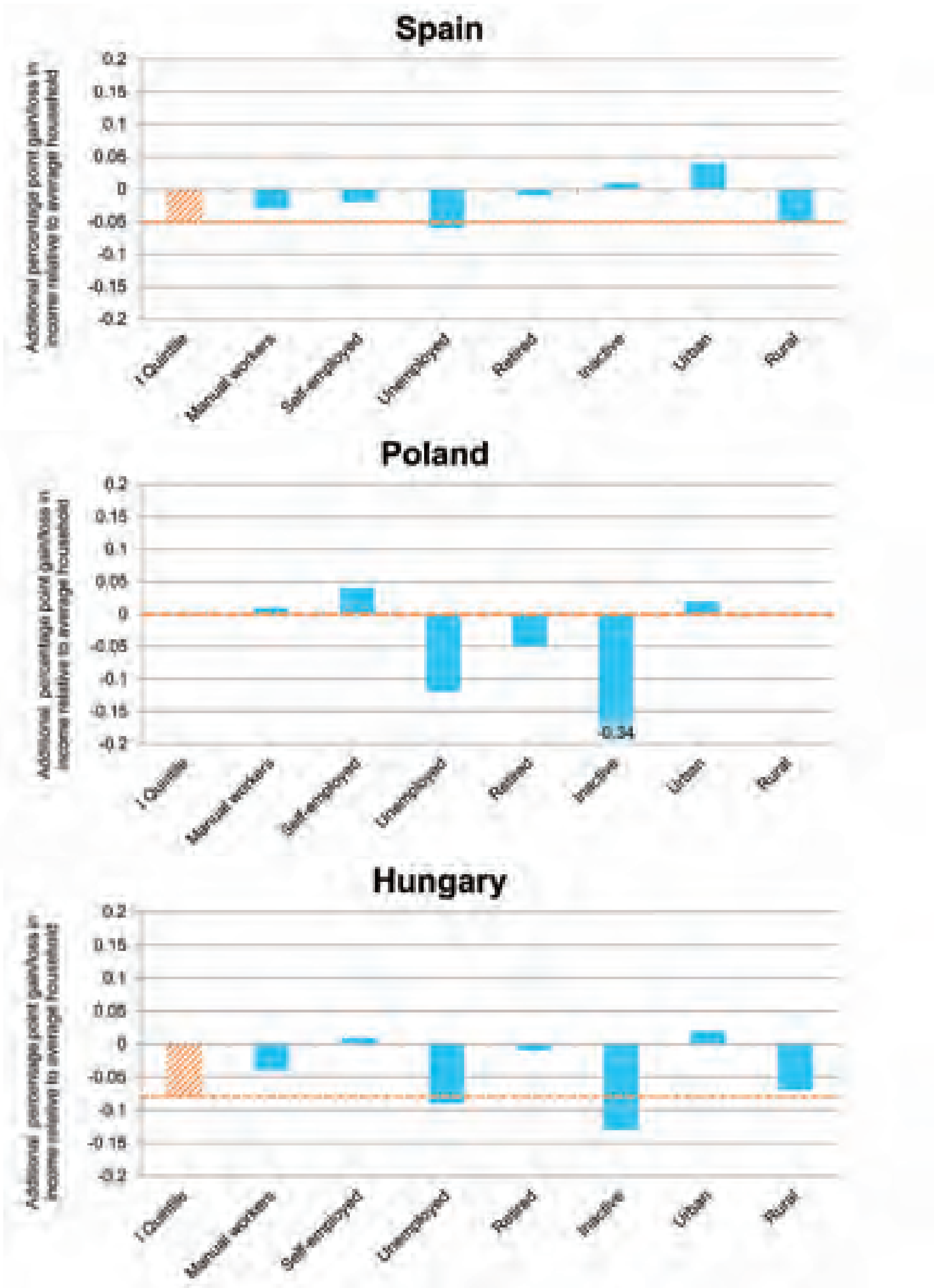
Numbers are for effect on annual real income in 2020 of the proposed energy tax reform, as well as the effect of two alternative taxes raising the same revenue.

Bars indicate for each tax whether the average household in the respective quintile stands to lose more (bar going down) or less (bar going up) as a percentage of their income than the average household. Note that the absolute losses do not correspond to the percentage losses, i.e. a household from the fifth quintile is still likely to face a higher absolute burden than a household from the first quintile, even if the percentage burden on the richer household is lower.

Source: *Vivid Economics based on Cambridge Econometrics E3ME models*

Moreover, the modelling results also underpin the second finding of the literature review. The distributional impacts on households vary significantly with characteristics other than income. Three groups generally suffering a larger-than-average percentage real income loss are the unemployed, the economically inactive (those not in paid work), and rural residents. In Spain the unemployed face heavier burdens than the poorest quintile. In Poland rural households do not suffer any more than the population average, while unemployed, inactive and retired households all suffer substantially larger percentage losses than both the average household and the poorest quintile. In Hungary the unemployed and inactive are hit harder than the poorest quintile, whereas rural households suffer just less, but still substantially more than the average household. This is illustrated in figure 47 below.

Figure 47. **Different social groups' change in income due to the energy tax reform proposals relative to the average household's change in income and relative to the poorest quintile**



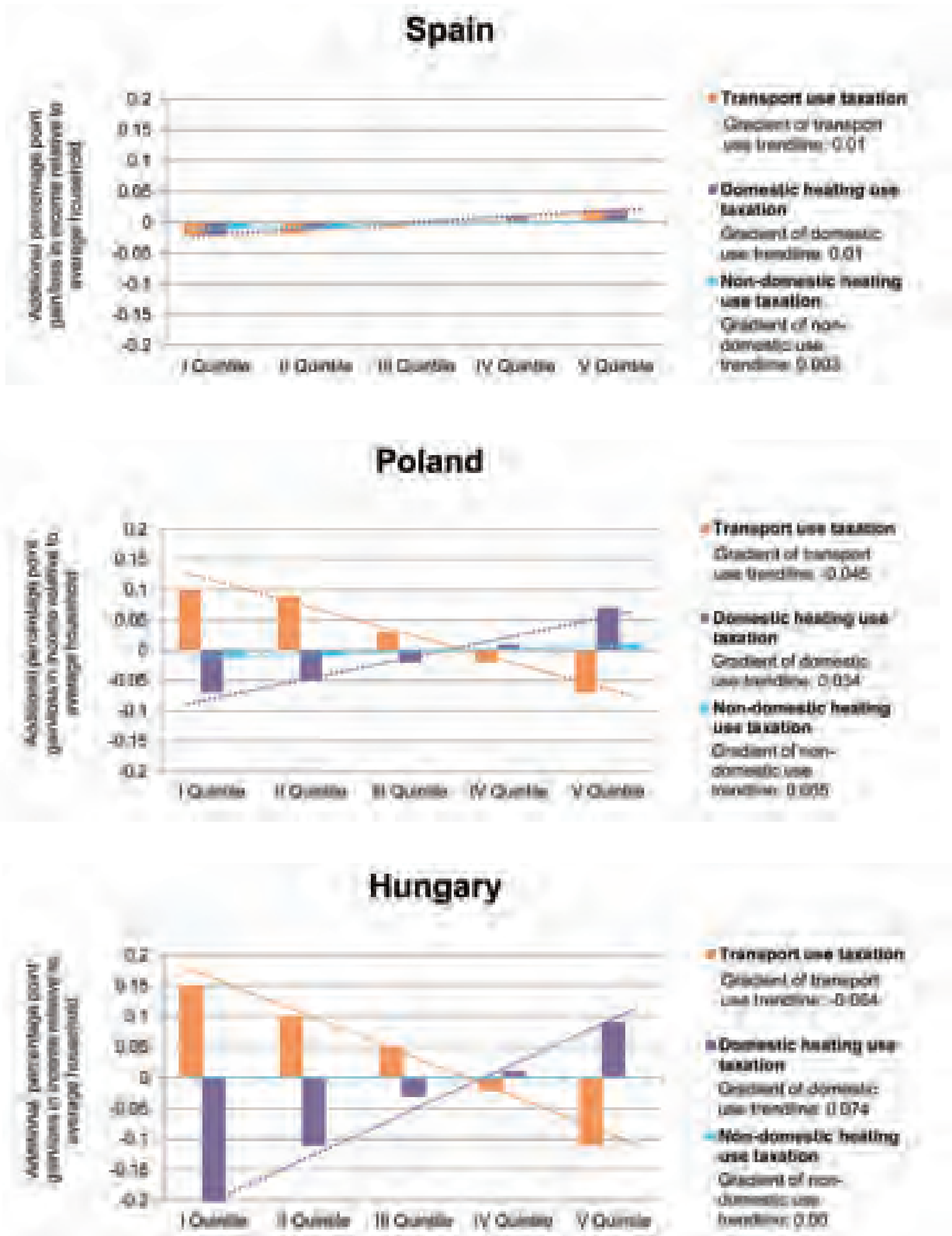
Note: *Bars indicate for each tax whether the average household in the respective social group stands to lose more (bar going down) or less (bar going up) as a percentage of their income than the average household. Note that the absolute losses do not correspond to the percentage losses due to differing average group income.*

Numbers are for effect on annual real income in 2020 of the proposed energy tax reform, as well as the effect of two alternative taxes raising the same revenue.

Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

Finally, the modelling results also support the third finding from the literature review: the elements of the energy tax reform packages have different distributional impacts. While this varies from country to country, the general pattern is clear. The taxation of residential fuel use is the most regressive, the taxation of industrial fuels is mostly neutral, while the taxation of transport fuels is generally the least regressive (or even progressive, as in Poland and Hungary). This de-composition of the distributional impacts of the individual components of the reform packages is shown below in figure 48.

Figure 48. **Change in income along the income distribution, relative to the average household's change in income, comparing transport use, domestic heating use, and non-domestic heating use taxation**



Note: *The first quintile contains the poorest 20 per cent of all households, the fifth quintile the richest 20 per cent.*

Numbers are for effect on annual real income in 2020 of the proposed energy tax reform, as well as the effect of two alternative taxes raising the same revenue.

Bars indicate for each tax whether the average household in the respective quintile stands to lose more (bar going down) or less (bar going up) as a percentage of their income than the average household. Note that the absolute losses do not correspond to the percentage losses due to differing average group income.

Source: *Vivid Economics based on Cambridge Econometrics E3ME model*

5.1.3 Energy taxes may still be preferable for low income groups

Given the fiscal situation, governments may face a question of *which* tax to raise rather than whether or not to raise taxes. The relevant comparison becomes *between* the impacts of different tax reforms rather than *within* the impacts of one tax reform on different groups. On this metric, energy tax reform scores highly in all three countries.

The modelling suggests that in Spain, every social group may be better off under the proposed energy tax reform than under alternative proposals that would raise the same revenue. Table 12 shows that, while the distributional effects within each tax reform vary, each subgroup is better off under an energy tax reform than under a revenue-equivalent VAT increase or a direct tax increase. This result is explained by the fact that the overall macroeconomic impact of the energy tax package is expected to be less damaging than the indirect or direct tax packages, although the result is also partly created by some of the modelling assumptions in the E3ME model, most notably that social security payments scale up and down in line with total GDP.

Table 12. **In Spain, the modelling suggests that every vulnerable subgroup identified in the modelling faces the smallest losses, in absolute terms, from an energy tax reform**

Income loss in 2020 from different tax options (per cent loss relative to baseline)

Social groups	Energy tax reform	Indirect tax increase	Direct tax increase
Poorest quintile	**-0.60%**	-0.68%	-1.15%
Manual workers	**-0.58%**	-0.70%	-1.14%
Self-employed	**-0.57%**	-0.70%	-0.99%
Unemployed	**-0.61%**	-0.70%	-0.96%
Retired	**-0.56%**	-0.68%	-1.07%
Inactive	**-0.54%**	-0.70%	-1.00%
Urban	**-0.51%**	-0.69%	-1.08%
Rural	**-0.60%**	-0.69%	-1.12%
All-household average	**-0.55%**	-0.68%	-1.09%

Note: *Baseline refers to a scenario in which none of the three tax reforms are implemented.*

Source: *Vivid Economics and Cambridge Econometrics E3M3 model*

In Poland, the modelling similarly suggests that almost all groups are better off under energy tax reform than under the alternatives. The underlying drivers for this result, and associated caveats, are the same as for Spain. The exceptions to the general finding are the retired, facing a loss of 0.76 per cent of income, higher than the 0.73 per cent loss under a direct tax increase; and the inactive, facing a substantial loss of 1.05 per cent under energy tax reform, considerably higher than the 0.41 per cent loss under a direct tax increase. This finding warrants extra attention being paid to the economically inactive population when introducing energy tax reform in Poland. The findings for Poland are summarised in table 13.

Table 13. **In Poland, most vulnerable subgroups identified in the modelling face the smallest losses, in absolute terms, from an energy tax reform; exceptions are the retired and the inactive.**

Income loss in 2020 from different tax options (per cent loss relative to baseline)

Social groups	Energy tax reform	Indirect tax increase	Direct tax increase
Poorest quintile	**-0.71%**	-0.79%	-1.08%
Manual workers	**-0.70%**	-0.82%	-0.91%
Self-employed	**-0.67%**	-0.83%	-1.25%
Unemployed	**-0.83%**	-0.95%	-0.92%
Retired	-0.76%	-0.84%	**-0.73%**
Inactive	-1.05%	-1.22%	**-0.41%**
Urban	**-0.69%**	-0.89%	-1.19%
Rural	**-0.71%**	-0.82%	-1.46%
Population average	**-0.71%**	-0.86%	-1.48%

Note: *Each tax option is calibrated so to raise the same revenue in aggregate. This can lead to different average income losses as different tax options have different effects on overall GDP growth.*

Baseline refers to a scenario in which none of the three tax reforms are implemented.

Source: *Vivid Economics*

The situation in Hungary is similar to that in Spain, with the same explanation and caveats. The modelling suggests that all vulnerable subgroups are better or at least as well off under an energy tax reform than under the two alternatives.

Table 14. **In Hungary, the modelling suggests that every vulnerable subgroup faces the smallest losses, in absolute terms, from an energy tax reform**

Income loss in 2020 from different tax options (per cent loss relative to baseline)

Social groups	Energy tax reform	Indirect tax increase	Direct tax increase
Poorest quintile	**-0.66%**	**-0.66%**	-1.05%
Manual workers	**-0.62%**	-0.68%	-1.18%
Self-employed	**-0.57%**	-0.72%	-1.10%
Unemployed	**-0.67%**	-0.68%	-1.06%
Retired	**-0.59%**	-0.66%	-0.86%
Inactive	**-0.71%**	-0.80%	-0.83%
Urban	**-0.56%**	-0.71%	-1.26%
Rural	**-0.65%**	-0.67%	-1.11%
Population average	**-0.58%**	-0.69%	-1.17%

Note: *Each tax option is calibrated so to raise the same revenue in aggregate. This can lead to different average income losses as different tax options have different effects on overall GDP growth.*

Baseline refers to a scenario in which none of the three tax reforms are implemented.

Source: *Vivid Economics and Cambridge Econometrics*

5.1.4 The minimum amount required for compensation

It is possible to estimate approximately how much money would be required to leave all households in the poorest quintile unaffected by the respective reform proposals. This is done by comparing the income of the poorest quintile under the energy tax reform scenario with its income under the baseline scenario. The minimum amount required for compensation is the income loss suffered by the quintile in the energy tax reform scenario relative to the baseline scenario. Taking this number as the amount required for compensation assumes perfect targeting, zero transaction costs, zero information cost, and zero fraud. It is a lower bound and the real figure would be somewhat higher. Section 5.2 analyses some of the actual policy options in more detail, giving further reasons why the real costs of compensation may be considerably higher than indicated here.

This number is only indicative and only addresses compensation for the poorest 20 per cent of the population. The amount of compensation as percentage of additional energy tax revenues raised is less than 10 per cent. Hungary requires the lowest amount as percentage of the newly raised energy tax revenues to compensate its poorest quintile. This information is summarised in table 15 below.

Table 15. **Minimum amounts of compensation required to leave the poorest quintile's income unchanged by energy tax package**

Compensation required to leave poorest 20 per cent of population with unchanged income after implementation of energy tax package

Country	€m	as per cent of energy tax package revenues	as per cent of GDP
Hungary	60	6%	0.1%
Poland	430	8%	0.1%
Spain	715	7%	0.1%

Note: These results are indicative only, and assume zero costs for raising, allocating and paying out compensation.

Source: Cambridge Econometrics' E3ME model

5.1.5 Existing compensation policies

Certain compensation policies already exist in Spain, Poland and Hungary. These policies could be the basis of mitigation of the impacts identified above.

Energy poverty is a recognised issue in Hungary, and policy instruments for addressing it are in place. Energy price subsidies, historically the main instrument, have been abandoned in favour of a 'lakhatási támogatás' (housing benefit or support) facility that is granted on 'strictly social conditions by the local government' (Kaderjak and Szabo 2011). It may be that one option of addressing the distributional impacts of the proposed energy tax reform is to make use of this existing policy; for example, households currently receiving 'lakhatási támogatás' could receive additional support aligned with the tax increases.

In Spain, certain regulated features of its (otherwise deregulated) electricity and gas markets serve as protection for vulnerable households. Between 2003, when consumer deregulation came into force, up until 2009, all households were able to choose between (generally more expensive) free market suppliers, and the old regulated (generally cheaper, at below production cost prices) tariffs. The government paid utilities the difference between the costs of electricity production and the regulated tariffs. Due to fiscal pressures, this system was replaced in 2009 with a so-called 'last resort tariff' system, which is set by the Spanish government (every 6 months for electricity, every 3 months for gas), no longer below the costs of production. However, four categories of households are now eligible for a 'bono social', which consists of a reimbursement calibrated to freeze the prize of electricity at the level of former regulated tariffs: the eligible categories are large families; pensioners on low benefits; households in which all members are unemployed; and households with a maximum contracted power of 3 kW. In total the Spanish government expects about 5 million people to be eligible for the 'bono social'. This policy does not in and of itself shield vulnerable households against future tax increases. However, it could be used as the basis for other policies, e.g. an exemption from new taxes for households receiving the 'bono social'.

Poland does not have a compensation or support policy targeted specifically at energy poverty. However, there are multiple welfare policies that support the poorest parts of the population. According to a presentation by the Polish Energy Regulatory Office, it is possible to address fuel poverty by making use of existing regulations and acts, together with various types of assistance delivered through energy companies (Woszczyk 2009). The most important of these is Social Assistance, a programme designed to assist people and families living in poverty. It comprises means-tested cash benefits, a housing allowance, and a variety of services, such as social work, care services for the elderly and the disabled, family counselling etc. Family benefits constitute a further source of support for poor households. Originally a universal benefit encouraging large families and a traditional division of labour within the family, this programme underwent significant reforms during the 1990s. According to Staręga-Piasek et al., 'in results of the various changes, family benefits became first of all an instrument to mitigate […] poverty' (Staręga-Piasek et al. 2006). As of 2004, family benefits constituted approximately 0.9 per cent of GDP, while social assistance amounted to approximately 1 per cent of GDP (Staręga-Piasek et al. 2006).

5.1.6 Summary of findings

Summing up, both the literature review and the modelling of the specific proposals outlined in this section confirm the following findings: first, energy taxation is broadly speaking regressive; secondly, impacts vary as much, or more, with household characteristics other than income as they do with household income; thirdly, while transport use taxation is the least regressive form of energy tax (and can even be progressive), the taxation of domestic fuel use is the most regressive form.

In addition, the analysis shows that whether or not a tax reform is regressive or non-regressive may not be the most relevant metric in the current circumstances. Given that one of the main aims of reforming energy taxes is the raising of revenue, the relevant comparator may not be how well other groups fare under the same reform, but rather how the same group would fare under other tax reforms that would raise a similar amount of revenue. Energy tax reform performs better in this comparison. The modelling suggests that it imposes smaller absolute and percentage-of-income losses on almost all vulnerable groups in the three countries studied than the two main alternatives, an increase in indirect or an increase in direct taxes.

5.2 Dealing with distributional impacts

A qualitative analysis of policy options

The previous section summarised findings on the distributional impacts of the proposed energy tax reform packages, indicating that they may be more regressive (relatively wide *dispersion* of burdens on different groups) but potentially less harmful (lower *level* of burden, both on average and for vulnerable groups) than an indirect or a direct tax.

Nevertheless, it remains the case that certain groups, such as the elderly, suffer disproportionally from energy taxation. An analysis of the proposed reform packages is incomplete without discussion of the best ways of addressing distributional concerns.

5.2.1 Criteria for assessing compensation policies

First, let us identify the criteria for assessing compensation policies. An important criterion is consistency with the overall aims of the energy tax reform packages: reducing emissions and reducing fiscal deficits (at low economic cost). A compensation policy consonant with these two aims scores higher than a policy that compromises one or both of them. A second criterion for assessment is the extent to which a compensation policy shields vulnerable groups from the impacts of higher energy taxes. The more effective a policy is at achieving this, the higher it will score. Therefore the most desirable compensation policy will have the following features:

- it will be cost-effective, thereby not obstructing the goal of fiscal deficit reduction;
- it will leave unaffected or strengthen the incentive to reduce emissions, thereby supporting overall abatement; and
- it will effectively protect those in need, thereby reconciling energy tax reform with social policy.

5.2.2 Structure for classifying compensating policies

Given the purpose underlying energy tax reform and its associated compensating policies, a debate about the relative merits of different measures can be structured along three key questions:

- What form should compensation take so that its incentive effects are consistent with the overall aim of the reform?
- Who to compensate with how much assistance?
- How to best implement the support?

5.2.3 What form of compensation?

Compensation policies can be structured to create incentive effects. The three main variants applicable to energy taxation are:

- Compensation which reduces the price of energy. Examples of this are common,[30] and include tax exemptions and VAT reductions. Leaving the choice of quantity in the hands of households, this type of compensation reduces impacts by counteracting the higher prices resulting from the tax increase.
- Compensation which reduces the quantity of energy consumed, such as vouchers for the installation of energy efficient equipment or expansion of public transport. It leaves energy prices unchanged.
- Compensation in the form of universal refunds, reductions in unrelated taxes (such as income tax or social security contributions), or refunds based on location. Leaving both prices and quantities unaffected, this type of compensation counteracts the general welfare loss from higher energy taxes.

Of these three, the first is the least compatible with the aims of energy tax reform. By lowering the price of energy, price-reducing compensation measures weaken the incentive to economise. Due to the conflict between the purpose of energy tax reform, and the incentives provided by this form of compensation, it is not an optimal choice.

The second kind of measure is not only compatible with the aims of energy tax reform, but positively supports it. However, energy efficiency programmes take time to implement. Furthermore, the cost structure of such programmes is front-loaded, placing a heavier burden on governments in the near term than other forms of compensation, while having lower future costs than alternative programmes. This cost structure may not be well suited to the current fiscal environment. Quantity-reducing policies may also be particularly prone to type I (a false positive, the inclusion of households that do not need support) and type II (a false negative, the exclusion of households that do require support) errors. Measures such as an expansion of public transport are likely to over-support commuters, not all of whom require assistance (type I), while under-supporting retirees and other households with relatively small travel needs (type II). It may also be the case that the reduction in the quantity of energy consumed is not sufficient to offset the tax-driven price increase. Given these three drawbacks, energy efficiency programmes may not be the most appropriate compensation policy. However,

30 In our sample of 9 countries there are: reduced VAT for electricity and gas used by households in Greece and the UK; reduced VAT for gas used by households in Italy; reduced VAT for fuel oil used by households in Portugal; tax exemption for coal, gas and electricity used by households in Hungary; tax exemption for coal used by households in France and Portugal; and reduced tax for electricity used by households in Greece. There are further tax expenditures on agriculture and certain modes of transport.(European Commission 2011g).

they may be a useful policy tool to complement an energy tax reform, regardless of whether it is used as the primary compensation policy or not.

The third kind of measure outlined above, compensation neither aimed at lowering energy prices nor aimed at reducing energy consumption, is, unlike the first type, compatible with the aim of the underlying energy tax reform. Compensation through lump-sum refunds or cuts in unrelated taxes does not detract from the incentive to economise on energy that is given by higher end-user prices. At the same time it shields those who receive this form of compensation from welfare losses, by allowing them to use the additional income at their own discretion. Furthermore, unlike the second form of compensation, it need not leave poor households exposed for a period of time between facing higher costs and receiving support nor need it impose front-loaded fiscal costs on government. The overall cost of this type of measure varies directly with its scope: a tightly targeted lump-sum rebate will be most cost effective, while a broadly targeted or universal rebate may use up most (or all) of the additional tax revenues. Examples of this type of policy are the Swedish cut in personal income taxes, the German cut in social security contributions, or the Swiss refund of CO_2 taxes. Where accurate targeting is possible, this type of policy is likely to offer the best combination of cost effectiveness, incentive structure, and social protection.

The modelling undertaken for the three national energy tax reform proposals includes analysis of a policy of this third type: using energy tax reform revenues to lower national insurance contributions. The results show that all sub groups of the population benefit approximately equally in all three countries, with the exception of unemployed, inactive, and retired households, who benefit relatively less. Due to the unequal reduction in impacts, regressiveness is not significantly reduced; however, the level of impacts is softened on all households.

It would be possible to design compensation arrangements at a national level which are more targeted than the simple reduction in national insurance contributions which has been tested here. It ought to be possible to obtain a more progressive outcome which is better from a social policy perspective, but this work has not been taken forward here because of the time it would take to devise realistic details of these arrangements for individual countries.

Finally, a further option of the third type is the allocation and trading of personal carbon allowances, proposed by Gough et al. (2011). This policy places a cap on a country's total greenhouse gas emissions and hands out equal emission allowances to each person. Those who emit less carbon than their allowance are able to sell their surplus allowances to households consuming more than their allowance. Unlike monetary lump-sum compensation, lump-sum carbon allowances have no immediate fiscal impacts (though they do carry an opportunity cost). The allocation of allowances can be designed in a way to support households with special needs, for example giving a larger allowance to disabled people. However, the administrative costs of designing and implementing such a system are likely to be considerable, and this type of policy may not be feasible in the time frame envisaged for energy tax reform. Nevertheless, as information technology advances, this may evolve into an effective and equitable combination of energy taxation and compensation policy.

5.2.4 Who to compensate with how much assistance?

Given the aim of fiscal consolidation, tight targeting is desirable both in the scope and in the level of assistance. Ideally a policy would target those who deserve to be shielded from energy price increases, and only those. The level of compensation would be set just high enough to leave all eligible households wholly unaffected by the reform. The appropriate granularity of targeting is not easily achieved, as explored below. Under certain circumstances a universal compensation policy may therefore be the preferred (second-best) solution.

To achieve the desired level of targeting, both the eligibility and level of support need to be considered.

In terms of the former, one option is to consider all households eligible for compensation whose members already receive some form of benefits. Although this would broadly capture many of those who it would be likely to be appropriate to support, there may be a number of households not receiving benefits who should also be eligible. An example of this may be households with high energy needs due to medical requirements, who may not yet receive benefits. A further challenge is mixed household where some members receive benefits and others do not, although it might be possible to adjust the level of compensation in these circumstances.

In terms of the level of support, the appropriate level of support should be as close as possible to the additional costs imposed by higher energy taxes, so that eligible households end up with little to no change in their household budgets. This amount will vary considerably from household to household and is not captured well by income data nor the social welfare system: 'even within income deciles dwellings and households are extremely heterogeneous in their energy requirements' (Gough et al. 2011).

Therefore, equity and efficiency considerations point towards the use of social welfare records on the one hand, and historical energy bills on the other. By combining the two pieces of information it is in theory possible to determine *who* is eligible, and *how much* support they are to receive, even where persons move house. In practice however, implementation may not be easy or indeed impossible. A central register of all benefits recipients, to determine eligibility, may not always exist. Creating one may be costly. Combining household-level energy consumption data and person-level benefits receipt data may be a serious challenge, with potentially large IT costs and legal obstacles. It may not be possible at all in some countries. So even where energy use and income data is available, depending on how they are stored and processed it may be practically impossible, prohibitively expensive, or illegal to combine them into a single data set.

An alternative low-cost option of creating the required data set might be through self-selection. Instead of paying out rebates automatically, the policy could require households to apply. The application procedure could be streamlined by using only pre-existing documentation: eligibility can be proven via welfare receipt documents; historical energy consumption can be shown with energy bills. However, this may face obstacles if people perceive the requirement to provide historic energy consumption data as intrusive.

First best policy option

Where such an arrangement proves possible, or where the two datasets can legally be combined at reasonable costs, the following policy may be best suited: using a monthly rebate not tied to current consumption, those households who qualify for social assistance receive the amount by which their energy bill is expected to increase due to higher taxes (using historical energy consumption to determine the energy bill increase). The lump-sum nature of the rebate encourages households to respond to higher prices (as they can keep the returns from energy efficiency investments), ensuring efficiency; the targeting reduces overall costs; and linking the size of rebates to historical energy consumption ensures that, among the eligible households, no one is worse off than before the energy tax reform, ensuring equity.

Second best policy options

However, this will not be possible in all places. Where the required datasets are unavailable or not combinable, there may be concerns about using a self-selection procedure: not all eligible households may in fact apply, leaving some households (potentially some of the most needy) exposed. Given this, it may be preferable not to rely on self-selection, and to use a second-best policy.

There are two main types of second-best compensation policy.

- First, an average lump-sum support (either annually, quarterly, or monthly fixed rebates) paid out to all eligible households. This retains the incentive effect, but will inevitably over-compensate some households while under-compensating others.
- Alternatively, exempting all eligible households from the tax increase. This will leave all eligible households as well off as before, and will only cost the actually foregone revenue, but it removes the incentive effect created through higher prices. It may also require, to a certain extent, the combination of different data sets: the tax-levying authority needs to know whom to exempt, which is likely to be determined by welfare receipt status (and perhaps one or two other specific and narrow criteria). The relevant tax-levying authority (frequently utilities themselves) may not have direct access to this information, and may even be legally prohibited from having it.

The choice between these two options will be influenced by the dispersion in energy costs across the eligible group of households. In countries where the difference between those households requiring the most energy, and those requiring the least energy is small (e.g. due to a relatively homogenous housing stock), an average per capita fixed support scheme may be viable (together with provisions for certain special needs households). Given the small dispersion, the extent of over- and under-compensation will be small. However, in a country where this difference is large (e.g. due to big differences in the energy efficiency of the housing stock), an average lump-sum may not make sense, and it may be preferable to exempt eligible households from the tax increase.

5.2.5 How to deliver support to households?

There are two relevant dimensions to this question: first, when should payments be made? Secondly, which institutional arrangements are best suited for delivering the payments?

With regards to the timing of payments, there is a case for linking them as closely as possible to the costs which they are compensating. In other words, support payments should be made at the same time as, or just before, energy bills are due.

There are three existing systems that could be used for delivering support payments: first the tax system; secondly the benefit system; thirdly utility bills. While government access to the tax and benefit system is guaranteed, this may not be the case with utility bills. Similarly, utility providers may not have access to benefits information. The coverage of utility bills is near universal, and assistance payments would be at the household level and guaranteed to coincide with the higher energy bills that they aim to compensate. This may be the preferred option if it is feasible. Payment via the benefit system has the attraction that it easy to target individuals on low wage incomes and those without employment, although it may not operate on a household basis.

5.2.6 Conclusion

In conclusion, the design and implementation of good compensation policy for energy tax reforms is not easy. Tightly targeted fixed rebates tied to both income and (historical) energy use is the first-best option. In countries where sufficient data is available, or where policy makers have sufficient confidence in a self-selection mechanism, they offer the best combination of incentive structure, fiscal cost-efficiency, and social protection. In countries where this level of targeting is impossible, two options are available. Where the dispersion of energy costs is small, a single-level fixed support scheme for all eligible households may be the best choice, preserving the incentive effect. Where the dispersion is large, tax exemptions for eligible households may be more appropriate. This analysis is summed up in table 16 below.

Table 16. **Targeted lump-sum support is the first-best compensation policy, while tax exemption and average fixed support schemes are second best options**

Uniform or customised support?	TYPE OF POLICY		
	Price reduction	Quantity reduction	Fixed support
Uniform	e.g. uniform and general subsidy on energy prices • Reduces incentive to cut emissions • Fiscal burden depends on ambition of policy, but likely to be large • Type I error if universal scope	e.g. universal reduction in public transport ticket prices • Incentive compatibility with energy tax reform objectives • fiscal burden depends on ambition of policy • both type I and type II targeting errors; level of support may also be too high or too low for different households	e.g. uniform lump-sum assistance • Incentive compatibility with energy tax reform objectives • higher fiscal burden • some over- and under-compensation; the more waste the higher dispersion of energy needs **Second best, where dispersion of energy needs is low**
Customised	e.g. exemption from energy tax increase for selected households • Reduces incentive to cut emissions • In theory costs are same as for lump-sum compensation, namely the foregone revenue from supported households • Appropriate compensation as eligible households are just as well off after reform as before **Second best, where dispersion of energy needs is high**	e.g. energy efficiency investment subsidies calibrated for each household • Incentive compatibility with energy tax reform objectives • fiscal burden depends on ambition of policy; front-loaded cost structure; high administrative costs likely • level of support may be too high or too low for different households; liquidity issues;	e.g. household-level monthly fixed assistance determined by historical energy consumption • Incentive compatibility with energy tax reform objectives • Low fiscal burden • Appropriate compensation; some waste due to distortion in historical consumption data **First best, where possible**

Note: Assessment is structured according to three criteria: incentive compatibility, cost effectiveness and efficiency, and social equity (appropriate level of support).

Source: Vivid Economics

6

Proposals for carbon-energy tax reform

Reconciling economic efficiency with political feasibility in ETD reform proposals

Section contents

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Proposals for carbon-energy tax reform

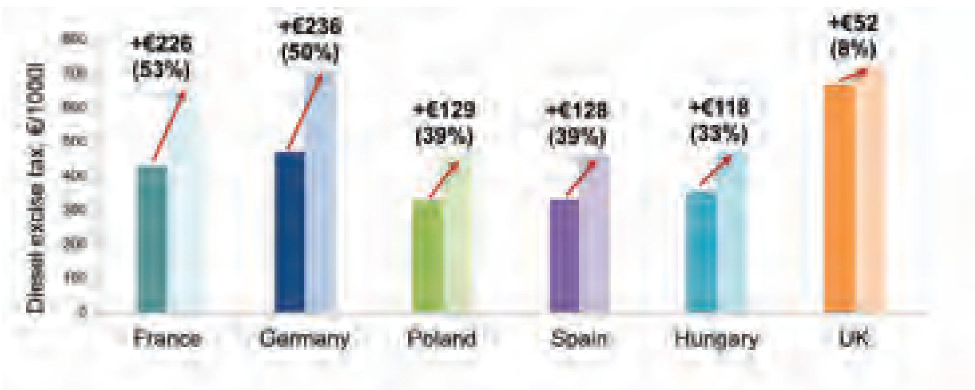
Proposals and modelling results

Dropping energy content taxation may be a way forward

This section begins with a review of the European Commission's reform proposals for the Energy Tax Directive. The main thrust is that, while the proposals are generally well structured, the rationale for taxing energy, rather than carbon and other externalities, may not be compelling. In addition, the current proposals require politically challenging increases in diesel tax, shown in figure 49 below.

The second half of the section presents a possible alternative amended proposal. We propose heating fuel taxation exclusively on a CO_2 basis. For transport fuel taxation, we propose the possibility of a CO_2 tax plus an additional (constant) mark-up. The mark-up reflects that there are significant non-climate externalities associated with transportation but that these are unlikely to vary significantly, or at all, by fuel type.

Figure 49. **Current ETD reform proposals imply very large diesel tax increases**



Note: *National petrol taxes are assumed to stay constant, and it is assumed that the energy-content and carbon-content component rates are scaled up (from €9.60/GJ and €20/tCO2 respectively) so to minimise the increase in diesel tax rates. Analysis in real (2011) prices.*

Source: *Vivid Economics*

6.1 A critique of the current reform proposals

Are the EC's proposals economically efficient?

6.1.1 Structure of this sub-section

This section offers a brief review of the reform proposals for a revised Energy Tax Directive (ETD). In summary, the argument is this: the European Commission is proposing to tax heating and transport fuels based on both their energy and their carbon content (see European Commission 2011a and also section 4 for details). While the rationale for carbon taxation is clear (see section 2 and Annex A), there are three reasons why it may not be optimal to tax fuels based on their energy content.

- First, it is not immediately obvious what externalities are corrected by energy taxation. Energy may not be a good proxy for some of the other externalities caused by energy consumption.
- Secondly, some lower-carbon fuels have high energy contents. Taxing them according to their energy content discourages their use and instead encourages the use of more carbon intensive fuels.
- Moreover, tax rates based on energy content require substantial increases in diesel tax rates in some member states. These increases (more than 50 per cent in France and Germany) may not be politically feasible and could present a serious obstacle to the ETD reform as a whole.

Box 2. **Reform proposals for the Energy Tax Directive envisage taxing both energy and carbon content**

In April 2011, the European Commission submitted draft proposals for a reform of the ETD, which was originally adopted in October 2003 and entered into force in January 2004. The proposals consider a restructuring of the way in which the minimum tax levels of energy products are determined: according to the proposals, new minimum tax levels would be based on the sum of an energy-content and a carbon-content component. Furthermore it is envisaged that member states 'will have to reflect the relation [between the new minima] in national rates' (Diemer, 2011) although in the case of transport fuels they will be given until 2023 to comply with this aspect of the proposals.

The proposal envisages taxing the carbon content of fuels at €20 per tonne of CO2 from 2013. Nine member states will be allowed to postpone this until 2020. The energy content of heating fuels is to be taxed at €0.15 per GJ, from 2013 with no option for deferral. The energy content of transport fuels is to be taxed at €9.60 per GJ, by 2018. Electricity is to be exempt from the carbon component, but subject to a minimum tax of €0.15 per GJ (equivalent to €0.54 per MWh) (European Commission, 2011a).

These proposals would lead to a major increase in the minimum tax levels of some fuels, but not others. Petrol used as a motor fuel would see a negligible rise in its minimum. Diesel used as a motor fuel on the other hand would see an increase from €330 per 1,000 litres to €390. The minima applicable to heating fuels would be lifted significantly across the board: minima on gas oil (light fuel oil, or heating diesel), heavy fuel oil, natural gas, and coal and coke would increase six-fold on average (European Commission, 2011c).

Furthermore the draft proposes to abolish low rates of tax for commercial diesel, stating that 'this provision would appear to be no longer compatible with the requirement to improve energy efficiency' (European Commission, 2011a).

6.1.2 Economic principles suggest care in taxing of energy

There are two main economic reasons for imposing a tax: either to raise revenue and finance government spending; or to influence behaviour, by providing an incentive to steer away from the taxed good or activity, for example because it causes harm to others.

Consider the argument on behavioural change. The reduction of emissions, a major externality associated with energy use, may be addressed in part by placing a price on the carbon content. Equally the reduction of other pollutants may be achieved in part by pricing the relevant pollutant load of fuels. Neither may be closely related to the energy content because not all energy is generated from combustion of fuels, fuels differ in their combustion products, exhaust gases receive different processing to clean them and because impacts are location-specific. The clearest example of this is in relation to renewable energy sources: although these provide energy, they are typically responsible for causing fewer of these other pollutants.

One area where there may be a relationship between energy content of fuels and the incidence of externalities is in transport fuels. Transport fuel combustion causes externalities such as congestion (often the primary externality), accidents, noise and road wear and tear. Economic principles suggest that these might be best tackled by time- and location- specific road user charging. However, this remains politically challenging in the near term and excise duty on transport fuels is used instead. Transport fuels that provide more energy per unit of volume will allow vehicles to travel further than fuels that provide less energy per unit of volume. Vehicles that travel further are more likely to cause congestion, accidents etc. This would appear to support varying transport fuel taxes by their energy content.

However, there are also a number of other factors which determine the extent to which transport fuel combustion causes externalities including the time of day travelled and whether the journey is made in an urban (already congested) environment or in a rural location. Indeed, to the extent that diesel, a transport fuel with a higher energy content than gasoline, is used particularly by heavy goods vehicles that might travel out of rush hour and on the main trunk road network, it may well be that the combustion of the 'average' litre of transport diesel causes fewer externalities than the average litre of gasoline. Further empirical analysis would be required to make definitive statements but, in short, it is plausible that the externalities per unit energy consumed in transport fuels may not vary significantly by transport fuel type (and its associated energy content).

There is also the question of energy efficiency. Although energy efficiency is encouraged by energy taxation, there is no reason why energy efficiency should be encouraged over and above the level delivered by the market. To the extent that the market equilibrium level of energy efficiency investment falls short of a social optimum, relevant market failures have to be clearly identified and then appropriate public policies can be designed to remedy them. Indeed Sorrell, O'Malley, Schleich, & Scott (2004) argue that the response to a price incentive alone 'will be muted in many sectors unless steps are taken to lower transaction costs'. They conclude that 'effective policy solutions will need to address the particular features of individual energy service markets […]. As a result, it is likely that a *policy mix* will be required' [authors' italics] (Sorrell et al. 2004). Indeed, once the price of energy has been adjusted to reflect all of the other externalities associated with energy consumption, there is a risk that further energy tax increases will cause inefficient energy efficiency investment: resources would be allocated to energy efficiency which could be more productively used elsewhere in the economy.

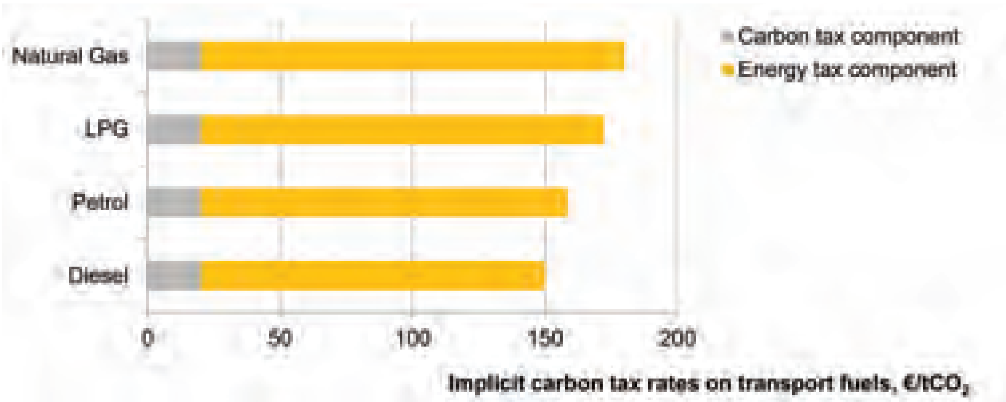
Finally, taxation by energy content may be a means of achieving energy security since it reduces demand for energy across the board, and therefore demand for imported energy. However, given that the incentive to economise applies equally to domestic and foreign sources of energy, energy content taxation is a blunt tool for energy security.

In short, a compelling economic case for taxing energy use per se, rather than the externalities associated with that use, is difficult to find.

6.1.3 By taxing fuels based on their energy content, the use of low-carbon transport fuels may be discouraged

A consequence of including an energy component within the overall tax rate could be to discourage the use of relatively low carbon fuels. By their nature, low carbon fossil fuels have high energy content when measured per unit of emissions. This fact enables, for example, natural gas to deliver the same energy as coal at lower overall emissions. Taxing both natural gas and coal based on their energy content will therefore lead to a higher implicit carbon tax on natural gas than on coal. The same number of GJs of natural gas 'hold' fewer emissions than the same amount of GJs of coal. If a GJ from each source is taxed the same amount, the tax per unit of emission is higher on natural gas than on coal, or higher on LPG than on diesel. This is most apparent in relation to the proposals for transport fuels where, as shown in figure 50, the overall implicit carbon tax is highest on natural gas and LPG, the fuels with relatively lower carbon intensity.

Figure 50. **Current ETD reform proposals: the proposals result in the least carbon intensive fuels facing the highest implicit carbon tax rates**



Note: *These figures are a conversion of a €9.60/GJ tax into a tax per tonne of CO2, added to a €20/tCO2 tax, using the emission factors given in Commission Decision 2007/589/EC.*

Source: *Vivid Economics and European Commission (2011b)*

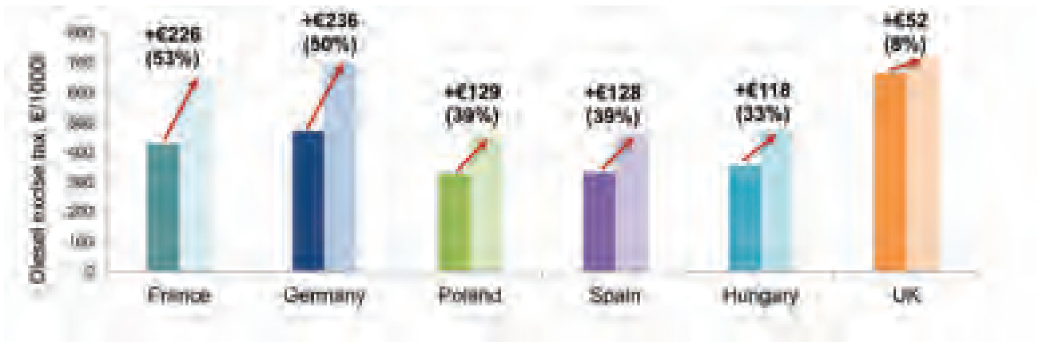
6.1.4 The European Commission's proposals may face considerable political opposition in their current form

The current proposals of the European Commission for ETD reform have two implications for diesel taxation that may be politically challenging: the taxation of fuels based on their energy content and the application of the same rate structure for all fuels used for the same purpose. These may endanger the project of ETD reform as a whole.

The proposed formula for calculating minima creates a higher minimum for diesel than for petrol.[31] The proposals furthermore envisage that as of 2023 'the same rates and structure must […] be applied to all fuels used for the same purpose (motor fuels or other fuels)' (European Commission 2011e). Thus a member state government is free to increase either the carbon-content component of energy taxation, or the energy-content component, or both. Nevertheless, the same calculation method must underpin the taxes levied on all fuels used for the same purpose.

This rule, were it to be introduced, necessitates major changes in the tax structure of a number of member states, such as Germany, France, and the United Kingdom. Given prevailing high levels of petrol taxation, and lower or equal levels of diesel taxation, diesel tax must increase significantly in order to comply with the EC's proposal if petrol taxes are not to fall. For Germany, France and the UK, diesel tax rates would have to increase by 50 per cent, 53 per cent, and 8 per cent respectively. This is illustrated in figure 51 below.

Figure 51. **Current ETD reform proposals: given current petrol taxes, diesel taxes have to increase significantly to comply with the Commission's proposals**



Note: *National petrol taxes are assumed to stay constant, and it is assumed that the energy-content and carbon-content component rates are scaled up (from €9.60/GJ and €20/tCO2 respectively) so to minimise the increase in diesel tax rates. Analysis in real (2011) prices.*

Source: *Vivid Economics*

Excise tax increases of this order, and corresponding price increases at the pump, may not be politically feasible. While it is possible in principle to lower petrol tax rates, this is undesirable from a fiscal point of view in the current climate. Lower motor fuel taxes would also run counter to the Directive's intentions of encouraging energy efficiency and emission reduction.

31 The proposed minimum for diesel is €390/1000l, the minimum for petrol €360/1000l (European Commission 2011a).

6.2 An amended proposal

Combining economic efficiency with political feasibility

The previous section suggested that it is hard to find a compelling argument that energy taxes will result in an efficient targeting of the externalities caused by energy consumption. This is particularly true for heating fuels but may also be the case for transport fuels. Further, in the case of transport fuels, the energy taxation component translates into high implicit carbon taxes on low carbon fuels, and vice versa which will make it more difficult to cut emissions. Finally, the requirement for countries to apply the same rates and structures across fuels used for the same purpose would necessitate increases in diesel tax of 50 per cent and more in some of the key member states. While a gradual reduction and eventual phase out of the tax difference between diesel and petrol is desirable, an increase of this size may prove to be a major obstacle in the negotiations surrounding ETD reform.

Based on this review, this section presents a modest reform to the existing proposals that may overcome these challenges.

6.2.1 Is a tax on energy content necessary?

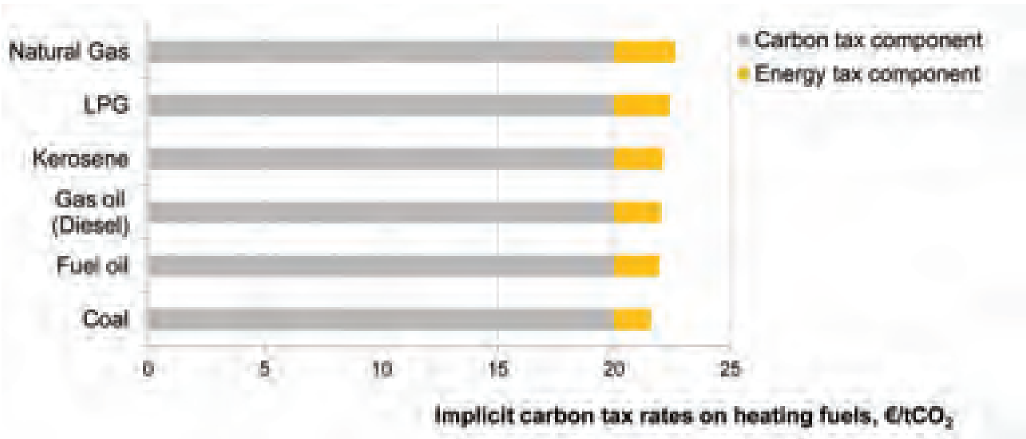
The first element of the alternative proposal would be to remove the energy-content component from the proposals. This reflects the idea that it may be difficult to construct a compelling argument that the externalities caused by energy consumption are closely related to the energy content of the fuel combusted.

In the case of heating fuels this does not have a major impact: the carbon-content component accounts for the majority of proposed minima: more than 90 per cent for all fuels other than natural gas and LPG, as shown in figure 52. If particular countries had greater climate ambition, and also wished to raise more revenue, then a higher level of carbon content taxation could be implemented.

For transport fuels, there are externalities other than CO_2 emissions which justify higher rates of taxation: congestion, road accidents (when they impose damages on others besides the guilty party), as well as localised air and noise pollution. Furthermore, there is a good argument for funding the construction and maintenance of roads not from general taxation, but rather through levies on the actual users of these roads. The taxation of transport fuels is a convenient mechanism for doing so.

Given this, the second element of the proposal would be to introduce a transport fuel mark-up in addition to the carbon tax element. This mark-up is designed to reflect the externalities other than carbon emissions, associated with the use of transport fuels, as well as the need to raise revenues for road maintenance and other purposes.

Figure 52. **Current ETD reform proposals: the energy content component only accounts for a small fraction of the proposed minima for heating fuels**



Note: Minima from EC's proposal for ETD reform, converted into €/tCO2 using emission factors given in Commission Decision 2007/589/EC.

Source: Vivid Economics and European Commission (2011b)

6.2.2 A transport fuel mark-up may bring the right combination of economic efficiency, political viability, and future flexibility, while keeping relative carbon prices constant

Depending on its design, a mark-up on transport fuel taxation on top of carbon taxation could have a number of benefits.

First, it is an approach that can ensure that the relative prices between petrol and diesel taxation more accurately reflect the CO_2 content of these fuels than exists in virtually all member states at present.

Second, the proposal may have political benefits from smaller increases in diesel tax rates than the current ETD proposals. Diesel is both more carbon intensive and more energy intensive than petrol, therefore the current ETD proposals require a larger difference in tax rates for the two fuels than would be justified by climate considerations alone. The mark-up approach results in smaller increases in diesel rates.

Third, a mark-up allows for more flexibility with regards to technological advances. The progress of technology may make it possible to deal with some of the externalities associated with transport in more efficient manners at a reasonable cost. For example, GPS-based charges could be used to price congestion externalities, while GPS-based tolls could be used to finance road construction and maintenance.[32] The use of a mark-up instead of energy content taxation allows the introduction of such policies to be accompanied by a reduction of the size of the mark-up, without fundamentally reforming its nature. Equally a mark-up may be better suited to major changes in fleet composition: in case a member state's vehicle fleet becomes predominantly electric, it may no longer be desirable or possible to price transport externalities through fuel taxation at the pump. A generic mark-up could then easily be lowered or abolished, to be replaced with a suitable alternative. The alternative, the use of energy-content taxation for electricity used by cars would have serious side effects: applying the proposed rate of €9.60 per GJ could yield implicit carbon prices ranging from as high as €480 per tonne of CO_2 in France to as low as €32/tCO_2 in Estonia, due to vastly different carbon intensities of electricity production in different Member States.

6.2.3 Two options for a mark-up on transport fuels

A generic mark-up could be calculated and implemented in a number of different ways.

One option would be to set a single mark-up, expressed in euros per 1,000 litres, which applies equally to all fuels used for transport. While member states would be free to increase this mark-up above the European minimum, the same mark-up would have to be applied to all fuels. This constant mark-up would create a price signal covering externalities and elements of road financing. Key member states like France, Germany and the UK would still be required to increase diesel taxes, given current levels of petrol taxation, but by less than under the EC's proposal. The EU-wide minimum would also increase, though again by less than under the EC's proposal. This is illustrated in figure 53, depicted as option 1. It is assumed that each country sets the mark-up so to keep petrol tax rates the same.[33]

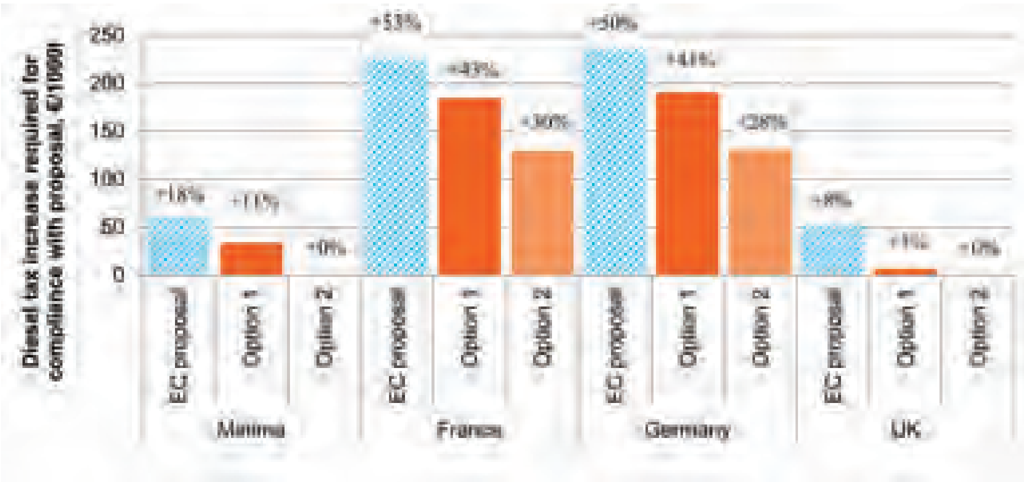
A second option would be to allow different mark-ups on each fuel, with a requirement that tax rates reflect the ratios between the minimum tax rates. Taking the minimum tax rates in the current Energy Tax Directive, and a carbon tax of €20/tCO_2, the increases in diesel tax in France and Germany would still be substantial (around 30 per cent), given current petrol taxes. However, the EU minimum would not increase, nor would the UK have to increase its diesel tax rate to comply with this version of a mark-up. An illustration of this version of the mark-up is given in figure 53, depicted as option 2.

It can be seen that both options would still require substantial increases in diesel tax rates but that these would be smaller than those required under the current proposals.

32 A GPS-based toll system, Toll Collect, is already in place in Germany for trucks of 12 tonnes or more.

33 Thus for each country: transport fuel mark-up = Total petrol tax - CO2 tax component of petrol tax

Figure 53. **Comparing different ETD reform proposals: each proposal requires different increases in diesel tax**



Note: Similar absolute increases in diesel tax can be equivalent to different percentage increases due to differences in existing diesel tax levels. Based on real (2011) prices.

Source: Vivid Economics

6.2.4 Conclusion

A review of the European Commission's proposals for reform of the Energy Tax Directive identifies both political and economic challenges associated with taxing the energy content of fuels.

An alternative approach would be to drop the energy content. For heating fuels, just the carbon-content would remain, although this constitutes the bulk, more than 90 per cent, of the minima within the ETD. For transport fuels, a transport fuel mark-up could supplement the carbon content element to account for transport-specific externalities and road financing. In contrast to energy-content taxation such a mark-up allows for additional flexibility both with regards to negotiations and with regards to the future development of technology.

7

Reforming the EU ETS

Options to raise revenue

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Reforming the EU ETS

Options to raise revenue

7

Comparison with other options for raising revenue

This section considers how the reforms to Phase III of the EU ETS that are already under discussion could help with deficit reduction. Given that the EU ETS covers approximately half of the EU's CO_2 emissions, it constitutes a significant and broad tax base, and can contribute well to fiscal consolidation. However, it also follows that EU ETS reform must be accompanied by Energy Tax Directive reform, covering the remaining 50 per cent of emissions, to deliver abatement incentives throughout the entire economy.

The EU is contemplating moving from an emissions target of 20 per cent below 1990 levels to 25 or 30 per cent. The principal tool to achieve this would be a tightening of the EU ETS cap. Existing European Commission analysis has already illustrated that, due to the recent recession, the costs of this action would be considerably lower than previously anticipated.

This analysis examines the impact of tightening the EU ETS cap from a new perspective. It considers whether the macroeconomic impacts of raising revenue in this way would be more or less desirable than by direct taxes. The analysis suggests that over the period 2013 to 2020, there would be smaller reductions in GDP, and fewer jobs lost, from EU ETS reform. This result is found both at the level of the EU as a whole and also for a significant majority of member states. In addition, the EU ETS delivers substantial emissions reductions not matched by increases in direct taxes. The most important assumptions underpinning these results are contained in the section itself, while a complete set of assumptions is given in Appendix D.

The section shows why the level of free allocation is a key determinant of the attractiveness of EU ETS reform from a macroeconomic perspective: the smaller the proportion of allowances that are allocated for free, the more attractive EU ETS reform becomes as a means of raising revenue.

7.1 Introduction

Tightening the EU ETS cap is already being considered

The European Commission is currently examining the impacts of raising its level of ambition for emissions reduction from 20 per cent on 1990 levels by 2020 to 30 per cent by the same date.[34] Its analysis (European Commission 2012) suggests that the impact of the recession has placed the 20 per cent target within reach already. However, it argues that because these emissions reductions have been achieved through an economic downturn, rather than through emissions mitigation measures, there is a greater risk that the EU will become locked into a high emissions trajectory. Its analysis suggests that the cost of reaching a 30 per cent reduction target has fallen to around €70 billion, significantly lower than earlier estimates.

The key mechanism to reach a more ambitious emissions reduction target would be a tightening of the EU ETS cap, accompanied by carbon energy tax measures covering non-EU ETS emissions. This would raise the price of allowances under the scheme and hence the revenues that could be raised through their sale. In this section, we complement the existing analysis by the European Commission. Specifically, we analyse the macroeconomic impacts of tightening the EU ETS cap and compare this with increases in direct taxes that would raise the same amount of revenue.

The modelling results suggest that over the period 2013-2020 there would be smaller reductions in GDP and fewer jobs lost from EU ETS reform than from equivalent direct taxes. As with the national tax results, the modelling results use the Cambridge Econometrics E3ME model. Further details on the assumptions about the model are provided in Appendix A, with details about the assumptions associated with the EU ETS in Appendix D.

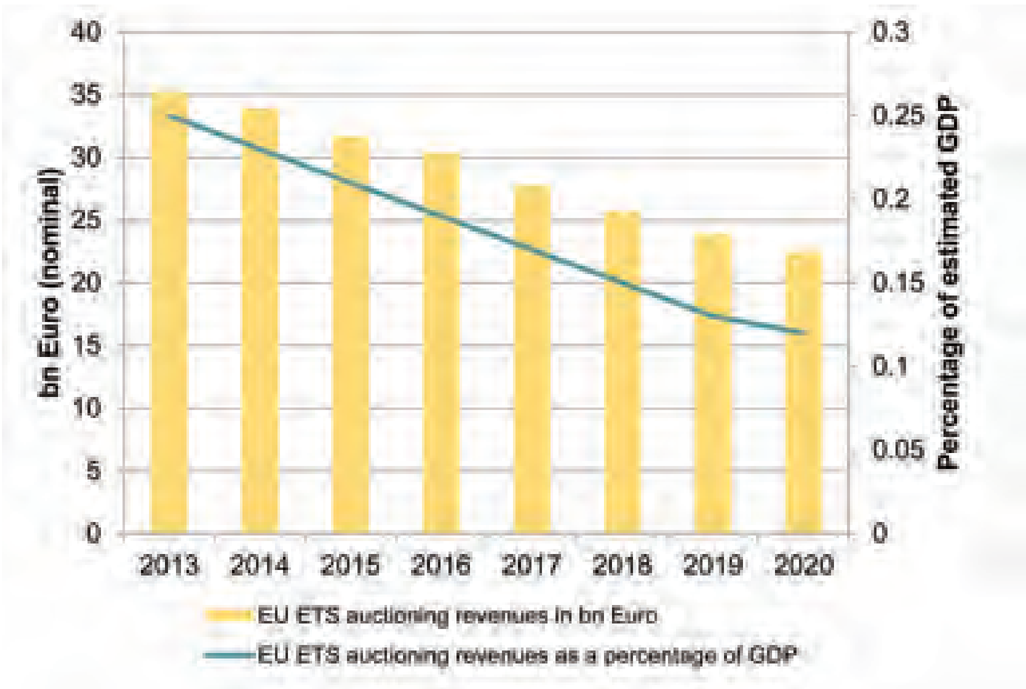
34 In the scenarios considered by the European Commission 5 percentage points of this 30 per cent reduction would be achieved through the use of international offsets with the remaining 25 percentage point reduction through lower domestic emissions.

7.2 EU-wide results

Tightening the EU ETS cap may be a more preferable way of raising revenues than direct tax increases

The E3ME model estimates that by tightening the EU ETS cap to help achieve a 30 per cent reduction target, which is equivalent to reducing EU ETS emissions by 34 per cent on 2005 levels, would bring in additional revenues of around €30 billion per annum, equivalent to around 0.18 per cent of EU GDP in the period.[35] As the figure shows, the revenue raising potential would be highest in the near term, which coincides with the period when the fiscal crisis is most acute, and slowly declines over time. This reflects the tightening of the cap over the period, resulting in fewer allowances being auctioned each year.[36]

Figure 54. **EU ETS: a reform could result in more than €30 billion per annum of additional revenues in Europe before 2015**



Source: *Cambridge Econometrics E3ME model*

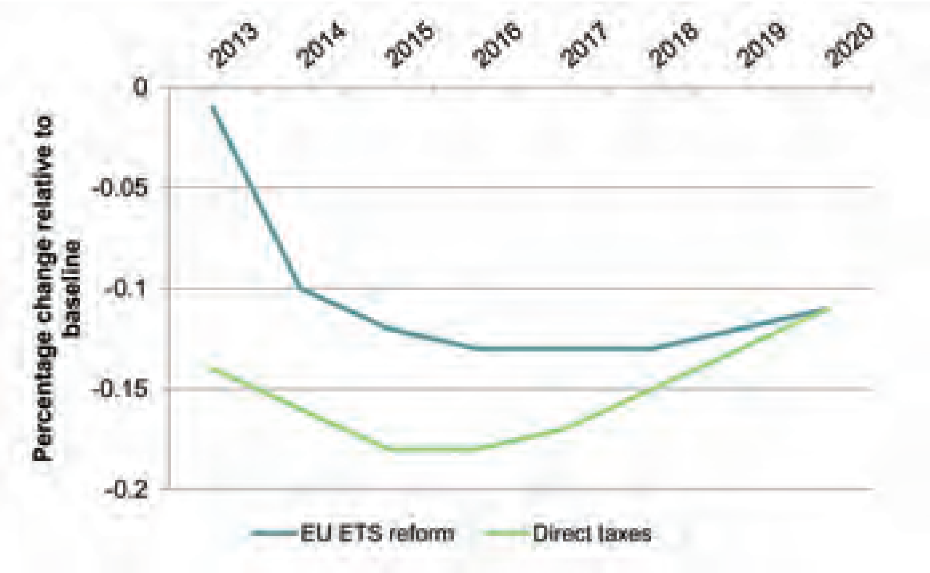
The carbon price estimated by the E3ME model that is consistent with these auction revenues is approximately €44/tonne on average over the phase III period (2008 prices).

Figure 55 below compares the impact on EU GDP from tightening the EU ETS with the equivalent direct taxes.

35 As explained in Appendix B, these reforms are assumed to be introduced in a situation in which the EU is already assumed to meet the Climate and Energy Package, including the renewable energy target i.e. the counterfactual is what the European Commission refers to as the 'reference scenario'. This is consistent with the way in which the European Commission has analysed the impact of tightening the EU ETS cap.

36 As there is unlimited banking and borrowing between years within Phase III of the EU ETS, allowance prices should remain broadly similar in each year (unless new information becomes available).

Figure 55. **EU ETS: the E3ME model suggests that using direct taxes to raise the same revenue as provided by EU ETS reform would result in greater losses in GDP**



Source: Cambridge Econometrics E3ME model

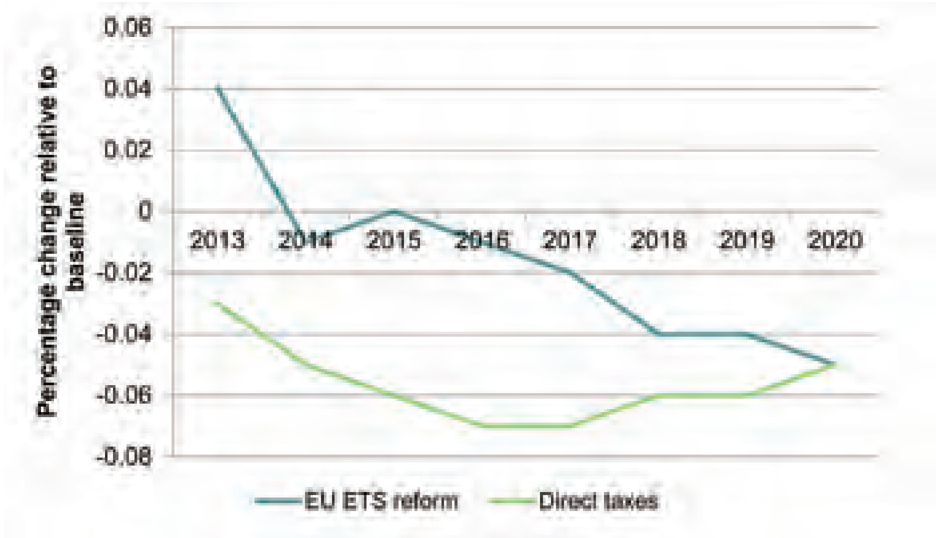
The modelling suggests that direct tax increases have a much more immediate negative impact on GDP than EU ETS reform, although the performance of the two taxes converges over the period. Nevertheless, by 2020, the cumulative loss in GDP has been almost fifty per cent greater from direct tax increases than from EU ETS reform.

The differential performance of the two alternative ways of raising revenue is explained as follows. Increases in direct (labour) taxes have an immediate depressing impact on take-home real wages, which in turn leads to an immediate decline in consumption and hence GDP. However, over time, and as described in section 4, the model assumes that, through higher wage bargaining, the burden of direct tax rises is shared between employer and employee in proportions broadly consistent with existing economic evidence. This (relative) appreciation in real wages, which has a positive impact on consumption, ameliorates the initial negative impact on GDP.

By contrast, the model estimates that the impact of the higher costs brought about by a tighter EU ETS cap will take longer to feed through into the wider economy, and even then the pass through to final consumers will be incomplete. It takes time for there to be a depression in real wages via this route and, in the interim, consumption remains relatively more buoyant. In addition, the modelling also anticipates that there will be a modest increase in investment under the EU ETS reform option, of around €2 billion per annum in the period 2013-2016 as firms respond to higher implied energy prices through energy-capital substitution. As with the national tax results above, it should be noted that the E3ME model does not include any feedback loops between changes in profits and changes in GDP, although for the reasons also discussed above this is likely to have limited bearing on the overall results.

The difference in employment impacts between the two alternatives is illustrated in figure 56.

Figure 56. **EU ETS: increases in direct taxes are expected to lead to larger declines in employment than EU ETS reform**



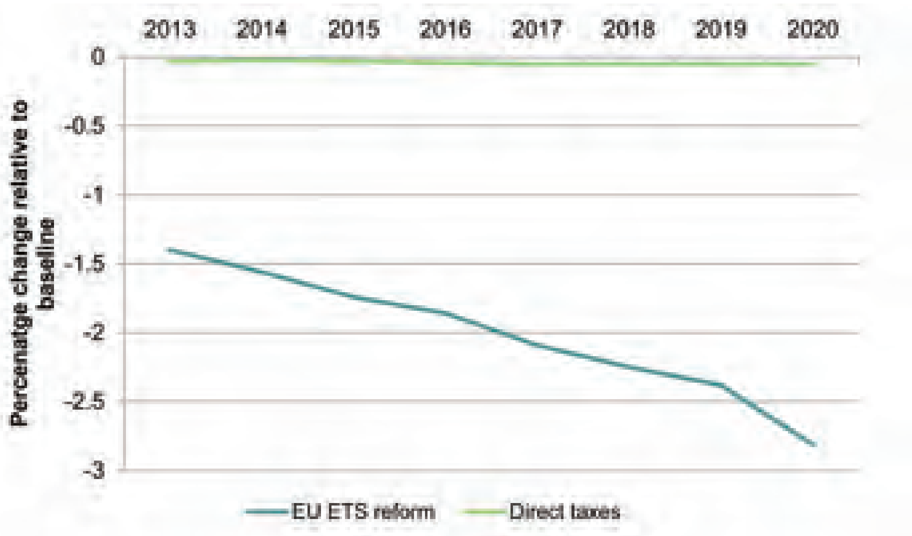
Source: Cambridge Econometrics E3ME model

The modelling suggests that employment impacts from the EU ETS reform are notably more favourable: on average, per annum; employment declines are around three times as large under the direct tax reform as they are under the EU ETS reform option (126,000 compared to 40,000).

The same explanations for the relative differences in the policy options for the GDP impacts also apply to the employment impacts. A further contributory factor is that the impact of EU ETS effect is concentrated in sectors which are not particularly labour intensive (or large employers). In line with expectations, the modelling suggests that the direct tax increase leads to larger declines in output than EU ETS reform in a number of service sectors responsible for significant amounts of employment including retail, banking, insurance, professional services and public administration.

Finally, and in line with expectations, as well as having equivalent or more benign macroeconomic impacts, reform to the EU ETS also results in greater EU emissions reductions. The model estimates an immediate reduction in emissions, relative to the baseline, of almost 1.5 per cent with this steadily increasing to between 2.5 and 3.0 per cent by 2020.

Figure 57. **EU ETS: reform to the EU ETS leads to substantial CO_2 emissions reductions while direct taxes have no real impact on emissions**



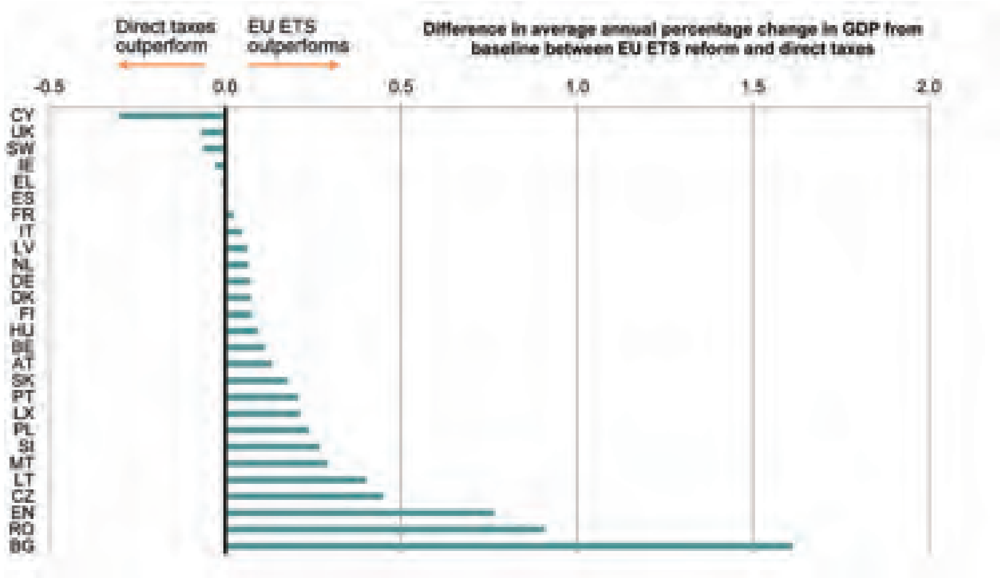
Source: Cambridge Econometrics E3ME model

7.3 Country results

The EU-wide results are replicated for most member states

The impacts of EU ETS reform can be compared with the impacts of direct taxes at the country level. Figure 58 shows the difference in average annual GDP impacts between the two policy options in each member state.

Figure 58. **EU ETS reform versus direct taxes: EU ETS reform is preferable to raising direct taxes – in terms of its impact on GDP – in most member states**



Source: *Cambridge Econometrics E3ME model and Vivid Economics calculations*

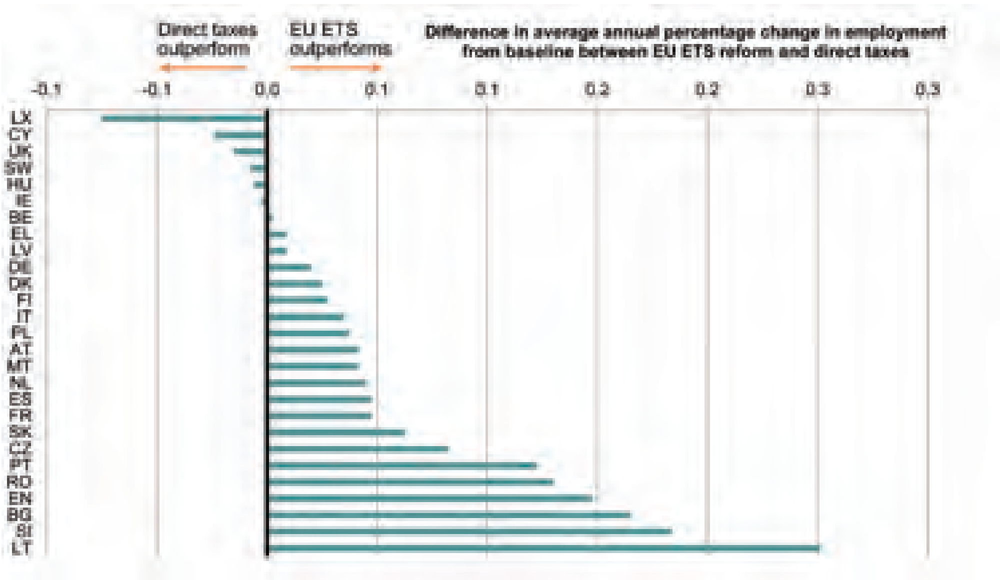
The results largely reflect those seen at the EU-wide level: in the majority of countries, EU ETS reform has a less damaging impact on GDP over the period than direct taxes that raise the same amount of revenue.

A further feature of EU ETS reform reflected in these results is the redistribution of a proportion of auction revenues towards East European member states. The details of this redistribution are shown in table 23 in Appendix D below.

This serves to make EU ETS reform particularly attractive for these countries: some of the macroeconomic costs associated with raising the revenue they receive are borne by other countries. As a corollary, member states that are net providers under this redistribution mechanism lose out (relatively speaking). This explains why, for some member states, raising direct taxes may lead to smaller GDP losses.

Figure 59 below shows the same analysis with respect to employment and shows broadly similar patterns.

Figure 59. **EU ETS reform versus direct taxes: twenty-one out of 27 member states experience smaller losses in employment as a result of EU ETS reform than from raising direct taxes**



Source: *Cambridge Econometrics E3ME model and Vivid Economics calculations*

7.4 The impact of free allowance allocation

The higher the proportion of auctioned allowances, the more attractive tightening the EU ETS cap becomes

A key feature of the way in which free allowances are allocated under the EU ETS is that, except in the event of closure, the quantity of allowances received by an installation are fixed and do not vary according to output changes within the period i.e. they are a lump sum transfer.[37] By contrast, decisions on how much output to produce, or what price to set for the product, will normally be made on the basis of considerations at the margin i.e. firms will ask, taking into account the additional revenues and additional costs, whether it is profitable to produce an extra tonne of product. Since the free allowance allocation influences neither the additional revenues gained nor the additional costs incurred in producing this extra tonne of output, the free allowances are not expected to lead to a change in their production (or pricing) decisions. Free allowance allocation would only affect whether a firm or installation decided to enter or exit. This is why electricity prices rose significantly in phases I and II of the EU ETS despite the provision of free allowances to electricity generators.

Some market practitioners dispute that output and pricing decisions are made according to the above logic. They suggest, instead, that firms will produce at close to full capacity, in order to maximise market share, so long as the firm is profitable. In this event, more free allowances would lead to more production. While conclusive evidence remains elusive, a recent study provided evidence that a number of energy intensive industries had been making their production and pricing decisions independently of the level of free allocation (Sander et al. 2010).

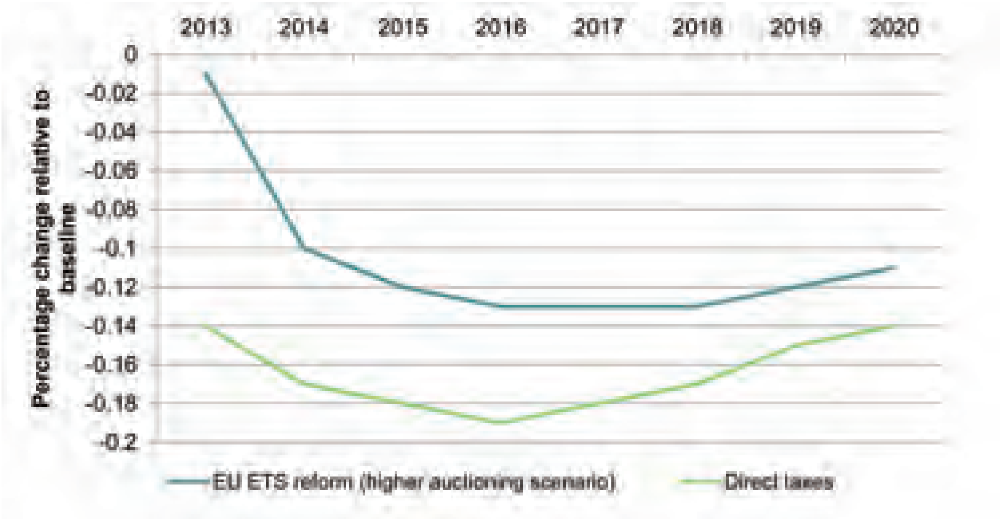
If the logic that firms make output and pricing decisions on a marginal basis is accepted, it has important macroeconomic implications. If each firm makes its decisions independently of the level of free allowances it receives then economy-wide levels of economic activity i.e. GDP and employment, will also be independent of the level of free allowance allocation. In other words, the same GDP impacts from EU ETS reform would be realised regardless of the level of free allowance allocation. Hence, reducing the level of free allowance allocation – and increasing the proceeds from auctions flowing to governments – could be achieved with little or no additional costs to GDP or employment.

To illustrate this idea, we have looked at an alternative scenario for tightening the EU ETS cap. In the baseline scenario described above, we adopted the approach of the European Commission in some of its recent analysis (European Commission 2012) and assumed that the reduction in allowances needed to tighten the cap came entirely through a reduction in the number of auctioned allowances. The number of allowances allocated for free stayed the same, implying that their proportion increased. In the alternative, the tightening of the EU ETS cap is brought about through a reduction in both auctioned and freely allocated allowances, keeping the proportions between the two types of allowances constant.

This second approach boosts the revenue raised by an estimated €20 billion over the period to 2020, an additional 10 per cent. Following the logic described above, this revenue is raised without any impact on GDP or employment. By contrast, raising this higher amount of revenue from direct taxes would be significantly more economically damaging, as shown in the figure 60 and figure 61.

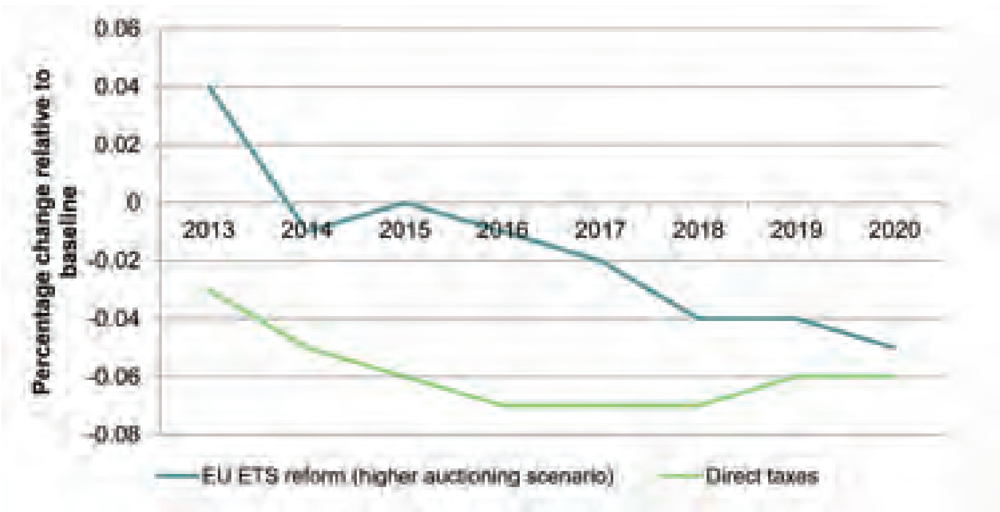
37 This contrasts with the way that free allowances are or will be allocated in a number of other cap and trade schemes including those in Australia, California and New Zealand.

Figure 60. **More auctioning in the EU ETS: in terms of GDP impacts, a higher proportion of auctioning increases the attraction of the EU ETS relative to direct taxes**



Source: *Cambridge Econometrics E3ME model*

Figure 61. **More auctioning in the EU ETS: auctioning a higher proportion of allowances also make the EU ETS more appealing than direct taxes in reducing job losses**



Source: *Cambridge Econometrics E3ME model*

7.4.1 Conclusion

In summary, the greater the proportion of allowances that are auctioned, the more appealing the EU ETS becomes as a means of raising revenue. A move towards a tighter cap combined with a move towards full auctioning could raise 0.3 per cent of GDP at low macroeconomic costs, contributing significantly to fiscal consolidation. Together with a reformed Energy Tax Directive and national tax reforms (covering sectors not included in the EU ETS), raising between 1.0 and 1.3 per cent of GDP, EU ETS reform could create a consistent carbon price signal throughout the economy. This policy mix could hence both deliver additional revenues for budget consolidation, and achieve low cost abatement.

8

Beyond 2020

Long term options for raising revenues from carbon pricing: Border Carbon Adjustments

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Beyond 2020

8

Long term options for raising revenues from carbon pricing: Border Carbon Adjustments

Border carbon adjustments (BCAs) in post-2020 EU climate policy: assessment and possible design options

This section examines the longer term options available for governments that wish to consider using carbon pricing as a means for raising revenues. It looks, in particular, at the role of Border Carbon Adjustments (BCAs) as a potential measure for providing a remedy for competitiveness impacts of carbon pricing while raising revenue. As the competitiveness assistance is being provided through free allocations of permits in Phase III of the ETS, which lasts until 2020, BCAs are considered here as a possible part of the post-2020 EU policy mix.

BCAs are adjustments to the prices of traded goods based on some measure of the greenhouse gases embodied in the good. They can be applied to imports (as a tariff) or to exports (as a rebate). Although politically controversial, it is an important option for addressing leakage and declining competitiveness caused by carbon pricing. They allow the substantial revenues currently tied up in free allowances to be recovered by governments.

If BCAs are to replace free allowances then it will be necessary to show that they are both as or more effective than free allowance allocation at addressing leakage and to show that they will not provoke retaliatory action and a trade war with countries outside the EU. In terms of the former, the new modelling analysis presented here suggests that they may stem output losses in European sectors exposed to carbon prices. In terms of the latter, we present design options for smarter BCAs which could be more acceptable to the broader international community.

For the interested reader, there are two appendices with further material on BCAs. Appendix E gives a brief literature review of the most important recent articles and reports covering BCAs. Appendix F gives a summary of BCA-relevant WTO rules and international climate change treaties.

8.1 Motivations for and potential problems with BCAs

BCAs can enable the move to full auctioning, but face obstacles

The main focus of this report has been on the immediate opportunities for carbon pricing to assist with deficit reduction. This section explores whether there may also be longer term opportunities to raise greater revenue from carbon pricing while improving the efficiency and effectiveness of the EU ETS.

The European Union has committed to reducing greenhouse gases by between 80 per cent and 95 per cent of 1990 levels by 2050. This necessitates significantly higher carbon prices than currently prevail; the European Commission's modelling has indicated carbon prices of at least €50/tonne by 2040, while in some scenarios the prices are significantly higher (European Commission 2011b). These levels of carbon prices would imply significant opportunities for further revenue raising, although, of course, over time, these prices will also significantly erode the level of emissions. However, there is a cost to higher carbon prices when the EU acts alone. Carbon prices undermine the competitiveness of certain sectors of the economy, leading to shifts in the geographic patterns of production to places where carbon prices are lower. Furthermore, if the emissions intensity of production is higher after the shift in production, global emissions could rise.

To date most estimates of carbon leakage as a result of differential carbon pricing have been modest.[38] For example, both economy-wide modelling (for example Winchester, Paltsev, and Reilly (2010), McKibbin and Wilcoxen (2009)), and sector modelling (Monjon and Quirion (2011) find leakage rates of around 10 per cent when no assistance is provided. These rates are sensitive to assumptions about the elasticity of fossil fuel supply, the substitutability of domestic and foreign goods, and the mitigation opportunities available to regulated firms (Burniaux, Chateau, and Duval 2010). In particular, an assumption that firms subject to carbon pricing have no mitigation opportunities can lead to higher projected leakage rates. Examining leakage rates for cold-rolled steel production in the EU, Ritz (2009) estimates a leakage rate of 9 per cent when regulated firms make efficiency improvements and 75 per cent in the absence of those improvements.

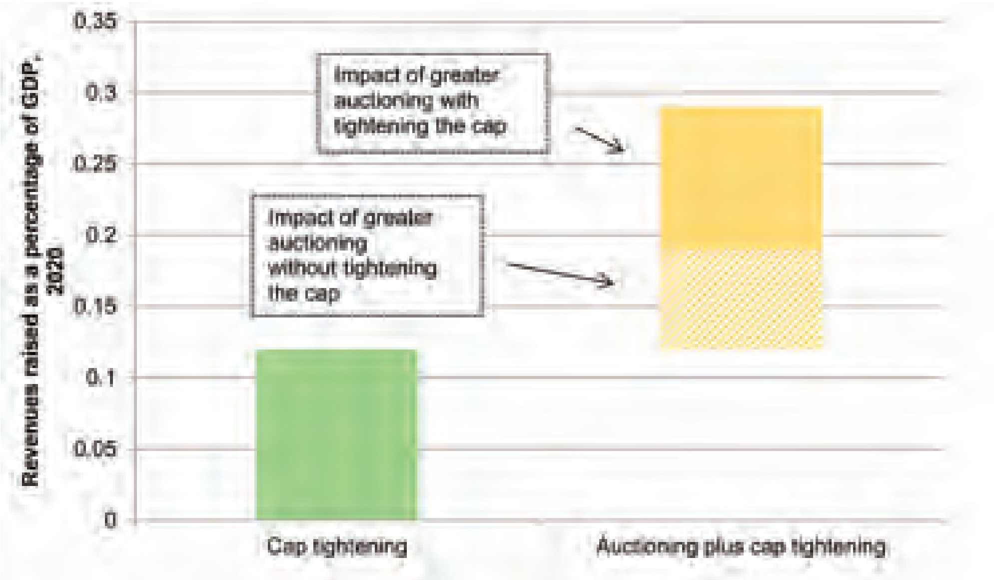
With higher carbon prices, concerns about carbon leakage and competitiveness would become stronger.[39] To date the EU has addressed these concerns through the provision of free emissions allowances. In Phase III of the EU ETS installations in industries determined to be at 'significant risk' of carbon leakage will receive 100 per cent of a benchmark amount of allowances for free until 2020 (European Commission 2010a). This benchmark is based on the emissions intensity of the 10 per cent most efficient installations in the EU for that sector and average historical output of the specific installation (European Commission 2010a).

However, as the figure below shows, this is an expensive way of providing assistance. If free allowance allocation were gradually phased out in the period to 2020 at the same time that the EU ETS was tightened then revenues amounting to an extra 0.29 per cent of GDP (more than €54 billion) could be raised by 2020. Of this, more than half would come from the impact of auctioning additional allowances. With deeper emissions cuts and hence higher carbon prices beyond 2020, planned in order to reach the 80-95 per cent reduction target by 2050, the fiscal cost of free allowances could grow higher. If ways can be found of reducing or removing this fiscal cost through a mechanism that deals with leakage and competitiveness concerns at least as well as, if not better than, then this would represent a significant gain to taxpayers.

38 As many factors influence the production and investment decisions of firms, rates of carbon leakage have to be estimated. These estimates are conventionally reported as the increase in emissions elsewhere as a proportion of those reduced within the area with mitigation policy. For example, an estimated leakage rate of 10 per cent indicates the policy induces 10 units of emissions outside the jurisdiction for every 100 reduced within.

39 Although the rate of carbon leakage may be independent of the carbon price, higher carbon prices will lead to greater absolute emission reductions and hence greater absolute levels of leakage.

Figure 62. **Full auctioning in the EU ETS: if it was possible to move to full auctioning of allowances, this would significantly increase the revenues that could be realised from the EU ETS**



Source: *Cambridge Econometrics E3ME model*

BCAs are adjustments to the prices of traded goods based on some measure of the greenhouse gases embodied in the good. They can be applied to imports (as a tariff) and to exports (as a rebate). An import BCA exposes imports to the EU to its carbon price and an export BCA removes the impact of the carbon price for EU exports to jurisdictions with (lower) carbon prices. While it is not necessary for a BCA to be applied to exports as well as imports, when one of the objectives of the BCA is to provide assistance remedy for competitiveness impacts caused by the absence of carbon pricing elsewhere, then a BCA will provide better assistance if it considers the effects on producers in both import-competing domestic and international export markets.

BCAs might have further positive effects on global emissions by inducing more mitigation in other jurisdictions. This could happen by altering the costs and benefits of mitigation. For example, depending on the design of the BCA, it could create incentives for a firm or country to invest in lower-emissions technology or raise the stringency of mitigation policy to reduce the tariff applied to its goods. Further, BCAs could enable the EU to take on a more stringent mitigation target, which could in turn induce other countries (especially those with mitigation targets conditional on other countries' action) to raise their targets.

However, as the controversy around the inclusion of international aviation emissions in the EU ETS has shown, (The Economist 2012), such virtuous circles are not a guaranteed outcome. BCAs might reduce the prospects for success in international climate change negotiations and might strain wider trading and other international relationships. These challenges mean that, if the benefits associated with this policy instrument are genuine, obtaining them would require carefully designed, smart BCAs.

This chapter asks two questions: is there a case for investigating a shift from free allocations to BCAs as part of the EU's post-2020 climate policy? If so, what would a smart BCA look like? While there is a strand of literature estimating the effects of mitigation policies on leakage, and a smaller strand investigating the effects of BCAs as an instrument for reducing leakage, there is a paucity of research addressing the questions which are the focus of this chapter. In particular, it is rare that researchers directly compare the environmental and economic effects of BCAs with those of free allocations, or model the effects of BCAs in a scenario in which mitigation action, albeit fragmented, is occurring in countries with a wide range of incomes.

There is sufficient evidence here to justify further consideration of BCAs. A smart EU BCA could:

- be based on emissions permits rather than taxes for WTO-compatibility reasons;
- be applied to both imports and exports in order to act as a substitute for free allocations;
- start gradually and expand its sectoral scope only if initial outcomes were favourable;
- set the scope of the emissions liability of foreign producers no larger than that for domestic producers and apply an

import tariff based on the carbon content of either the average EU or producing-country-specific emissions intensity, or an average of the emissions intensity of the major production technologies, together with a right of appeal;
- adjust the import tariff so that the full EU carbon price was not applied to imports from countries judged to have less capacity to contribute to mitigation, or who have already applied a comparable carbon price to their production.

The rest of the section proceeds as follows. The next sub-section sets out what is currently known about both the legality and practical aspects of BCAs and then focuses on their possible economic impacts. This analysis reveals that there is a dearth of modelling comparing the effects of the current policy with those of a feasible EU BCA. As a contribution to remedy this, we present some new modelling results showing the possible differences between BCAs and free allowance in different sectors. Sub-section 8.4 sets out the objectives and principles for BCA design and presents a number of smart BCA options consistent with these. The final sub-section discusses next steps for empirical and policy work.

8.2 What we already know about BCAs

There is a small but growing literature on BCAs

This section discusses the state of knowledge on both the legal and practical aspects of BCAs as well as their possible economic and environmental effects.

8.2.1 Legality and practical aspects of BCAs

While some earlier literature claimed that BCAs were incompatible with WTO rules (see the discussion in Monjon and Quirion 2011), more recent analyses tend to conclude that BCAs are at least potentially compatible, with compatibility dependent on the design and implementation of the BCA (World Trade Organisation and United Nations Environment Program 2009; Pauwelyn 2007; Eichenberg 2010). There are two potential routes to WTO-compatibility: compatibility with the General Agreement on Tariffs and Trade (GATT) general regime, and compatibility with one of the general exceptions of Article XX of the GATT (Monjon and Quirion 2011). Broadly speaking, the first of these routes would stress uniform treatment, both for domestic and foreign producers and across foreign producers from different countries, while the second route may require differential treatment of countries with different mitigation policies (Monjon and Quirion 2011).

Early concerns that border carbon adjustments would prove administratively complex have more recently been questioned. The EU ETS carbon leakage investigations have identified a range of energy intensive sectors exposed to carbon leakage. Some produce homogenous outputs and some do not. BCAs are best suited to those with homogenous outputs, and this contains the administrative complexity and cost of a BCA. Second, there are existing arrangements under which value added tax is levied on products sold within the EU and not on those sold outside it. A BCA scheme might free-ride on the systems established to run the Value Added Tax scheme.

8.2.2 Effects of BCA

To understand the overall potential outcomes from BCAs it is useful to consider imports and exports, and their associated emissions separately.

- Without a BCA or other assistance, imports produced in jurisdictions with no or low effective carbon prices compete in EU markets with goods whose production costs incorporate a carbon price. The application of an import BCA to a good raises its price in the domestic market by the amount of the BCA. Other things being equal, this will lower demand for that good, and the cost of its carbon content is incorporated in its price. The BCA affects domestic and foreign producers differently. Domestic producers can realise a larger share of this smaller market because they expand supply in response to the higher domestic price. However, foreign producers do not receive the higher price (the BCA is applied at the border and the tariff collected as revenue) so their production levels will be unchanged. In an emissions trading scheme, global emissions fall when a BCA is applied to a good covered by the scheme, as emissions under the scheme cap are unchanged and lower foreign output results in lower foreign emissions.
- Without a BCA or other assistance, producers from jurisdictions with carbon pricing face an input cost which competitors without carbon pricing do not face, and cannot raise the price of their products as these are set on world markets. An export rebate reduces input costs and raises profits per unit of output, other things being equal, which can alter optimal output and international market share relative to a situation of no assistance. As exports from assisted industries expand with an export BCA, the effect on global emissions depends on whether the emissions-intensity of domestic producers is higher or lower than the world average.

BCAs have been investigated in 'partial' (sector-specific) and 'general' (economy-wide) models. The literature as a whole is relatively small. While the precise characteristics of the BCA differ across models, some general conclusions are:

- BCAs are successful in reducing leakage rates in both partial and general equilibrium models (Winchester, Paltsev, and Reilly 2010; McKibbin and Wilcoxen 2009; Monjon and Quirion 2011). These models, typically based on current mitigation targets, estimate the amount of leakage in the absence of assistance to be small. The proportional reduction in leakage from a BCA can be large while the overall level of avoided leakage is relatively small. However, as discussed above, higher EU carbon prices likely after 2020 may increase the level of leakage.
- Authors who have modelled the effects of BCAs and explicitly express views on them are divided on whether they are a useful addition to a carbon pricing regime; some, like McKibbin and Wilcoxen (2009), argue that their small benefits are not worth the high political and administrative costs. Others, for example Fischer and Fox (2009), argue they may be the most desirable instrument for protecting competitiveness in a world of incomplete carbon pricing;
- While BCAs can reduce leakage *rates* they do not necessarily protect domestic *production*. Leakage rates are typically measured as the increase in emissions elsewhere as a proportion of those reduced within the

area with mitigation policy. BCAs can change both the numerator and denominator of this expression, and leakage rates can fall in a situation where both foreign and domestic emissions fall and domestic production is lower overall. [40]

- No researchers have examined a BCA which adjusts tariffs for the different levels of effective carbon prices in other jurisdictions, or explicitly takes into account the principle of common but differentiated responsibility.
- Most literature compares BCAs with a scenario of carbon pricing and no assistance, so cannot provide information about the merits of BCAs relative to free allocations. Monjon and Quirion (2011) is an exception, explicitly comparing BCAs and free allocation as alternative methods of assistance for at-risk industries.

Further details on the literature on BCAs are provided in Appendix F.

40 Several general equilibrium models (Winchester, Paltsev, and Reilly 2010; McKibbin and Wilcoxen 2009; Burniaux, Chateau, and Duval 2010) produce scenarios in which the BCA reduces domestic output relative to a situation of carbon pricing and no assistance. Winchester, Paltsev, and Reilly (2010); McKibbin and Wilcoxen (2009) find that BCAs have a protective effect in the EU but that, if imposed in the US, the decline in world GDP and reduced demand for US exports more than offset increased domestic sales. The possibility that BCAs might reduce the output for assisted industries, relative to the no-assistance case, is not confined to general equilibrium modelling: Monjon and Quirion (2011) find the same effect for the cement industry, as higher cement prices and the associated fall in demand for cement more than offsets any increases in domestic market share or exports

8.3 New modelling analysis

An initial comparison of free allowance allocation and BCAs

As identified above, one of the key features of the existing literature is that it often fails to explicitly compare BCAs with the alternative of other forms of assistance for firms facing the risk of carbon leakage. The modelling undertaken in this project begins to correct for this deficiency. We model the economic and environmental effects of a BCA applied to steel, aluminium and cement; those sectors where the practical challenges associated with introducing BCAs are smallest.

Although the mechanism for providing assistance to emission intensive trade-exposed (EITE) sectors has been set up until 2020, which makes the earliest plausible timing for introducing BCAs after 2020, the difficulties associated with modelling this far into the future mean that we look at the possible impacts of introducing BCAs in the period 2013-2020. The modelling results for this period are hence only indicative: they are intended to broadly illustrate the economic effects of BCAs, which would also apply if introduced post-2020. As elsewhere in this report, we use the E3ME for this analysis; see Appendix A for more details.

8.3.1 Description of modelling scenarios

A BCA is applied to both imports and exports as an import tariff and an export rebate. As the overall aim of this modelling is to focus on effects within the EU, international trade and mitigation in other jurisdictions is included with only minimal detail in the form of a single 'rest of world' region, which is assumed not to be implementing emissions reduction policies. The BCA is applied to steel, aluminium and cement sectors.[41] Allowances to the remaining industries receiving free Phase III allocations are assumed to be fully auctioned by 2020. This means that the scenario highlights the effects of BCAs on particularly emissions-intensive and/or trade-exposed industries, but does not examine the impacts of a BCA applied to all sectors currently deemed to be at significant risk of leakage.

As the BCA scenario assumes that allowances to remaining 'at risk' industries are fully auctioned by 2020, it models a change in both the form and scope of assistance. This BCA scenario can be compared to:

1) the 'full auctioning' scenario, to determine which has the more favourable impact on government revenue;
2) a 'free allowance' scenario modelling the distribution of allowances under Phase III, to compare the effects of different assistance policies on the output of assisted industries; and
3) an 'equivalent direct taxes' scenario, to gauge the economic impacts of raising the same amount of revenue from direct taxes rather than a BCA.

8.3.2 Results

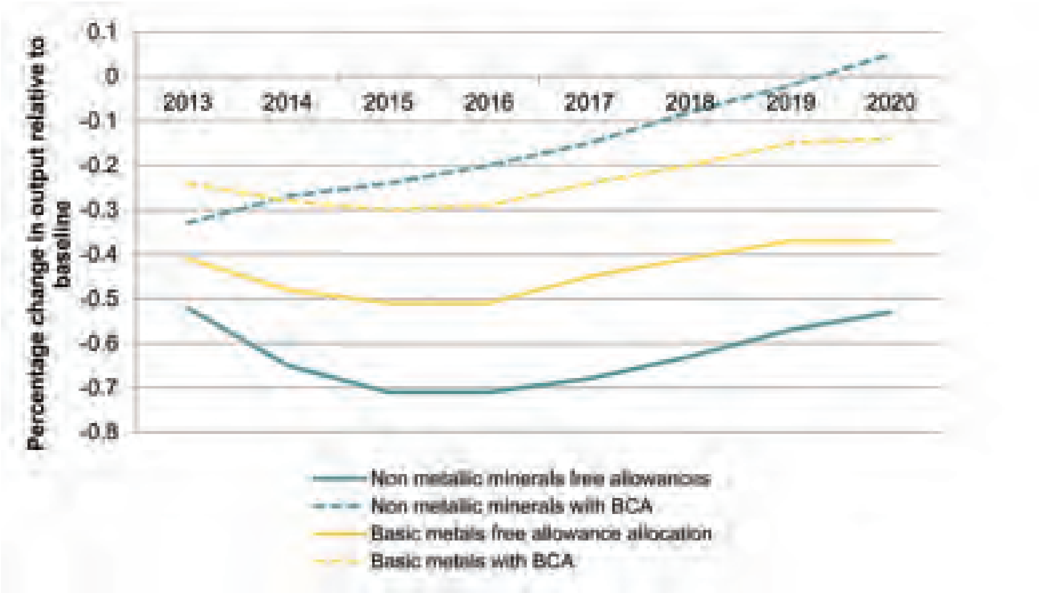
Relative to the full auctioning scenario, by 2020 the BCA scenario results in slightly higher consumer and carbon prices, investment, output and employment. The import tariff raises the price of steel, aluminium and cement in the EU, raising consumer prices. As domestic producers receive a higher price for these goods, they expand supply. As the overall level of emissions is capped by the ETS, carbon prices rise to meet the higher level of demand for permits. Consistent with previous findings on BCAs in the EU discussed above, BCAs have a protective effect in this scenario, with overall output, investment and employment higher than in a no assistance scenario.

A comparison between the BCA and free allowances shows that output losses are often more than halved with BCAs (figure 63). This finding is driven by the current approach to free allowance provision (as also discussed in section 8.3) which provides a lump-sum amount of allowances regardless of output levels. This means that even though installations receive assistance they still experience an increase in marginal cost, and decline in competitiveness, relative to those firms located in jurisdictions without (as high) a carbon price. Output consequently declines. In contrast, border carbon adjustments directly address the difference in marginal cost that the EU ETS creates, implying no loss in competitiveness for European producers.[42]

41 As these industries are not separately identified in the E3ME model, this is implemented by applying the BCA to a sub-set of the output of the non-metallic minerals and basic metals sectors. The 'adjustment bases' for the BCAs (discussed further in section 8.4 below) is average country-specific direct emissions (for imports) and average emissions from the exporting country within the EU (for exports).

42 The remaining decline in output in is the result of broader, macroeconomic impacts.

Figure 63. **BCAs and specific sectors: BCAs are projected to reduce output losses in the sectors where they are applied**



Note: *Output refers to all output from the sectors 'non-metallic minerals' and 'basic metals'. The model applies the BCA to only a sub-set of output in these sectors reflecting the estimated proportion of cement and iron and steel and aluminium in each of these sectors.*

Source: *Cambridge Econometrics E3ME model*

The results also suggest that BCAs would induce fractionally more CO_2 abatement than free allowance allocation. This is probably because BCAs incorporate carbon prices into a greater proportion of European-consumed goods. However, as the modelling analysis only includes BCAs for a small number of sectors, the effect is very small (around 0.2 per cent over the 8 years to 2020). The model does not provide estimates for global CO_2 reductions.

The results suggest that a BCA is projected to raise around €2bn per annum more revenue than a move to full auctioning without BCAs. They also suggest that if, instead, the revenue were raised through direct taxes there would be larger reductions in GDP and employment. It is worth noting that the modelling excludes the transactions costs of both free allowances and a BCA. Differences in transaction costs between policy instruments are difficult to capture well in an economy-wide model, so are best investigated by direct estimation as part of further work. At first pass, it is difficult to tell whether the transactions costs of free allowances would differ substantially from those of BCAs, although opting for producing-country-specific adjustment bases might raise the transactions costs of BCAs relative to the option of a uniform adjustment basis.

Overall, BCAs have the potential to deliver better protection against leakage than free allocations. They could contribute more to fiscal consolidation than a shift to full auctioning on its own, and are a more attractive way of raising revenue than an increase in direct taxes. However, considerable challenges relating to the feasibility, compatibility and political acceptability of BCAs remain. Some options for how these may be overcome are discussed in the following section.

8.4 Possible design options for smart BCAs

A review of the most attractive alternatives

To consider options for the design of BCAs, we begin by setting out possible policy objectives. These might include:

- *competitiveness*: to ensure that domestic producers are not adversely affected in domestic or overseas markets by the absence of effective carbon prices in other countries;
- *leakage:* to increase the environmental effectiveness of the EU ETS by reducing leakage from the EU to other jurisdictions;
- *domestic incentives for producers:* to assist industries at significant risk of leakage such that assisted entities retain incentives to reduce their emissions;
- *domestic carbon price signals for consumers:* to improve the efficiency and environmental effectiveness of carbon pricing, giving the carbon price the widest cost-effective coverage possible;
- *raising mitigation ambition elsewhere:* by lowering the economic costs of mitigation, a well-designed BCA could stimulate more ambitious mitigation policies in other countries. A necessary condition for achieving this objective would seem to be that the policy is perceived to be compatible with WTO rules and the principle of common but differentiated responsibility (CBDR) (see Appendix F for further discussion);
- *raising mitigation ambition within the EU:* if industries at risk of leakage prefer BCAs to free allocations and concerns about competitiveness are a barrier to the EU adopting more stringent mitigation targets, BCAs could improve the political acceptability of raising the ambition of EU mitigation policy; and
- *least economic cost:* a BCA should achieve these objectives at least cost to the EU economy as a whole. Given the possibility that the poor fiscal positions of many European economies will persist for some time, least fiscal cost is also important.

This section sets out design options for a BCA which might best meet the objectives set out above. When designing a BCA, choices must be made for each of the four components below:

- form of the BCA (tax- or allowance-based);
- coverage (which includes the components of trade, choices of sectors, and emissions);
- adjustment base for emissions; and
- whether and how overseas mitigation action and common but differential responsibility are incorporated.

For some of these aspects, the objectives or the overall design of the EU ETS make the choice relatively easy; in other cases (such as the adjustment base and the incorporation of CBDR) the objectives above do not point to a single best design option, so the report presents plausible options.

8.4.1 Form of the BCA

A BCA based on emissions permits rather than taxes may be preferable for WTO-compatibility reasons although it would raise less revenue than a tax-based BCA.

As domestic firms with liabilities under the ETS have to surrender permits, a BCA providing obligations or rebates in terms of permits rather than prices means that the form of the liability is the same for domestic and foreign producers, which is desirable for WTO-compatibility (Monjon and Quirion 2011). One implication of an allowance-based BCA is that it would raise less revenue than a tax-based one to the extent that some allowances will be permits for genuine emissions reductions achieved overseas.

On economic efficiency grounds, the form of the allowance would not be expected to make a great difference to liable parties. If the BCA were allowance-based, importers could acquire permits, hedge, trade, and so on, and would then be liable to surrender permits equal to their eligible emissions at a compliance date in the same way as other liable entities If, instead, the BCA was tax-based, the liability would be calculated from the permit price and, while the importer would lose the ability to manage the cost of the liability directly, it is likely that financial products for managing the value of obligations would become available.

Two further implications of an allowance-based BCA are worth noting:

- an allowance-based BCA requires enlarging the ETS cap (as is the case with the inclusion of aviation emissions in the ETS). If the cap is not enlarged, the BCA will effectively tighten it. This may not be a concern if the coverage of the BCA is small, but would be more important with larger coverage;
- with a BCA, the EU would in effect be running a quasi-consumption-based ETS (that is, one which involved capping emissions from consumption rather than production in some sectors), while remaining obliged under international climate change treaties and agreements to report and attain certain levels of national emissions based on domestically occurring production. This is feasible: as long as a country running a consumption-based ETS with a production-based national target can determine whether permits surrendered under the ETS were from domestic or imported emissions, the country can determine whether its national production-based emissions target has been met.

8.4.2 Coverage

Components of trade

To act as a substitute for free allocations a BCA should be applied to both imports and exports. If free allocations were to be removed it would be necessary to provide compensation for the absence of carbon pricing for producers in both import-competing domestic and international markets.

Sectors

A smart BCA would start gradually and expand its sectoral scope only if initial outcomes were favourable. Given the objective of addressing leakage, the sectoral scope of the BCA should not be larger than the industries the European Commission has determined are at significant risk of carbon leakage (see European Commission 2010). Further, for some manufactured goods, as discussed above, difficulties in estimating the emissions content (see below) may be too great and it may be preferable to retain free allowances.

Concerns about legality and other countries' reactions suggest a gradual expansion from a very small number of priority sectors. Candidates for early BCAs are large and particularly 'at risk' industries as determined by the Commission's criteria, which also have relatively homogenous output, for example: steel, cement, and aluminium. One way of resolving certainty about the legality of BCAs is to deliberately choose to apply a BCA early in a sector where this may be controversial. This could mean that a WTO challenge occurs earlier and a more definitive view of legality is obtained quickly.

Emissions

The principal question here is whether to cover just the emissions directly associated with the production of the good, or to include 'indirect' emissions from the electricity consumed in production. For complex manufactured goods, estimating even the direct emissions embodied in a good can be demanding. This reinforces the gradual introduction of BCAs, suggesting that a BCA should first be introduced for goods for which direct emissions can be relatively easily determined, such as less elaborately transformed goods for which there are a limited number of technologies for production. These are also likely to be the products that would see the largest cost increase, as a proportion of the product's value, from higher carbon prices.

In Phase III of the ETS, a BCA applying only to direct emissions would not protect domestic producers completely as they also face higher costs for electricity. While estimating indirect emissions is challenging, an internationally recognised body (the Executive Board of the Clean Development Mechanism) has already developed a methodology for the purpose (CDM Executive Board 2009). This method is already accepted by both developed and developing countries and is used in estimating the emissions reductions from projects implemented in developing countries. However, the inclusion of indirect emissions in the BCA would imply a somewhat different treatment of domestic and foreign producers, which may be problematic for WTO-compatibility. This is because the carbon costs that domestic producers incur from electricity depend on the proportion of costs passed through from generators, a proportion which may vary over time or between locations. The application of a BCA to indirect emissions would therefore require a general assumption about the pass-through rate.

8.4.3 Adjustment base

The adjustment base determines 'whose' direct emissions intensity is used to determine the carbon content of imports. For example, once the sector and scope of emissions for the BCA have been chosen, the adjustment base applied to calculate an import BCA could be the emissions intensity that relates specifically to that plant or firm, or a measure taken across multiple firms in one or more countries. Relevant considerations for determining the adjustment base are administrative feasibility, effectiveness in addressing competitiveness and leakage, and consistency with WTO rules. The feasibility criterion immediately rules out plant- or firm-specific adjustment bases as the number of entities outside the EU which would have to be assessed is simply too large.

There are three potential adjustment bases for the import component of smart BCAs: the average EU emission intensity, or country-specific emissions intensity, or a' technology-based' adjustment base, each of which should be accompanied by a right for low-emissions producers to appeal to use their own adjustment base after an audit by an EU-approved independent body.

Monjon and Quirion (2010) suggest using the emissions intensity of the most efficient 10 per cent of European plant as the adjustment base for a BCA for feasibility and on non-discrimination grounds: the adjustment bases have already been calculated for the purpose of providing free allocations, and their application would treat all foreign firms the same and not less favourably than domestic ones. However, an adjustment based on the most efficient European plants would under-adjust most imported goods, as the best EU plants will often be less carbon intensive than global rivals. An alternative to using the emissions intensity of the top 10 per cent of EU plants would be to use the average emissions intensity. The data to determine the average should be readily available given that the top 10 per cent has already been determined. Using an average has the advantage of continuing to treat all importing countries equally, while providing better compensation for domestic producers as the proportion of goods whose carbon content is under-estimated would be lower. One drawback to using an average is that the carbon content of the most efficient foreign producers will be over-estimated, however this can be addressed by letting producers opt in to having their BCA calculated using their plant-specific emissions intensity after undergoing an audit (Holmes, Reilly, and Rollo 2011). The EU could determine suitable bodies for conducting audits and consider bearing some of the costs of audits for producers from developing countries.

While it would require significantly more information, the average emissions intensity of the sector in the country of origin is also a possible adjustment base. For sectors in which relatively few countries sell to the EU, and when there are relatively few technologies used in a sector and its characteristics are well known, the number of additional adjustment bases would not be large and their calculation would be relatively straightforward. The EU could consider charging an independent organisation such as the International Energy Agency with determining country-specific adjustment bases. This approach could be accompanied by the ability for non-EU low-carbon producers to have a BCA calculated using their own emissions intensity following an independent audit.

A variation on the country-specific approach would be to construct a weighted average of the emissions-intensity of each major production technology subject to a BCA. Depending on the choice of weights, this either requires less information than the country-specific approach (but also less accuracy), or is informationally and computationally similar to the country-specific approach. For example, as there are seven main technologies for producing cement (Demailly and Quirion 2006b), a 'simple' approach would take an average of the direct emissions intensity of the seven processes for the adjustment base. Alternatively, the adjustment base could be a weighted average of the direct emissions intensity of each technology where the weights were the shares of each technology in recent EU imports of that product. However, it takes the same information to estimate the shares of each technology in EU imports as to estimate country-specific emissions-intensities for a given product.

8.4.4 Adjusting for mitigation action in other jurisdictions and incorporating Common but Differentiated Responsibility

It is arguably desirable not to apply the full EU carbon price to imports from countries judged to have less capacity to contribute to mitigation (that is, incorporating CBDR), or who have already applied a comparable carbon price to their production.[43] In an allowance-based BCA, the application of the full EU carbon price is equivalent to requiring all importers to surrender permits for all of their liable emissions. An alternative would be to scale down the liability to incorporate mitigation action and CBDR. While these adjustments lower the revenue raised by a BCA relative to a system which does not incorporate action or CBDR, there are good arguments for adjusting for both. However, the incorporation of CBDR involves a judgement about the appropriate carbon price in other jurisdictions.

Nonetheless, it is possible to incorporate both mitigation action and differentiation in a relatively simple way using a scalar which adjusts the importers' liabilities. This scalar embodies the difference between the actual and appropriate carbon price in a country. Call the 'appropriate' price in sector *j* of country *i* $P_{i,j}^{*}$ and effective price $P_{i,j}^{act}$. Then the scalar applied to the allowance-based liability from imports from sector *j* of country *i* is:

$$\left(\frac{P_{ij}^{*} - P_{ij}^{act}}{P_{ij}^{*}}\right)$$

which is equal to 1 when the sector in that country faces no carbon price and falls to 0, (so that there is no BCA), when a country applies what the EU judges to be appropriate level of effective carbon pricing.

Determining the effective carbon price

The aim of the adjustment is to correct for differences in carbon pricing in competitors, so Pi,jact takes into account both explicit carbon prices and the cost of regulations (such as performance standards) which impose implicit carbon prices either domestically or abroad (for examples of these calculations see Vivid Economics 2010; Productivity Commission 2011). To avoid accusations that BCAs are green protectionism the EU could co-operate with countries such as Australia and New Zealand who have an interest in the same information for the purposes of adjusting assistance levels to their own at-risk industries. Countries could charge an independent organisation such as the IEA or OECD with the calculation of effective carbon prices.

Determining the appropriate carbon price

Pi,j*could be determined through a three-part system which implements the widely accepted principle that countries at different levels of income per capita have different capacities to contribute to global emissions reductions. Countries might be split into three groups as follows:

- for Least Developed Countries (LDCs), the scalar in (equation 1) is zero (so that their goods face no BCA);
- for the most developed countries, countries with income per capita above a chosen level, the appropriate price is the carbon price imposed in that sector in the EU (that is, Pi,j* = PEU,jact);[44]
- for countries with intermediate income levels, the appropriate carbon price is a proportion of EU carbon price which rises from 0 to the full EU carbon price with rising income per capita. Figure 64 shows this as a linear relationship but the actual relationship could rise more or less quickly with changes in income.

A potential income threshold for the boundary between the second and third categories could be the income at a point in the distribution for OECD countries.

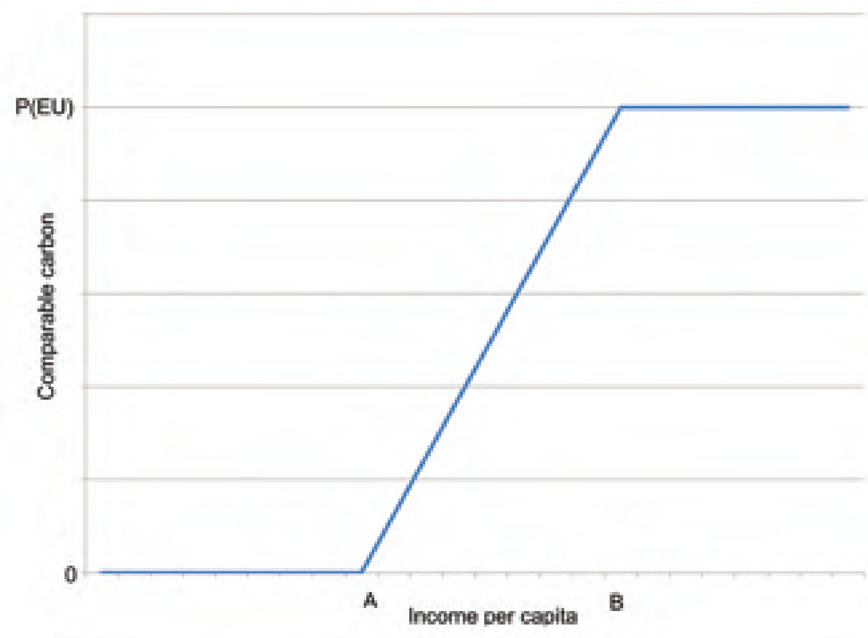
43 Note that this differs from the EU's current approach to the inclusion of aviation emissions, which treats all carriers equally, regardless of the level of development of their host country.

44 More precisely, this should apply if the effective carbon price in the other country is strictly less than that in the EU, with a zero-rated BCA being applied otherwise.

One argument against adjusting BCAs for CBDR is that the international regime already incorporates CBDR through a system of differentiated emissions reduction targets or actions, so that further adjustment of prices is unnecessary. However, one (desirable) outcome of a future legally binding emissions reduction treaty would be a world in which all major emitters take on legally binding targets appropriate to their level of development, and emissions reductions are traded between countries in a deep and liquid global carbon market with a uniform global price.

The benefits of this approach are that it is simple, transparent, uses a metric of capability and capacity which is universally recognised as relevant and important, and does not create sharp changes in countries' treatment as they shift between categories. The drawback is that it does not make additional adjustments to the appropriate price for factors other than income per person. However, the more variables are introduced the more likely it is that other countries would feel that the EU is imposing less widely held views on the appropriateness of carbon prices in other countries.

Figure 64. **BCAs could incorporate CBDR by applying a carbon price which increases with income per capita**



Note: Income levels A and B could be chosen as discussed in the text.
Source: Vivid Economics

8.4.5 Possible perverse incentives

The first is a possible incentive for shifting the production of import-competing goods, lowering domestically produced volumes of those goods. For example, a BCA on steel could create an incentive for domestic car producers to shift their operations to other jurisdictions to avoid having to pay a BCA on the steel they import from outside the EU. If the scope of the BCA matched the scope of industries deemed 'at risk', this would be unlikely to be a problem, as those industries have been assessed as precisely the set for which carbon costs are a sufficiently large proportion of gross value added. Even for a BCA focused on some of the most emissions-intensive industries within the 'at risk' group, these incentives could still be marginal but further modelling would be required to investigate the likely size of cost changes.

The second incentive arises from treating goods from different countries individually, which creates the incentive to claim that goods were produced in a country with lower per capita income in order to receive a lower import tariff. The strength of the incentives to misrepresent a good's country of origin, and the ease with which this could be done, will vary by good. Further work would be required on whether existing customs systems could be used to verify country of origin information.

8.5 Conclusions and next steps

A proposed research agenda

There is sufficient evidence here to justify further consideration of BCAs as part of the post-2020 climate policy mix. While the economic and environmental case for a post-2020 move from free allocations to a well-designed BCA is not proven, there is sufficient potential to justify further modelling work comparing the two alternatives and further development of the design details of a smart BCA.

Further modelling to investigate free allocations and BCAs could investigate the environmental and economic performance of the two instruments under scenarios which provide a realistic depiction of the current and likely future effective carbon prices in other major economies. Important modelling outputs from these scenarios are:

- emissions impacts both inside and outside the EU, as the expected impact on global emissions could be an important part of arguments demonstrating the compatibility of a BCA with international trade law;
- the fiscal impacts of the two policies under design options for a smart BCA;
- more detailed examination of the impacts of a shift to BCAs on industries at risk of leakage, including changes in product and input prices; and
- how the economic impacts of BCAs depend on the carbon intensity of firms.

Further work on the design details could include investigation of how the cap would be set and adjusted for an allowance-based BCA.

Concluding remarks

The role of carbon-energy taxes in efficient tax policy

Many European countries are running high fiscal deficits and have high debt liabilities and it is not desirable to correct this situation through cuts in expenditure alone. Many countries are looking at the options for raising taxes and it would be sensible for them to consider the full range of tax options. Carbon-energy taxes have generally been considered an instrument of environmental policy rather than fiscal policy, but it is time to reconsider that view.

Recognising that raising tax revenues is costly, the tax portfolio ought to be weighted towards tax bases associated with the lowest costs of taxation. Energy and carbon taxes perform well in comparisons against labour and indirect taxes like VAT when assessing their impacts on GDP and employment. This can be explained by a country-specific and a general effect. In countries which rely heavily on imports for energy supply, taxes beneficially divert spending away from imports to domestically-produced goods and services, boosting the economy. In all countries, energy taxes protect the consumption component of GDP better than wage taxation, because wages adjust to changes in a basket of prices of which one component is energy, whereas they adjust much less to changes in taxation. The evidence collected in this study is sufficiently strong, being derived from empirical statistical analysis of the European economy, to make the claim that energy carbon taxes currently play too small a role in the tax portfolio of many European countries. This evidence is not widely known, and perhaps this is why carbon-energy taxes do not fulfil their potential role in fiscal strategy. Road transport fuels, which already make a large contribution to revenues, and whose economic effects are perhaps more widely understood, are an exception to this observation: they already play a substantial role though there is also still quite some potential left unused.

Furthermore, to the extent that energy-carbon taxes do contribute, governments have allowed the energy carbon tax schedule to become overly complex, decreasing the cost-effectiveness of this class of tax. Governments have also reduced tax efficiency by varying taxes by activity or input without good reason, and unsurprisingly there is substantial variation between nations. These features increase costs by distorting the allocation of resources within the economy and in so doing it reduces the welfare of citizens. The European economy is less able to bear costs now than when it is growing strongly; thus, at a time when the cost of restoring fiscal balance is high, it is especially important for governments to act efficiently in taxation. It is plain to see that improvements could be made, preferably through reforms directed towards a unified carbon-energy tax rate.

Including/Internalising the cost of carbon consistently in the energy price

Unlike the taxation of labour or consumption via VAT, there is an appropriate minimum level of energy taxation. This minimum reflects the costs energy consumption imposes on society. Those costs are primarily in proportion to the carbon content of energy (more precisely, its contribution to global warming). This is a matter of efficiency and fairness in the long-run, and of avoiding the regret of living with the burden to society and nature of dangerous climate change. At a minimum, efficient energy taxation should ensure that all energy consumers pay the carbon costs of their energy consumption, but because of numerous exemptions, subsidies and the excessive issue of allowances within the ETS this is currently not the case. This is not a matter of narrow national interest but of European and global interest; and, to avoid intra-regional distortion of resources, the minimum carbon price ought to be set at the very least at EU level, both within the tax system and through the control levers of the ETS. This would bring both tax rates and allowance prices broadly in line with each other and to raise them to an appropriate level. These reforms could raise significant revenue at the same time as delivering an environmental dividend.

If the ETS and taxation in the EU sent out an appropriately strong, stable and persistent price signal, it would neither be necessary nor appropriate to continue with inefficient double taxation, whereby both taxes and the ETS apply to the same energy use.

Smart border carbon adjustments - a workable alternative to free allowances

In the long term, higher energy taxation and a higher EU ETS price may make it necessary to reinforce the protections against distorted international competition. This is because, while consumers and earners largely cannot move their consumption or earnings outside Europe to avoid tax, the production of energy-intensive goods could be encouraged to partly shift away from the EU by taxation. The current system of protection imposes an onerous fiscal burden through the granting of free allowances. It would be better to retain these fiscal revenues than to continue giving them out to industry. In their place, a new system of border carbon adjustments might offer both protection and impose appropriate climate policy incentives on trade partners, while delivering a net fiscal contribution instead of a cost. It is too early to dismiss border carbon adjustments as unworkable: it is time to explore smarter designs that address the criticisms levelled at them

Rational taxation of road transport fuels

Much of the political discussion around energy carbon tax reform has been about road transport fuels, particularly petrol and diesel. It is crucially important for the future low carbon competitiveness of the EU to get the taxation of these fuels right.

Given that they currently make by far the largest fiscal contribution, it is of no surprise that road fuels have occupied much of the discussion time in Brussels. Nevertheless, the sizeable fiscal contribution alone is not sufficient reason: it does not explain the political heat that has been created, which has come about partly because countries have competed for road fuel tax revenue, especially diesel tax revenues, partly because some of this competition is with non-EU countries, and partly because a large diesel-driving constituency has built up over long years of favourable tax treatment. As a result, EU countries individually and collectively collect less revenue from diesel than they could, which has worsened the fiscal balance. Furthermore, the tax preference given to diesel has led to an imbalance in the demand for oil products, imposing costs on European refining. The solution is to agree a collective increase in diesel tax rates. Of course, rates which have for so long remained differentiated cannot be raised overnight, because the public would not accept it. Yet the benefits suggest that a gradual programme of alignment would be worthwhile for all countries collectively and for each individually. Perhaps if this were more widely recognised, it might be easier to obtain an agreement from which all are likely to benefit.

Annex A

The theory of energy tax reform

Structure of this appendix

This appendix discusses the economic theory underlying energy taxation. It is structured into two broad sections. First, a discussion of the basic rationale for taxing energy and carbon. Second, an analysis of three further relevant issues pertaining to energy taxation: the double dividend, Porter's hypothesis, and the Green Paradox. While the double dividend and Porter's hypothesis support energy tax reform, the Green Paradox weighs against it. Ultimately, however, none of the three additional considerations proves decisive.

The rationale for energy and carbon taxation

The taxation of energy or carbon to address externalities

Where the consumption of a commodity or the act of producing it imposes costs on others for which no compensation is provided, the market does not allocate resources optimally and welfare languishes below its potential. The solution, identified by Pigou, is that 'everything of this kind must be counted in', which can be achieved with a tax or trading scheme to reflect the external cost (externality) (Pigou, 1920, page 109). The question is what is the value of everything that must be counted in? This question could be answered with reference to a valuation of the damage from the externality (most notably climate change). However, practical considerations have led to an alternative formulation: consistency with targets such as emissions reduction targets (see Baumol & Oates, 1988, chapter 5, for an introduction).

The external costs of energy use arise, in chronological order, first, from the extraction, transport and manufacture of energy and fuels and, second, from their combustion products. The European Commission paid for a thorough investigation of this life-cycle of impacts. It found that the greatest impact for most common energy consumption is the emission of greenhouse gases, particularly CO_2,[45] from combustion (Bickel, Friedrich, Droste-franke, & Preiss, 2005:36).[46] Carbon dioxide causes climate change, including increases in global average temperatures (Hegerl et al. 2007), sea level rise (Pethica et al. 2010), and a higher frequency of extreme weather events (Smith et al. 2009). Also, there is the possibility of there being discontinuous and irreversible effects from climate change, so-called tipping-points. This is considered likely by many (Lenton et al., 2008).

It follows that the optimal level of tax is at least the value of the damage caused by CO_2. The value of damage from emission of a tonne of CO_2 is known as the social cost of carbon. It is difficult to estimate, and estimates of it range widely and are uncertain. Yohe et al. (2007) report estimates ranging from between € -2 to €72 per tonne of CO_2 and even more widely with peer-reviewed estimates having a mean of €9/tCO_2 and a standard deviation of €17/tCO_2.[47] These figures are likely to change in the future as understanding improves.

Although the level of the social cost of carbon is uncertain, there is a tentative consensus that it may grow at a rate of 2 to 4 per cent per year (Yohe et al. 2007).[48] This reflects the fact that CO_2 is a stock pollutant, where the level of damage is given by the overall stock of CO_2 in the atmosphere rather than by emissions in any given year. As the stock of CO_2 in the atmosphere increases, so does the damage associated with each additional tonne, which in turn leads to a higher social cost of carbon.

The wide range of estimates is explained partly by uncertainties in the underlying climate science; partly by different choices of key variables such as the social discount rate, the choice of aggregation

45 In our discussion, we refer to carbon dioxide as this is the dominant greenhouse gas resulting from energy consumption.

46 Other externalities can include various air pollutants including, for instance, SO2, NOx. As discussed below a further range of externalities become important in the case of combustion of fuels for transportation, for instance, congestion and accidents.

47 Range reported in Yohe et al. 2007: US$ -10 to US$ +350 per tonne of carbon; peer reviewed estimates mean of US$43/tC, with a standard deviation of $83/tC. Converted to €/tCO2 using 1 tCO2 = 12/44 tC, and $1 = €0.755, the average $/€ exchange rate for 2010 (Source: OANDA.com).

48 This is the IPCC Fourth Assessment Report.

method and the weighting attached to income; and partly by the treatment of low-probability, high-impact events (Yohe et al. 2007). Furthermore, as Dietz and Fankhauser point out, 'there is often uncertainty not just about individual parameters but about the structure of the problem and how to model it' (Dietz and Fankhauser 2010). Given the multiple sources of both parameter and model uncertainty, and their mutual amplification, it may be that no single estimate can be used as the guide for a tax rate.

Some policy-makers have found estimates of the social cost of carbon to be inconsistent with policy targets that have been set, and have looked for alternative approaches (Watkiss 2005). This has led them to search for a shadow price that is consistent with their target, using a marginal abatement cost curve (MAC curve) or an emission trading scheme (ETS) to deduce the carbon price.

One advantage of a MAC curve is the lower uncertainty that it may offer compared with estimates of the social cost of carbon.[49] A disadvantage is that it relies on the emissions target which policy makers have chosen.

The alternative, an ETS, lets the market decide a price which satisfies the target. This avoids the administrative difficulty of estimating a MAC curve, but it brings other administrative and political economy challenges. On the other hand it introduces volatility into the carbon price, which creates uncertainty for firms and lower investment. The corollary is a higher carbon price for a chosen quantity of emissions. The design of the market, as well as the market structure (for example, number of emitters, liquidity of permit market, market share of importers and others), bear upon the overall volatility, liquidity and efficiency of the ETS. A full discussion of the advantages and drawbacks of an administratively fixed carbon price versus an ETS is beyond the scope of this paper. Hepburn (2006) gives it a comprehensive treatment.

Further externalities of consumption

In addition to the CO_2 emissions related to energy consumption, there are other externalities that justify energy taxation, particularly in the area of transport. These include congestion, noise, respiratory illness from air pollution, injury and damage from accidents, and road wear and tear. The relative importance of these additional externalities varies over time and space. In contemporary Europe, these additional externalities in the transport area are greater than the climate change externality.[50] However, although it is possible to address them via fuel or energy taxation, economic analysis indicates that this may be a second best policy option only. In the long run, a better option of addressing these externalities may be through road user charging (including congestion charging). Such a mechanism can take account of the spatial and temporal variability in the size of the externalities in a way that fuel taxation cannot, thereby providing more accurate price signals.

The taxation of energy or carbon to raise revenue

According to the Diamond-Mirrlees Production-Efficiency Theorem (Diamond and Mirrlees 1971), production decisions are best left undistorted. The intuition is the following: 'any distortion of production decisions reduces aggregate output, which cannot be wise so long as there is some useful purpose to which that output could be put' (Crawford, Keen, and Smith 2010). It follows that inputs into production should either not be taxed at all, or should all be taxed at the same rate in order to minimise distortion. Given that energy is an important input to production, the Diamond-Mirrlees Theorem advises against taxing (or subsidising) energy when used as a business input. It suggests that pure revenue raising is best done with low rates on large tax bases, such as Value Added Tax, rather than with high rates on narrow bases (J. Mirrlees et al. 2010).

The theorem is based on a number of assumptions, not all of which hold in reality: absence of externalities, absence of anti-competitive behaviour, ability to levy firm-specific taxes on pure profits, and others. In particular, externalities should be taxed or subsidised to reflect their social impacts, irrespective of whether the commodity is used as an input into production or for private consumption. However, externalities apart, 'the precise consequences of their [the underlying assumptions] failure appear to be sufficiently circumstance-specific, and the political risks from allowing special treatment sufficiently troubling, for production efficiency to remain the best guiding principle for practical tax design' (Crawford, Keen, and Smith 2010).

Thus we conclude that, other than for the correction of externalities, there is little theoretical justification for the taxation of energy when used as an input of production.

The inverse elasticity rule introduced by Ramsey

Suppose one did want to introduce taxes on the final consumption of energy. Would it be appropriate to single out energy as a good tax-raising base over and above that needed to correct externalities?

An optimal tax system aims to minimise the inefficiency and distortion necessary to raise a given amount of revenue, so the question becomes: is energy taxation, over and above the level necessary for correcting externalities, an efficient, non-distorting way of raising revenue? This question was first addressed in the 1920s but understanding has substantially advanced since then.

49 Dietz & Fankhauser (2010) estimate that the uncertainty surrounding SCC estimates is a factor of 10 larger than the uncertainty surrounding MAC curve estimates.

50 Fox example in Britain, the climate change externality accounted for only 1 to 4 per cent of all externalities associated with road transport in 1998. Congestion accounted for 71 to 88 per cent, accidents for 7 to 9 per cent, air pollution for 3 to 11 per cent, and noise for 0 to 5 per cent (Sansom et al. 2001).

First, let us review the long-standing conception, before providing the update. According to classical optimal tax theory, as pioneered by Ramsey (1927), the best system of commodity sales taxation taxes relatively inelastically demanded goods heavily, and elastically demanded goods lightly. This is because taxing a relatively inelastically demanded good will change the amount of the good consumed relatively little: that is, cause relatively little distortion. This analysis supports the taxation of energy, as demand for energy is inelastic[51] (Kilian 2007), and has been so for the last 20 years (Bernstein and Griffin 2006).

The update

Modern optimal tax theory cautions against the variation of commodity tax rates by elasticity. Two points from the modern treatment, which is more generally applicable than Ramsey's, are relevant here.

First, as Crawford et al (2010) explain 'the inverse-elasticity rule […] can prove dangerously misleading'. A household will respond to an increase in, for example, energy taxation by changing its consumption patterns across a range of different goods, reducing the revenue raised and potentially significantly reducing consumption (increasing distortion). In general:

> *'it is quite possible that increasing the tax on some good with a low price elasticity, while increasing revenue from that item, may actually reduce total tax revenue and/or lead to more distortion rather than less'* (Crawford, Keen, and Smith 2010)

All this is saying is that the taxation of inelastic goods may not be as non-distortionary to consumption as first appears, as although the tax may not reduce the consumption of the inelastic good very much, it may cause consumers to change their consumption of other goods. As these goods may also be taxed, it is possible that the net impact will be a reduction in tax revenues and greater distortion.

Second, there is another, more fundamental problem with the classic inverse-elasticity tax rule. The net benefits of differential commodity taxation are not driven by goods market effects, but rather by labour market effects. Taxation of either income or commodities 'unavoidably discourages labour supply' (Crawford, Keen, and Smith 2010), by reducing real wages. This induces people to shift away from labour and consumption, towards leisure. However, this result depends on the underlying theory of consumption held. In a target income theory of consumption, a tax-driven increase in commodity prices may increase labour supply, as households aim to maintain their targeted real income.

Differential commodity taxation is affected by the differential complementarity of goods with leisure. If all goods were *equally* complementary with leisure, Atkinson & Stiglitz (1976) show that the optimal system of commodity taxation would be a uniform rate. The Ramsey rule to tax price insensitive goods more (the inverse elasticity rule) is a special case of this theory.[52] However, these special conditions may not hold.

The above discussion is of interest perhaps only to economists, but the conclusion which emerges is of much wider interest. For optimal commodity taxation theory tells us that differential goods taxation should not be pursued merely in order to raise revenue. It does not rule out commodity taxation in order to address externalities. It merely tells us that energy taxation is unlikely to be justified other than to target externalities.

Three further considerations, two in favour, one against

This sub-section investigates three further considerations that are frequently voiced in favour or against energy/carbon taxation. The two arguments in favour are the double dividend and Porter's hypothesis; the third argument, making the case against energy taxation, is the Green Paradox. Analysis finds that none of the three considerations is conclusive. The strength of these three arguments hence rests on their empirical credentials: while there is empirical support for the double dividend, there is, at best, only weak evidence in favour of Porter's hypothesis. The Green Paradox has not yet been empirically tested, and hence is neither confirmed nor disproven. In sum, the three further considerations do not substantially affect the case for or against energy taxation.

The double dividend

The reform of environmental, and in this case, energy taxes may bring benefits in addition to the correction of an environmental market failure. This claim is usually described as a 'double dividend':

51 For the sample period February 1970 to July 2006, the PED of total energy consumption in the USA is given as -0.45 by Kilian. Bjørner and Jensen (2002) give the median price elasticity of energy demand in the Danish production sector as -0.38, and the mean as -0.44, based on time-series data.

52 The taxation of an inelastically demanded good results in increased household expenditure on it. This is because the greater spending driven by the higher price outweighs the lower spending from the purchase of fewer units. Since cross-elasticities are zero, the consumption of other goods does not change, and total household spending increases. In the absence of saving and borrowing, this increase can only be achieved through extra labour. Hence, in this particular special case, the taxation of an inelastically demanded good increases labour supply, offsetting the effects of taxation in general. The distortion-minimising effect comes through the labour market and is driven by zero cross elasticities, which prevent households in this model from reacting to the new tax by cutting the consumption of other goods, and forces them to increase labour supply in order to finance the higher spending caused by the tax.

the first dividend is commonly understood to be the correction of the environmental externality; the second dividend is understood to derive from the use of those revenues to reduce distortionary taxes elsewhere in the economy, with consequent lower unemployment and/or higher GDP.

The existence of a double dividend has been much debated in theoretical, empirical and modelling literature. These collectively point to the possibility of a double dividend which is contingent upon the fiscal context of the environmental tax. This is explored below, followed by a discussion of other ways in which revenues can be recycled.

The double dividend from first principles

The three possible impacts from an environmental tax are (T Barker et al. 2007):

- via a primary (Pigouvian) welfare gain: a tax levied on a negative externality brings private marginal costs in line with social marginal costs. This raises total social welfare (Parry and Oates 1998).
- via a positive but secondary revenue recycling effect: the revenue raised through an environmental tax can be used to cut distortionary taxes, for example, lowering labour taxes or social security contributions (Schöb 2003).
- via a negative but secondary tax erosion effect: the environmental tax reduces real wages or profits (by increasing prices), and hence erodes the base of pre-existing labour or capital taxes. In order to raise the same revenue from a smaller tax base, a higher excess burden is paid.

From these three impacts emerges a 'strong' and a 'weak' double dividend hypothesis (Goulder 1995). The weak double dividend hypothesis states that the second impact above improves welfare. It is essentially uncontested among economists. The strong double dividend hypothesis claims that the second effect above outweighs the third one. If this holds, an environmental tax would be welfare improving even in the absence of an environmental gain.

Economic theory suggests that a double dividend is only possible where other distortions already exist in the tax system. In an ideal world, there would be no other distortionary taxes that could be cut with the revenue raised from an environmental tax and the environmental benefit would be the only dividend. However, inspection of developed country tax systems reveals that much of the tax base is distortionary (T Barker, De-Ramon, and Pollitt 2009).

Moreover, in order to realise a double dividend, the benefits from cutting distortionary taxation must outweigh the additional distortion created by the tax erosion effect. Table 17 below shows seven examples in which this can occur and where policy-makers might hence secure a double dividend.

In summary the academic literature is clear that a double dividend will be present in specific circumstances only (T Barker et al. 2007). Given the uncertainty surrounding it, policy makers may prefer *not* to rest their case for reform on it. As expressed in the recent Mirrlees Tax review,

> *'the number of dividends, however, is not relevant in itself. Once we integrate tax and environmental policy reforms properly, all that really matters is whether the net effect is positive or negative on overall welfare'* (Fullerton, Leicester, and Smith 2010)

The salient question is not how many dividends an environmental tax achieves, but rather: how does carbon or energy taxation, introduced or increased to correct externalities, compare with other tax bases?

Table 17. **Example scenarios in which a double dividend might occur**

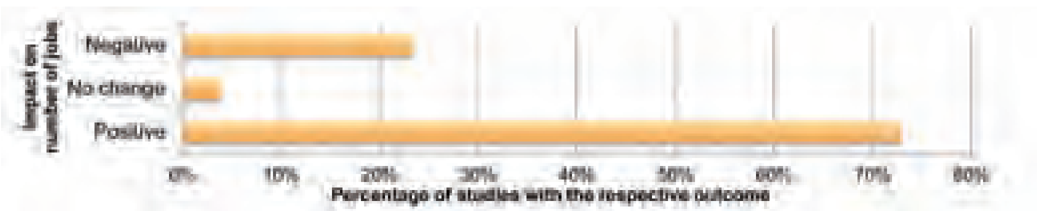
Scenario	Economic theory
Clean consumption as a better substitute for leisure	If clean and dirty consumption are equally good substitutes for leisure, a uniform tax on both is optimal from a non-environmental point of view. However, if clean consumption is a better substitute for leisure, then the optimal tax on dirty consumption would be higher (as taxing dirty consumption rather than clean would amount to implicitly taxing leisure). Moving the tax system from equal dirty and clean consumption taxing to heavier tax on dirty consumption would therefore move it closer to its optimum, and increase labour supply.
The environment as a substitute for leisure	If enjoyment of the environment is a close substitute for leisure, then higher environmental quality (achieved by environmental tax reform) may boost labour supply.
Environmental taxes as rent taxes	Environmental taxes may be used to tax rents associated with natural resources. Since taxing rents has no efficiency costs, the revenue raised could be used to secure a second dividend. Pure rent taxation does not affect consumer prices in the short term, so the environmental benefits from reduced demand will not be realised if an environmental tax is a pure rent tax. There may also be a long run effect, as reduced profits deter future investment.
Inefficient factor taxation	If the initial tax system involves differences in the marginal excess burdens of various taxes, an environmental tax reform can boost private incomes by shifting the tax burden away from factors with high marginal excess burdens to factors with low marginal excess burdens. However, the burden of the environmental tax could also fall on the overtaxed factor, leading to higher rather than lower efficiency costs.
Environmental taxes as optimal tariffs	In an open economy, governments can employ pollution taxes to improve the terms of trade. For example, a large oil-importing country may improve its terms of trade if it reduces the demand for oil by raising the tax burden on fossil fuels. If the terms-of-trade gains are sufficiently large, domestic non-environmental welfare may rise.
Pre-existing subsidies on polluting activities	The overall burden on polluting activities may be too low where these activities are subsidised. The tax reform analysis in Bovenberg (1999) illustrates this: if the dirty consumption good is subsidised, employment expands when the subsidy is reduced.
The environment as a public input into production	If the environment enters production as a public good and an input of production, improved environmental quality increases aggregate output. This can lead to a strong double dividend.

Source: Bovenberg (1999) and Vivid Economics

Empirical and model analysis

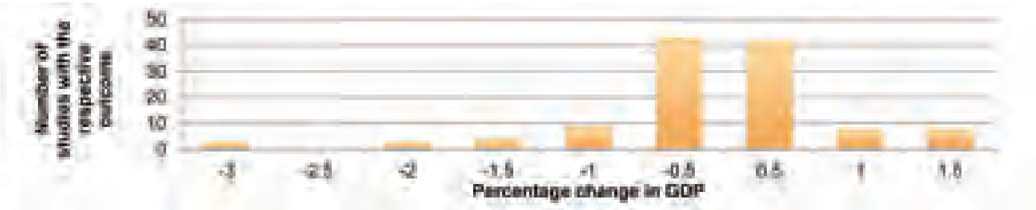
In support of the theory, economic models indicate that a double dividend is possible when the circumstances are favourable. Bosquet presents a systematic analysis of double dividend modelling evidence and shows mixed results (Bosquet 2000). The majority of studies have positive employment results. The impact on GDP is more ambiguous: most studies cluster around -0.5 per cent to +0.5 per cent change in GDP, though there is a slightly fatter tail on the negative side. Furthermore, investment falls as firms reduce investment in polluting activity, and prices rise. The findings for employment, GDP and prices are shown in figure 65, figure 66, and figure 67 below.

Figure 65. **The majority of studies covered by Bosquet show positive employment impacts from environmental taxes**



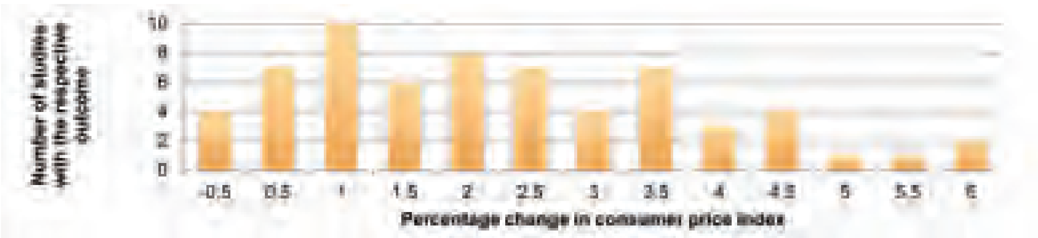
Source: Bosquet (2000) and Vivid Economics

Figure 66. **Studies are nearly evenly divided in their predictions of the GDP impact of environmental taxes**



Source: Bosquet (2000)

Figure 67. **Almost all studies predict an increase in consumer prices from an environmental tax**



Source: Bosquet (2000)

The Porter hypothesis

The Porter Hypothesis proposes that environmental taxes induce profitable innovations. The innovations thus triggered 'not only lower the net cost of meeting environmental regulations, but lead to absolute advantages' (Porter and van der Linde 1995). The implication is that firms need a regulatory stimulus before they innovate, even though the resulting innovations turn out to be profitable. The advocates of the hypothesis explain that there are market failures which discourage innovation in the absence of the stimulus (Mohr and Saha 2008; Lanoie et al. 2007). Although the Porter hypothesis might apply to any forms of regulation, taxation and market-based instruments might be particularly effective at generating such innovation, in contrast to command and control regulation, which may encourage firms to merely comply with a standard. That is because pricing instruments create a continuous incentive to improve (Stavins 2003).

The hypothesis has been criticised as it assumes that firms will pass-up on profitable opportunities until they are forced into making them as a result of the regulation. In other words, that 'there are lots of $10 bills lying around waiting to be picked up' Palmer, Oates, & Portney (1995). Critics accept that there are market failures, but disagree that regulation or environmental taxes address them.

Light is shed on this discussion by empirical investigations. They yield a more unified message: typically environmental regulation sparks some cost-reducing innovation, but not enough to fully offset the costs imposed by regulation. Palmer et al. (1995) find that innovation-led savings are in the region of 1 to 2 per cent of the costs of regulation. Lanoie, Laurent-Lucchetti, Johnstone, & Ambec (2007) survey several studies, and find that 'while some of these costs [of regulatory compliance] may be offset by the efficiency gains identified through investment in R&D, the net effect remains negative.' A further study in Quebec finds some evidence supporting the Porter Hypothesis for low polluting industries, but none for high polluting ones (Lanoie, Patry, and Lajeunesse 2008). In summary, the evidence that is available either refutes or does not strongly support the Porter Hypothesis.

The Green Paradox

The Green Paradox is a claim. It states that policies which aim to reduce demand for fossil fuels in the future induce fossil fuel producers to extract their resources faster, driving up emissions in the short term and accelerating climate change (Sinclair 1992). Under certain conditions this claim could be true, but these conditions are not met in reality.

The premise is as follows. Upon policy-makers introducing a carbon or energy tax, producers of fossil fuels anticipate that its rate will increase in the future. As a consequence, they believe that their total discounted cashflow is maximised by frontloading extraction over time. They 'act like a farmer who harvests in a drizzle because he expects a downpour' (Sinn 2008). The outcome is an increase in fossil fuel production, at least in the short term.

The Green Paradox comes in two forms: the weak Green Paradox states that a carbon tax accelerates emissions today; the strong Green Paradox states that a carbon tax increases the aggregate damages from climate change. There are reasons to doubt the assumptions underlying both statements. No empirical evidence has been offered to support either of them: Werf and Maria (2011) describe this as a 'most striking void in this literature'.

A number of the assumptions that result in either the strong or weak form of the Green Paradox are questionable. These include: the absence of extraction costs; rationality and long time-horizons; and the absence of strategic interactions among suppliers, among customers, or between suppliers and customers.

First, in the simplest model of the Green Paradox,[53] resource owners are assumed to face no extraction costs; all of the resource is ultimately extracted, all that changes is the time profile of this extraction. When extraction costs are taken into account and especially if, as seems consistent with reality, extraction costs grow with accumulated extraction then carbon taxes can reduce the amount of resource that is extracted. In these cases both a weak and strong Green Paradox are less likely to occur (Werf and Maria 2011).

Second, the assumptions of complete rationality, awareness of the finiteness of resource stocks and long time-horizons. If any one of these fails to hold, a profit maximising resource owner may decide that it is not in its interest to increase production now. Instead it might react like a regular producer by cutting production in response to lower demand. There is some evidence to suggest that oil producing countries do not behave like inter-temporally optimising resource owners, but rather like market makers (Werf and Maria 2011), or like regular producers (Hamilton 2011).

Third, the assumption that there is no strategic interaction between extraction companies and buyers; this assumption is highly unlikely to hold true. Energy is one of the most consciously strategized areas both in companies and in government, on both the supply and on the demand side (Paulus, Trüby, & Growitsch 2011, van Veldhuizen & Sonnemans 2011, and Haurie & Vielle 2010).

53 Hotelling models.

Appendix A

Description and details of the E3ME model

This appendix seeks to provide a brief overview of the E3ME model.[54] In doing so, it highlights some of the key interactions and assumptions underpinning the model. For a more technical description, as well as further detail on the model, the reader is advised to visit the E3ME website: www.e3me.com.

Overview

E3ME is a computer-based model of Europe's economic system, energy system, and the environment (hence three Es). It was originally developed through the European Commission's research framework programmes and is now widely used in Europe for policy assessment, for forecasting and for research purposes.

The structure of E3ME is based on the system of national accounts, as defined by ESA95 (European Commission 1996), with further linkages to energy demand and environmental emissions. The economic model runs on three 'loops', the export loop, the output-investment loop, and the income loop. These, as well as the energy and the environment sub-models, are described in more detail on the E3ME website. Last, the labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours.

In total the model comprises 33 sets of econometrically estimated equations, covering the individual components of GDP (consumption, investment, and international trade), prices, energy demand, and materials demand. Each equation set is disaggregated by country and by sector.

E3ME's historical database, which is used for the estimation of econometric relationships, covers the period 1970-2008. The model projects forward annually to 2050. The main sources of data are Eurostat, DG ECFIN's AMECO database and the IEA. This is supplemented by the OECD's STAN database and other sources where appropriate. Gaps in the data are estimated using customised software algorithms.

The main dimensions of the model are:

- 33 countries (EU27 member states, Norway, Switzerland and four candidate countries)
- 42 economic sectors, including a disaggregation of the energy sectors and 16 service sectors
- 43 categories of household expenditure
- 19 different users of 12 different fuel types
- 14 types of air-borne emissions (where data are available) including the six greenhouse gases monitored under the Kyoto protocol.
- 13 types of household, including income quintiles and socio-economic groups such as the unemployed, inactive and retired, plus an urban/rural split

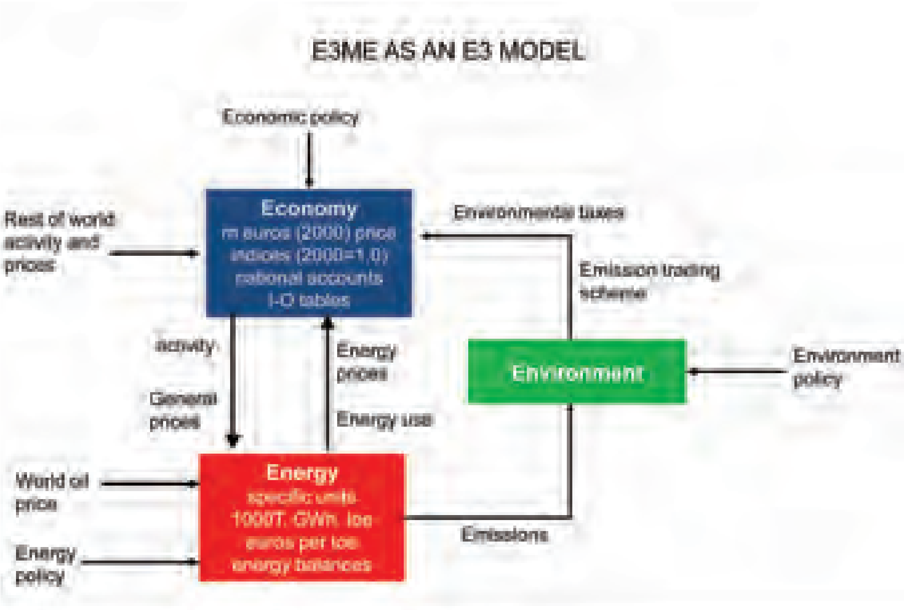
Typical outputs from the model include GDP and sectoral output, household expenditure, investment, international trade, inflation, employment and unemployment, energy demand and CO_2 emissions. Each of these is available at national and EU level, and most are also defined by economic sector.

The econometric specification of E3ME gives the model empirical grounding. This allows it to do without some of the assumptions common to Computable General Equilibrium (CGE) models, such as perfect competition or rational expectations. Instead E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2020) and rebound effects, which are included as standard in the model's results.

54 This description is in large parts based on material provided by Cambridge Econometrics, who own and operate the model.

The overall structure of E3ME is shown in figure 68 below.

Figure 68. **The E3ME model consists of three main modules, and their various interactions**



Source: *Cambridge Econometrics*

Difference between E3ME and CGE models

E3ME is an econometric rather than a computable general equilibrium (CGE)-type model. This means that it is driven by empirically observed relationships rather than by theoretical assumptions. For example, while most CGE-type models assume a flexible set of prices that instantly adjust to clear all markets, prices in E3ME are determined by how they have reacted to shocks in the past. Assumptions common to most macroeconomic modelling approaches that are not used in the E3ME model include perfect rationality/optimisation and perfect foresight (more below). E3ME also does not assume perfect competition as the universal structure of industry. Instead cost-pass-through rates and rates of profit are estimated based on historical data.

This difference is particularly relevant in the labour market, where numerous studies have shown that wages do not quickly adjust (especially downwards) to ensure that supply equals demand, i.e. that full employment is achieved. Wages in E3ME are instead determined by estimated relationships, based on bargaining power between employer and employee in each economic sector. The outcome of this can be an adjustment to obtain full employment, but is more likely to fall short in employment, leading to involuntary unemployment. E3ME also models the dynamic multiplier effects of changes in wage incomes on household spending and hence overall economic activity.

However, there are some drawbacks compared to CGE-type models: the econometric approach relies on good-quality data. This is more problematic outside Europe than within, but nevertheless may affect the results for certain countries. There are also problems in dealing with structural change, for example if behavioural relationships change over time or in response to policy changes.

Treatment of international trade

The E3ME model does not have explicit bilateral trade relationships, mainly because time-series data for this is not available, and because bilateral trade relationships do not have their traditional interpretation in an integrated trading bloc like western Europe. The model therefore works with total exports for each sector in each country, with only two destinations: EU and non-EU. Similarly every country imports goods from only two destinations, EU and non-EU.

Appendix B

Methodology and caveats of energy tax curves

Methodology

Energy Tax curves reveal how a country taxes the CO_2 emissions from its energy use. They show the total excise tax rate on each greenhouse gas emitting energy usage in the economy, displayed as euro per tonne of CO_2.

To do this, we have mapped emissions/energy and taxation onto each other i.e. we have attempted to calculate the total tax burden for each economic activity for which energy use and emission data were available.

Data for energy use and emissions were gathered from the IEA's Extended World Energy Balances (IEA 2011b) and the IEA's CO_2 Emission from Fuel Combustion (IEA 2011a). Data for energy taxes were compiled from the European Commission's Excise Duty Tables, Part II Energy Products and Electricity (European Commission 2011c), while data for tax expenditures were gathered from the OECD's Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels (OECD 2011a). We have supplemented this with further information from national tax sources. Furthermore we have treated the EU ETS as equivalent in its incentive effects to a marginal tax on emissions and therefore included it in the modelling. We have assumed the EU ETS tax rate is equivalent to the spot EUA prices, which we have taken from Bluenext.eu.

For both emissions and energy use and for tax rates we have used the most up to date data available. For taxes, this should closely resemble the status quo, though there may have been changes in tax rates between July 2011 and the publication of this report that have gone unnoticed. For EUA prices we have taken a simple average of daily prices between the 24th of January 2011 (when calculations for energy tax curves were performed) and the 25th of January 2011. For emissions and energy use, the latest year available at the time of writing was 2008.

In order to combine tax rates and emissions from energy use, we converted tax rates and tax expenditures from their original units (per weight, or per volume, or percentage of price) into a common unit (euro per tonne of CO_2). Taxes on volume or weight (excise taxes) and tax expenditures based on product price (reduced VAT rates) were first converted into taxes/tax expenditures per unit of energy (using standard conversion factors and prices from various sources). In a second step, these were converted into taxes per unit of emission, using emission factors calculated by comparing IEA energy use and IEA emission data.

Taxes on electricity and heat were converted into taxes per unit of emission by using country-specific grid emission factors. These were sourced from the CAIT database, maintained by the World Resources Institute. Once taxes are expressed in euros per tonne of CO_2, they can be matched to IEA emission data (which gives emission throughout the economy, split into more than 20 sectors and accounting for more than 40 fuels). For each combination of fuel and sector (representing the use of a particular fuel in a particular sector, e.g. natural gas used in households, or electricity used in iron & steel, or diesel used in road transport) we have determined the taxes that apply to it. The total tax burden on any fuel/sector is then given by the sum of the tax rates of all the taxes that apply to the particular fuel/sector combination.

In a final step, this information was plotted. On the Y-axis, total tax burden is shown in €/tCO_2. On the X-axis, emissions are shown. Each fuel/sector combination is represented as a rectangle on these axes, with the total tax burden shown as its height, and the associated emissions shown as its width. Emissions from electricity and heat are calculated by multiplying the amount of energy used (shown in the IEA's Extended Energy Balances) with country-specific grid emission factors (sourced from CAIT). These are displayed on the curve in ascending order of total tax burdens.

Caveats and assumptions

In applying the methodology outlined above, we have had to make a significant number of assumptions. These, together with a number of caveats, are shown below.

With regards to interpreting the European Commission's Excise Duty Tables, the following assumptions were made:

– 'Business use' in all countries except Germany corresponds to the following IEA sectors: Iron and Steel; Chemical and Petrochemical; Non-Ferrous Metals; Non-Metallic Minerals; Transport Equipment; Machinery; Food and Tobacco; Paper, Pulp and Print; Wood and Wood Products; Textile and Leather; Non-Specified (Industry); Commercial and Public Services (partly, see next caveat).
– 'Business use' category in Germany interpreted according to details given in Energiesteuergesetz (in particular §2, §51, §54 and §56) and Stromsteuergesetz (in particular §9).
– Energy used in the Commercial and Public Services category was allocated to business use and non-business use based on Eurostat input-output tables. The allocations are given in table 18 below.
– The Excise Duty Table category of 'Industrial and Commercial Usage' is assumed to correspond to the IEA's categories of Construction, and Mining and Quarrying.

Table 18. **Split between commercial and public use of energy in the IEA category 'Commercial and Public Services'**

Country	Fuel	Public use	Commercial use
France	Coal	71%	29%
	Refined products	11%	89%
	Electricity, Natural Gas	36%	64%
Greece	Coal	0%	100%
	Refined products	5%	95%
	Electricity, Natural Gas	13%	87%
Hungary	Coal	63%	37%
	Refined products	19%	81%
	Electricity, Natural Gas	34%	66%
Italy	Coal	90%	10%
	Refined products	2%	98%
	Electricity, Natural Gas	23%	73%
Poland	Coal	11%	89%
	Refined products	11%	89%
	Electricity, Natural Gas	15%	85%
Portugal	Coal	100%	0%
	Refined products	1%	99%
	Electricity, Natural Gas	27%	73%
Spain	Coal	62%	38%
	Refined products	34%	66%
	Electricity, Natural Gas	26%	74%
UK	Coal	100%	0%
	Refined products	21%	79%
	Electricity, Natural Gas	38%	62%

Source: Vivid Economics and Eurostat ESA 95 Supply Use and Input-Output tables

Appendix B - Methodology and caveats of energy tax curves continued

The European Union Emission Trading Scheme (EU ETS) has been treated as follows:

- All emissions from the following four IEA sectors are assumed to be covered by the EU ETS: Iron & Steel; Chemical and Petrochemical; Non-Metallic Minerals; Paper, Pulp and Print.
- 70 per cent of all emissions in the IEA sector Food and Drink are assumed to be covered by the EU ETS. This is based on a comparison of IEA emission data for the entire sector, and data from the UK's National Allocation Plan, giving EU ETS-covered emissions.
- 12 per cent of all emissions in the IEA sector Commercial and Public Services are assumed to be covered by the EU ETS. This number was calculated with the same methodology as the EU ETS share for the Food and Drink sector.
- The EU ETS allowance price is taken as the average spot price between 25.01.2011 and 24.01.2012, amounting to €11.74/tCO_2.
- We have assumed that electricity producers pass on 100 per cent of EU ETS costs, hence that all usages of electricity are assumed to be subject to an implicit carbon tax equivalent to the EU ETS rate.
- We have also assumed that refinery operators pass on 100 per cent of EU ETS costs.

Fuels used in agriculture, unless they are subject to special rates, are assumed to be used and taxed as follows: diesel, LPG, and motor gasoline as propellants; all other fuels as business heating use.

All fuels used in the IEA's category of Commercial and Public services are assumed to be used for heating, and not transport.

Assumed for all countries that Kerosene-type jet fuel is only used in commercial aviation

Assumed for all countries that Aviation gasoline is only used in private aviation

For Hungary, the following assumptions and caveats apply:

- EU ETS-covered industries are exempt from electricity, gas and coal/coke excise taxes;
- all heavy fuel oil is <1% in sulfur content, thus eligible for the lowest tax rate;
- approximately 14 per cent of all diesel consumed is commercial diesel which, absent any Hungarian specific data at the time of calculations (as the reduced rate has only been recently introduced) was based on the proportion from Spain;
- approximately 86 per cent of all diesel consumed is private diesel.

For Spain, the following assumptions and caveats apply:

- the breakdown between commercial and non-commercial transport diesel is 13.7% commercial, 86.3% non-commercial; this is based on 3.13 billion litres of commercial diesel out of a total of 22.87 billion litres in 2008, according to (Departamento Aduanas, 2010);
- the use of coal in residential use, metallurgical, electrolytic, and mineralogical processes (defined as the "manufacture of other non-metallic mineral products") is tax exempt.

For France, the following assumptions and caveats apply:

- where there are regional tax ranges, the top of the range is being charged;
- assumed that 5 per cent of transport diesel is used in buses, 13.7 per cent in commercial lorries (>7.5t), the remaining 81.3 per cent in other, fully-taxed, usages;
- diesel and petrol have the required 7% biofuels to avoid the extra-tax levied on diesel/petrol with less biofuel content;
- lower VAT rates on petroleum products used in Corsica have been ignored, as have VAT exemptions for petroleum products used in *départements d'outre-mer* (overseas) departments, Guadeloupe, Martinique, Reunion and French Guiana;
- excise duty refunds for taxi drivers have been ignored.

For the UK, the following assumptions and caveats apply:

- With regards to the Climate Change Levy, the following IEA categories are assumed to benefit from reduced rates (65 per cent rebate) due to sector umbrella agreements: Iron & Steel; Chemical and Petrochemicals; Non-ferrous metals; Non-metallic minerals; Machinery; Food and Tobacco; Paper, Pulp and Print; Textile and Leather.

For Germany, the following assumptions and caveats apply:

- all diesel and fuel oil consumed is assumed to have the relevantly low sulphur rate to fall into the low-sulphur tax brackets;
- 90% of domestic navigation diesel is assumed to be used for commercial navigation;
- natural gas used in transport is assumed to have the same emission intensity as natural gas used in 'Industry and Commerce' and agriculture;
- all CHP plants are assumed to be efficient enough (>70%) to be tax exempt on their inputs;
- assumed that all industrial companies receive the 'Spitzensteuerausgleich'
- 'Sockelbetrag' has been ignored.

For Poland, the following assumptions and caveats apply:

– all petrol used in Poland is 95 octane or above.

For Italy, the following assumptions and caveats apply:

– all heavy fuel oil is <1% in sulphur content, thus eligible for lowest tax rate;
– heavy fuel oil used in domestic navigation is taxed according to business heating rate;
– the IEA fuel category 'refinery gas' is taxed like natural gas.

For Greece, the following assumptions and caveats apply:

– all gasoil/diesel used in heating is bought during the so-called winter period when tax is lower (15 Oct through 30 April, tax 60 EUR);
– all IEA industry categories except Construction and 'Non-Specific (Industry)' as well as Railways, are assumed to be high voltage business customers, eligible for the high voltage electricity tax rate;
– the IEA categories Commercial and Public Services, Construction, 'Non-Specific (Industry)', non-rail transport, and Agriculture are assumed to be low voltage electricity business customers;
– the IEA categories Residential and 'Non-Specific (Other)' are assumed to be low voltage non business electricity customers;
– for the purpose of calculating reduced-VAT-rates implicit subsidies, it has been assumed that low-voltage electricity customers consume less than 20 MWh per year, while high voltage customers consume between 500 and 2000 MWh per year;
– residential use of charcoal is assumed to have the same emission intensity as the average of all types of coals used across the economy.

Appendix C

Full details of reform packages in Spain, Poland and Hungary

Spain

Based on conversations with country experts as well as on an analysis of Spain's energy tax curve, we developed the following possible package of national energy tax reforms for Spain. This package, outlined below, underlies the macro-economic modelling undertaken in section 4 and 5.

- An immediate increase in 2013 of the transport diesel rate for non-commercial use to bring the excise duty rate into line with the current petrol rate.
- A more gradual increase in the excise duty rate for non-commercial diesel use between 2013 and 2018 such that, by 2018, the relationship between the diesel and petrol rate reflects the minima in the Energy Tax Directive (as required under the ETD, although the ETD only requires this by 2023).
- A phased increase in the transport diesel rate for commercial purposes such that by 2018 there is no discount for commercial diesel use, as proposed in the ETD.
- Ending of tax exemption for railway diesel and a phased increase in the rate such that by 2020 it is brought into line with prevailing transport diesel rates.
- Phasing out of the reimbursement of diesel excise tax in agriculture by 2020.
- A phased introduction of a tax on domestic consumption of gas starting at €0.15/GJ in 2013 - the minima in the existing Energy Tax Directive - and increasing to €1.27 - the rate proposed for commercial use for installations outside of the EU ETS. 2020 is the year that many other allowances and exemptions identified in the proposed revisions to the Energy Tax Directive are anticipated to expire.
- A phased introduction of a tax on domestic consumption of coal starting at €0.15/GJ in 2013 and increasing to €2.04/GJ (the rate for commercial use) by 2018.
- Compliance with all other minima in the EU Energy Tax Directive. For transport fuel use this is phased gradually over the period to 2018, for non-transport commercial fuel use, there is an immediate adjustment in 2013.
- Automatic indexation on all energy taxes.

This would result in the following profile of energy taxes for Spain, in 2011 prices.

Table 19. **A possible profile of revised energy taxes in Spain**

Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1,000l)	425	425	425	425	425	425	425	425	425
Transport diesel (€/1,000l)	331	425	432	440	447	451	462	462	462
Transport diesel for commercial purposes (€/1,000l)	330	352	374	396	418	440	462	462	462
Transport diesel used in railways (€/1000l)	0	58	115	173	231	289	346	404	462
Agricultural diesel net of reimbursement (€/1000l)	0	9.84	19.7	29.5	39.4	49.2	59.0	68.9	78.7
Kerosene (€/1,000l)	316	329	341	354	367	379	392	392	392
LPG (€/1,000l)	57.5	131	205	279	353	426	500	500	500
Natural gas (€/GJ)	1.15	2.74	4.33	5.93	7.52	9.11	10.7	10.7	10.7
OTHER FUEL USE									
Gas oil, all uses, €/1,000l	84.7	84.7	84.7	84.7	84.7	84.7	84.7	84.7	84.7
Heavy fuel oil, installations outside the EU ETS, €/1,000l	15.0	67.8	67.8	67.8	67.8	67.8	67.8	67.8	67.8
Heavy fuel oil, installations inside the EU ETS,€/1,000l	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Kerosene, all uses €/1,000l*	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7	78.7
LPG, installations outside the EU ETS, €/100kg	0	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
LPG, installations inside the EU ETS, €/1,000kg**	0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Gas, domestic heating,€/GJ	0	0.16	0.32	0.48	0.64	0.79	0.95	1.11	1.27
Gas, installations outside the EU ETS, €/GJ	0	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Gas installations inside the EU ETS, €/GJ***	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Coal, domestic, €/GJ	0	0.26	0.51	0.77	1.02	1.28	1.53	1.79	2.04
Coal, installations outside the EU ETS, €/GJ	0.15	1.89	1.89	1.89	1.89	1.89	1.89	1.89	2.04
Coal, installations inside the EU ETS, €/GJ	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Electricity, domestic, €/MWh****	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Electricity, business use, €/MWh****	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8

Note: *2011 prices. Proposal also includes indexing to account for inflation in each year.*

* *Kerosene for industrial/commercial use as defined under Article 8 of the Energy Tax Directive would continue to be taxed at €315.8/1000l, subject to annual indexation.*

** *LPG used within installation inside the EU ETS for industrial/commercial use as defined under Article 8 of the Energy Tax Directive would continue to be taxed at €57.5/1000kg, subject to annual indexation.*

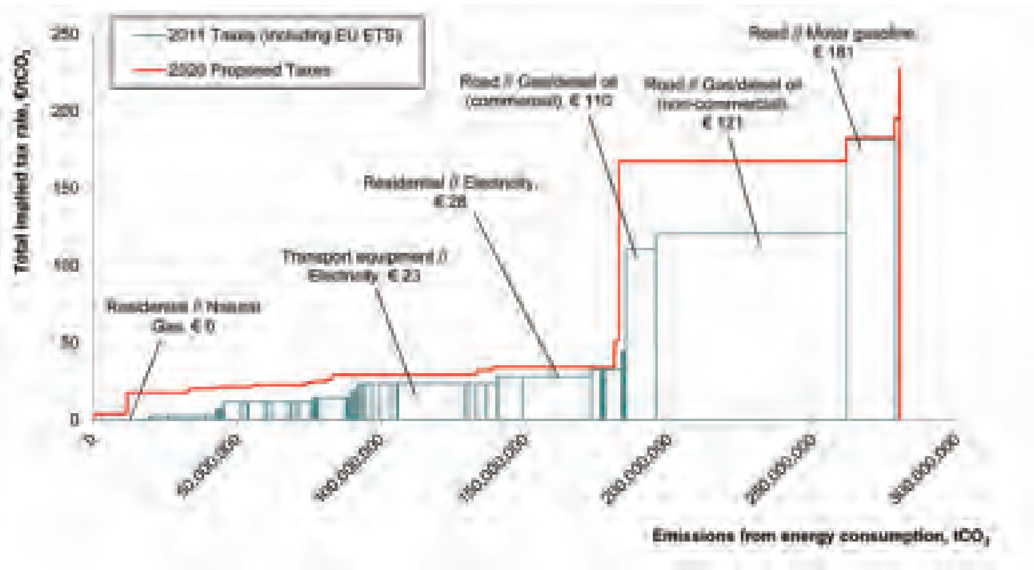
*** *Gas used within installation inside the EU ETS for industrial/commercial use as defined under Article 8 of the Energy Tax Directive would continue to be taxed at €1.15/GJ, subject to annual indexation.*

**** *Tax is levied at 5.113% of electricity price before VAT, which in 2008 came on average to 5.3 €/MWh for domestic electricity use, and 3.8 €/MWh for business electricity use.*

Source: *Vivid Economics*

Figure 69 illustrates how the indicative package of energy tax reforms would alter the energy tax curve for Spain by 2020 (in 2011 prices). It raises the implied CO_2 tax rate on energy[55] by just over 35 per cent. Implied carbon tax rates on non-transport and transport energy use each become more uniform, and the difference between the tax rates applied to transport and non-transport energy uses increases to bring the diesel rate into line with the gasoline rate.

Figure 69. **The proposed package of reforms increases the average implied carbon tax on energy consumption in Spain from €56/t/CO_2 to €76/tCO_2**



Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6/tCO_2 (2011 prices) by 2020, in line with European Commission assumptions. Labelled tax rates refer to existing implied CO_2 rates.*

Source: *Vivid Economics based on IEA (2011) and European Commission (2011e)*

Poland

Based on conversations with country experts as well as on an analysis of Poland's energy tax curve, we developed the following package of national energy tax reforms. This package, outlined below, underlies the macro-economic modelling undertaken in section 4 and 5.

- Steady increases in the excise duty rate on diesel so that Poland is on track to meet the required relationship between the minima rates in the Energy Tax Directive by 2023. This would require increases in transport diesel rates at a faster rate than needed for compliance with the minima in the Directive in 2018. Rebates not linked to energy consumption would be provided for diesel for agricultural use for distributional reasons while preserving the marginal incentive to reduce energy consumption/emissions.
- Introduction of taxes on domestic gas and coal consumption with the rates moving towards the level required by the EU Energy Tax Directive for installations outside the EU ETS.
- Compliance with all other minima rates in the EU Energy Tax Directive proposals, with steady increases between current levels and future minima where this is allowed.
- Automatic indexation on all energy taxes.

This would lead to the following profile of taxes, shown in table 20.

55 Using existing energy consumption as weights.

Table 20. **A possible profile of revised energy taxes in Poland, euros, 2011 prices**

Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1000l)	422	422	422	422	422	422	422	422	422
Transport diesel (€/1000l)	327	339	351	363	375	387	399	411	423
Kerosene (€/1,000l)	462	462	462	462	462	462	462	462	462
LPG (€/1,000l)	208	257	305	354	403	451	500	500	500
Natural gas (€/GJ)	0	1.8	3.6	5.4	7.2	8.9	10.7	10.7	10.7
OTHER FUEL USE									
Gas oil, all uses*, €/1,000l	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9
Heavy fuel oil, installations outside the EU ETS, €/1,000l	16.3	22.0	27.7	33.5	39.2	44.9	50.6	56.4	62.1
Heavy fuel oil, installations inside the EU ETS,€/1,000l	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Kerosene, all uses €/1,000l**	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9
LPG, installations outside the EU ETS, €/1,000kg***	0	7.2	14.4	21.6	28.8	36.1	43.3	50.5	57.7
LPG, installations insi,de the EU ETS, €/1000kg***	0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Gas, domestic heating,€/GJ	0	0.14	0.28	0.43	0.56	0.71	0.85	0.99	1.13
Gas, installations outside the EU ETS, €/GJ	0	0.14	0.28	0.43	0.56	0.71	0.85	0.99	1.13
Gas installations inside the EU ETS, €/GJ	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Coal, domestic, €/GJ****	0	0.23	0.45	0.68	0.91	1.13	1.36	1.59	1.81
Coal, installations outside the EU ETS, €/GJ****	0	0.23	0.45	0.68	0.91	1.13	1.36	1.59	1.81
Coal, installations inside the EU ETS, €/GJ****	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Electricity, domestic, €/MWh	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Electricity, business use, €/MWh	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1

Note: 2011 prices. Proposal also includes indexing to account for inflation in each year.

* *Gas oil used for industrial/commercial use as defined under Article 8 of the current Energy Tax Directive would continue to be taxed at €327.1/1000l subject to annual indexation.*

** *Kerosene used for industrial/commercial use as defined under Article 8 of the current Energy Tax Directive, as well as kerosene as defined as CN2710 1925 would continue to be taxed at €462.8/1000l subject to annual indexation.*

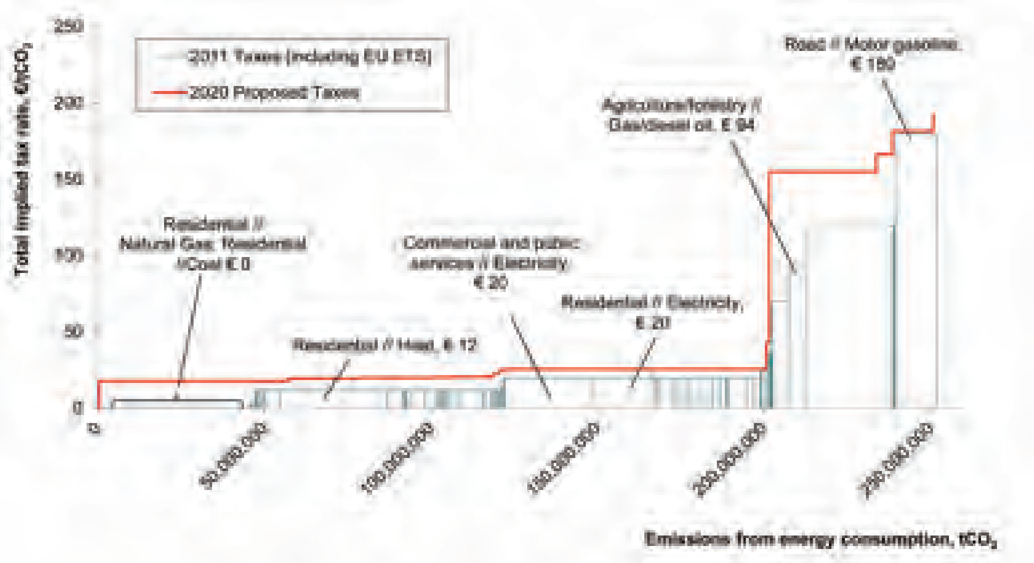
*** *LPG used for industrial/commercial use as defined under Article 8 of the current Energy Tax Directive would continue to be taxed at €207.7/1000kg subject to annual indexation.*

**** *This modelling was undertaken before the recent introduction of a coal tax in Poland was introduced. The 'current' coal tax rate is therefore given as 0 (as was used in the model), even though Poland is now levying a tax of €0.29/GJ on coal.*

Source: Vivid Economics

Figure 70 illustrates how the illustrative package of reforms alters the profile of energy taxes in Poland by 2020. It increases the real implied carbon tax rate on energy consumption, using current consumption weights, by around 36 per cent. There would be a more uniform implied carbon tax rate on all non-transport energy uses, and less variation in the implied carbon tax rates on transport fuels. The difference in implied tax rates on transport and non-transport energy uses would grow.

Figure 70. **The proposed package of reforms might increase the average implied carbon tax on energy consumption in Poland from €35/tCO_2 to €50/tCO_2**



Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6/tCO_2 (2011 prices) by 2020, in line with European Commission assumptions.*

Source: *Vivid Economics based on IEA (2011) and European Commission (2011e)*

Hungary

Based on conversations with country experts as well as on an analysis of Hungary's energy tax curve, we identified the following package of national energy tax reforms. This package underlies the macro-economic modelling undertaken in section 4 and 5.

- Removal of the reduced rate for commercial diesel use in 2013.
- Removal of tax exemption for railway diesel, and a phased increase in the rate such that by 2020 it is brought into line with prevailing transport diesel rates.
- A steady increase in the tax rate on transport diesel so that Hungary is on track to comply with the requirement of the EU Energy Tax Directive that the relationship between the different minima rate for petrol and diesel will be reflected in national tax rates by 2023.
- Removal of subsidies for domestic gas consumption in 2012.
- Introduction of taxes on the domestic consumption of coal and gas, steadily increasing at the same rate as taxes on the use of these fuels by installations outside the EU ETS will be required to increase in order to comply with the Energy Tax Directive.
- Removal of the lower rate for VAT for district heating in 2017 (halfway through the period during which increases in the real rates of tax on domestic coal and gas would be phased in).
- Compliance with all other minima rate set out in the EU Energy Tax Directive proposals, with steady increases between current levels and future minima where this is allowed.
- Automatic indexation on all energy taxes.

Table 21 outlines the impact of this proposal on the energy tax rates in Hungary, with tax rates given in euros.

Table 21. **A possible profile of revised energy taxes in Hungary, euros, 2011 prices**

Variable	2012	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORT FUELS									
Unleaded petrol (€/1,000l)	438	438	438	438	438	438	438	438	438
Transport diesel (€/1,000l)	362	372	383	393	403	414	424	434	445
Transport diesel for commercial purposes (€/1,000l)	362	372	383	393	403	414	424	434	445
Transport diesel used in railways (€/1,000l)	0	56	111	167	222	278	334	389	445
Kerosene (€/1,000l)	453	453	453	453	453	453	453	453	453
LPG (€/1,000l)	175	229	283	338	392	446	500	500	500
Natural gas (€/GJ)	0	1.79	3.57	5.36	7.15	8.93	10.7	10.7	10.7
OTHER FUEL USE									
Gas oil, all uses, €/1,000l	362	362	362	362	362	362	362	362	362
Heavy fuel oil, installations outside the EU ETS, €/1,000l	16.2	21.9	27.7	33.4	39.1	44.9	50.7	56.3	62.1
Heavy fuel oil, installations inside the EU ETS,€/1,000l	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
Kerosene, all uses €/1,000l	453	453	453	453	453	453	453	453	453
LPG, installations outside the EU ETS, €/1,000kg*	0	6.9	14.2	21.4	28.7	35.9	43.2	50.4	57.7
LPG, installations inside the EU ETS, €/1,000kg**	0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Gas, domestic heating,€/GJ	0 - subsidies removed	0.14	0.28	0.42	0.56	0.71	0.85	0.99	1.13
Gas, installations outside the EU ETS, €/GJ	0.32	0.43	0.53	0.64	0.74	0.85	0.95	1.06	1.16
Gas installations inside the EU ETS, €/GJ	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Coal, domestic, €/GJ	0	0.51	0.7	0.89	1.08	1.28	1.47	1.66	1.85
Coal, installations outside the EU ETS, €/GJ	0.32	0.51	0.7	0.89	1.08	1.28	1.47	1.66	1.85
Coal, installations inside the EU ETS, €/GJ	0.32	0.28	0.25	0.21	0.18	0.14	0.11	0.07	0.04
Electricity, domestic, €/MWh	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
Electricity, business use, €/MWh	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
District heating, VAT rate, %	5%	5%	5%	5%	5%	25%	25%	25%	25%

Note: *2011 prices. Proposal also includes indexing to account for inflation in each year.*

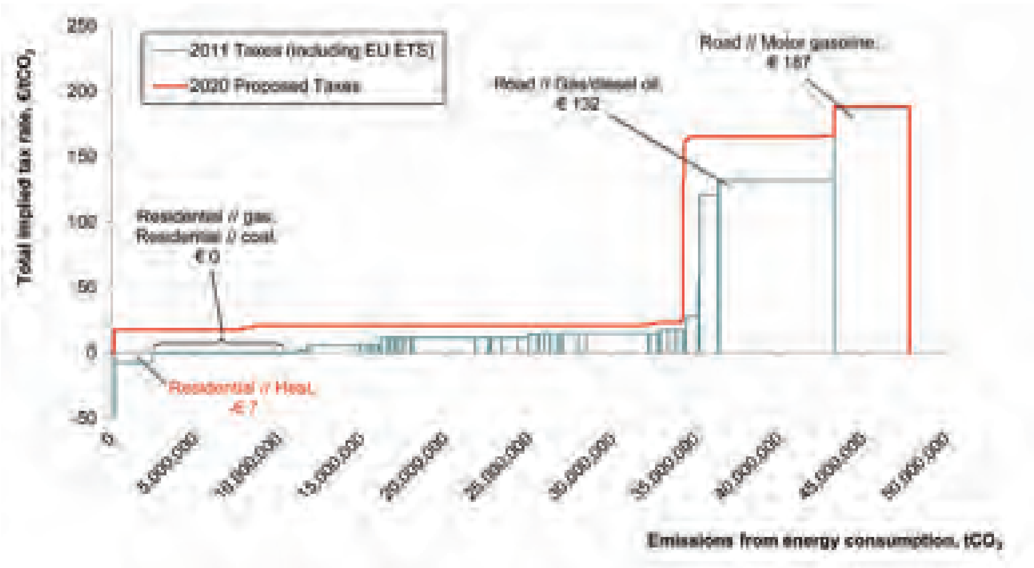
* *LPG used for commercial/industrial purposes as defined under Article 8 would continue to be taxed at €44.2/1000kg until 2019.*

** *LPG used for commercial/industrial purposes as defined under Article 8 would continue to be taxed at €44.2/1000kg.*

Source: *Vivid Economics*

Figure 71 illustrates how the illustrative package of reforms alters the profile of energy taxes in Hungary by 2020. By 2020, the implied carbon tax rate on energy consumption would increase by around 45 per cent (using latest available data on energy consumption as weights). There would be much less variation in the implied carbon tax rates within transport and non-transport energy use, although there would be a larger gap between the tax rates prevailing on these different energy uses.

Figure 71. **The proposed package of reforms would increase the average implied carbon tax on energy consumption in Hungary from €46/tCO_2 to €63/tCO_2**



Note: *Both curves use latest available data on final energy consumption. EU ETS allowance price assumed to rise to €17.6tCO_2 (2011 prices) by 2020, in line with European Commission assumptions.*

Source: *Vivid Economics*

Appendix D

Assumptions associated with tightening the EU ETS cap

In undertaking the modelling of the impact of tightening the EU ETS cap, we make a number of assumptions, which are typically drawn from European Commission documents. These are described below.

Baseline/reference scenario

In the EU ETS results, the impacts of the various policies modelled are assessed relative to the 'reference scenario'. This reflects full implementation of the Climate and Energy Package including the 20 per cent renewable energy target although not the proposed Energy Efficiency Directive. This reflects the European-wide commitment to meeting these policies as is consistent with the modelling approach adopted by the European Commission when considering possible reforms to the EU ETS and other European climate policies.

This is in contrast to the national tax results where the impact of the tax packages are reported relative to the impact of the existing mix of policies in each country.

Free allocation in the reference scenario

In the reference scenario, we make the following assumptions regarding the proportion of allowances that are allocated for free.

Table 22. **It is assumed that just over one third of allowances are allocated for free in the reference scenario**

Year	2013	2014	2015	2016	2017	2018	2019	2020
Percentage of freely allocated allowances	37%	37%	36%	35%	35%	35%	34%	34%

Source: *Vivid Economics based on sources below*

These estimates are based on 65 per cent of emissions being in the power sector, just under 27 per cent being in sectors at risk of carbon leakage and just over eight per cent being in other sectors not at risk of carbon leakages (European Commission DG Environment 2009). Aviation is treated separately (see below).

All allowances in the power sector are assumed to be auctioned. Although we note that up to eight member states may receive a temporary derogation from this requirement at the time of the modelling this had not been determined.

Sectors at risk of carbon leakage receive 100 per cent of benchmarked allowances for free. Sectors not at risk of carbon leakage receive 80 per cent of their benchmark emissions for free in 2013 declining in a linear fashion to 30 per cent by 2020. We assume that on average there is a 5 per cent difference between an installation/sector's actual emissions and the benchmark that has been set.

We assume just under 215 million allowances are included in the scheme in relation to the aviation sector (EEA Joint Committee 2011). We assume 85 per cent of these allowances are allocated for free.

Banked allowances from phase II

In all scenarios, we assume that there are 600 Mt of allowances banked from Phase II into Phase III of the EU ETS. This is based on visual inspection of the graphs (figures 5 and 7) as reported in (European Commission 2010b).

Impact of moving to a 30 per cent reduction target on the EU ETS cap

The impact of moving to a 30 per cent reduction target on 1990 levels is assumed to mean that the EU ETS cap tightens to be 34 per cent lower than 2005 emissions (excluding aviation). Following the European Commission (European Commission 2012), this is consistent with the 30 per cent reduction target being met through a 25 per cent reduction in domestic emissions and with the remaining 5 per cent achieved through the purchase of international offsets.

Redistribution of revenues

We assume that any revenues raised from the auctioning of allowances are re-distributed to member states using the proportions implied by table 7 in European Commission (2012). While Spain receives slightly more under a move to a 30 per cent target, it receives a smaller extra amount than the EU-27 as a whole (12 per cent extra as opposed to 35 per cent for the EU-27 as a whole). Hungary and Poland on the other hand receive more additional revenue than the EU-27 as a whole.

Table 23. **Redistribution of EU ETS revenues: new member states are net beneficiaries**

Member State	Revenue from EUA auctions in 2020 No redistributions, 20% target (€m in 2008 euros)	2020 revenue for EUA auctions Redistributions according to EC proposal, 30% target (% of No redistribution, 20% target amount)
EU-27	21,203	135%
Austria	328	99%
Belgium	545	109%
Bulgaria	381	274%
Cyprus	53	121%
Czech Republic	822	214%
Denmark	297	100%
Estonia	130	262%
Finland	392	99%
France	1,315	101%
Germany	4,706	99%
Greece	699	115%
Hungary	256	220%
Ireland	224	100%
Italy	2,222	101%
Latvia	28	361%
Lithuania	64	319%
Luxembourg	28	118%
Malta	20	195%
Netherlands	802	100%
Poland	2,012	233%
Portugal	359	186%
Romania	675	277%
Slovakia	245	235%
Slovenia	86	193%
Spain	1,815	112%
Sweden	194	110%
United Kingdom	2,504	101%

Source: European Commission (2012) and Vivid Economics

Appendix E

Further details on BCA literature

Table 24. **There is a relatively small literature assessing the economic and environmental impacts of BCAs using quantitative modelling**

Paper	Mitigation action scenario	Type of economic model; reference scenario/s	Details of BCA	Welfare measure and outcome	Emissions	Output	Other comments
Winchester et al 2010	Mitigation targets to 2030 in Annex I countries only	CGE (EPPA) Two manufacturing sectors (Emissions Intensive and Other); perfect competition; reference scenario is ETS with emissions targets outside Annex I before 2030	BCA is a tariff whose level is determined simultaneously with emissions price in the relevant ETS Four scenarios for import tariffs: US tariffs on all imports; Annex I tariffs on all imports; US tariffs on both manufacturing sectors; Annex I tariffs on all manufacturing sectors Adjustment base is direct and indirect emissions Carbon price applied to imports is equal to full carbon price in importing country	Equivalent variation; relative to ETS scenario, BCAs improve welfare within the coalition and reduce it outside for the Annex I scenarios but reduce both US and non-US welfare in US scenarios	Global emissions in 2025 lower than ETS without BCA in all BCA scenarios; adding non-manufactured sectors has small effects on leakage rate	Output of energy-intensive industries rises relative to ETS scenario except in US-all goods scenario where export falls offset higher domestic consumption	Also examines effects of a global oil tax; in contrast to Mc Kibbin and Wilcoxen (2009) finds that this is less effective at containing leakage and reduces welfare further
Fischer and Fox (2009)	$50 carbon price imposed unilaterally in the US	PE calibrated to CGE	BCAs are tariffs Four scenarios: import, export and import; export, 'home rebate' i.e. rebate of carbon costs on all domestic production Sectors are oil, electricity, non-metallic minerals, pulp and paper, iron and steel	Domestic output used as the competitiveness metric	Domestic production always higher in assisted industries with any form of assistance but no guarantee global emissions lower given tax- rather than allowance-based assistance		
Demailly and Quirion 2005	Mitigation in Annex I excluding US and Australia implemented through 15 euro carbon price	PE model of cement sector	BCA is tariff on both imports and exports Two different adjustment bases: tariffs and rebates based on full CO2 intensity and tariffs and rebates based on best technology available at large scale Adjustment base is direct and indirect emissions from cement production Carbon price applied to imports is equal to full carbon price in importing country	N/A, although price of cement in mitigating countries is calculated	World emissions from cement production slightly lower in both BCA scenarios compared to no BCA	Output relative to pricing and no BCA higher for producers in implementing region; output relative to BAU is lower with full BCA but slightly higher with BCA based on best available technology	

McKibbin and Wilcoxen 2009	No specific mitigation targets - carbon tax begins at $20 and rises by $0.50 per year to $40 Tax (or tax and BCA) implemented by EU or US	CGE (G-Cubed); implicit BAU of no carbon tax and no BCA; 12 industrial sectors	BCA is a tariff Import BCA only Four scenarios: tax in Europe but no BCA; tax in Europe but BCA in all sectors based on carbon content of US goods; tax in US but no BCA; tax in US with BCA all sectors based on carbon content of Chinese goods Carbon price applied to imports is equal to full carbon price in importing country	Change in real GDP (also reports effects on trade, real interest and exchange rates); changes in GDP from adding BCAs are negligible in implementing country; small reductions in other regions	Global emissions slightly lower with BCAs: emissions fall less in implementing region but fall more outside	Output in implementing region is not necessarily improved relative to the case of carbon tax and no BCA: in the EU, BCAs have a mild protective effect; in the US, the decline in world GDP and reduced demand for US exports more than offsets increased domestic sales	Note that EU BCA has negligible effect on Chinese GDP
Burniaux, et al 2010	EU or Annex I mitigation only; reference scenarios seem to assume no assistance (but not explicit)	CGE (ENV-Linkages); 25 perfectly competitive industrial sectors	BCA is a tariff Main scenarios are import tariffs only; sensitivity results include adding an export rebate Adjustment base is direct emissions or direct plus indirect emissions from electricity; sensitivity results include calculating tariff based on carbon content of product in importing country Coverage is all sectors Carbon price applied is equal to full carbon price in importing country	Equivalent variation; small welfare gains within the coalition offset by small welfare losses outside it	Global emissions in 2020 lower with BCAs either imports only or imports and exports	emissions-intensive output within coalition does not necessarily rise relative to scenario of carbon pricing and no BCA	
Monjon and Quirion (2011)	Overall EU ETS 2020 target of 20 per cent	PE (CASE II); models cement, aluminium, steel, electricity (about 75 per cent of emissions covered under EU ETS)	Scenarios with both tax- and allowance-based BCAs BCA on both imports and exports for the four sectors in the model; some scenarios with imports only Direct emissions Two scenarios for adjustment base: emissions of best 10 per cent of EU producers and average emissions in the rest of world	PE model, outputs include carbon prices, government revenue, domestic production	Global emissions are lower under any form of BCA than under free allocation or full auctioning	Cement output lower under BCAs than when no assistance provided; steel and aluminium have smaller reductions in output when BCA in place	Only model to explicitly compare BCAs, full auctioning and free allocations
Gros and Egenhofer (2011)	ETS in one of two countries	Simple single good, two-country model	BCA is a tariff Import tariff only on single imported good	Total global welfare, which is sum of welfare in two regions and is reduced by emissions and raised by consumption	Fall in global emissions and production		
Majocchi and Missaglia (2002)	EU-15 implements a 10 per cent increase in energy taxes	Simple static CGE model of EU-15 with three perfectly competitive sectors (energy, energy-intensive production; other production)	Examines an increase in energy taxes with and without compensation of various forms. Compares an equivalent reduction in labour taxes to a scenario including both a labour tax reduction and BCA applied at different rates to energy-intensive and non-energy intensive imports	Utility	BCA scenario achieves comparable emissions reductions to scenario with reduced labour taxes only, but better employment outcomes than reductions in labour taxes alone due to better targeting assistance with international competitiveness effects of the energy tax		

Source: Vivid Economics

Appendix F

WTO rules, international climate change treaties and BCAs

This Appendix provides further detail on the compatibility of BCAs with WTO rules and the United Nations Framework Convention on Climate Change.

World Trade Organisation rules

While some earlier literature considered BCAs to be incompatible with WTO rules (as discussed in Monjon & Quirion, 2011), more recent analyses tend to conclude that BCAs are at least potentially compatible, with compatibility dependent on the design and implementation of the BCA (World Trade Organisation and United Nations Environment Program 2009; Pauwelyn 2007; Eichenberg 2010).

There are two potential routes to WTO-compatibility: compatibility with the General Agreement on Tariffs and Trade (GATT) general regime, and compatibility with one of the general exceptions of Article XX of the GATT (Monjon and Quirion 2011). Different parts of international trade law are relevant when assessing the import and export components of BCAs (Monjon and Quirion 2011).

GATT general regime

The relevant parts of the general regime are Articles I-III (for imports) and Article XVI and the 1994 Agreement on Subsidies and Countervailing Measures (for exports) (Monjon and Quirion 2011:1214). Article I is the requirement for 'most favoured nation' treatment which requires signatories apply uniform treatment to goods from all members. Article III: requires that members treat foreign goods no less favourably than comparable domestic goods, and Article XVI contains requirements to avoid subsidies. The implications of these provisions are that import part of a BCA could be WTO-compliant if it did not treat imports less favourably than domestically produced goods (Monjon and Quirion 2011). Eichenberg (2010) finds that the export part of a BCA may be authorised by the Agreement on Subsidies and Countervailing Measures if it does not advantage domestic producers.

Article XX exceptions

Even if the general provisions of world trade law are judged to prohibit BCAs they may still be WTO-compatible if they are consistent with one of the exceptions in Article XX which allow trade restrictions under some circumstances. BCAs could fall under exceptions XX(b) which allow restrictions 'to protect human, animal or plant life or health', or XX(g) which permit restrictions to ensure 'the conservation of exhaustible natural resources' (Monjon and Quirion 2011). There are four points to note for assessing the compatibility of a CBA with Article XX (Monjon and Quirion 2011:1214-6):

- competitiveness is not one of the possible rationales for restricting trade;
- some authors have emphasised that the measure has to contribute directly to the environmental goal, implying that demonstrating a reduction in global emissions rather than the impacts on carbon leakage is important in justifying a BCA using Article XX;
- countries with mitigation policy or at a low level of development may have to be excluded;
- there are differences in opinion as to whether the export part of a BCA is compatible with Article XX or not; and
- the 'Chapeau' to the Article (its introductory text) is also important in assessing compatibility. It says that trade restrictions must not be 'applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade'.

Examining the legal literature summarised, Monjon and Quirion (2011) conclude that: demonstrating the environmental benefit of a BCA is very important for its legality; there is no clear conclusion on the legality of an the export component of a BCA; and that adjustment bases of either EU BAT or own-country emissions may be compatible. They also write (p.1216) that, among legal experts, there is a body of opinion that Article XX may be the more likely route to consistency, and describe the fact that this may require excluding some countries as a drawback due to the reduced coverage of the BCA. However, this is not necessarily a drawback: the rationale for the policy is the absence of effective carbon prices in competitor countries, so excluding those countries from the BCA does not diminish the environmental effectiveness of the measure.

United Nations Framework Convention on Climate Change

Article 3 of the United Nations Framework Convention on Climate Change (United Nations 1992) enshrines the obligations of all Parties to protect the climate and of developed country parties to 'take the lead':

> *'The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.'*

While the Agreements from recent Conferences of the Parties in Cancun and Durban have involved mitigation targets from both developed and developing countries, the Agreements continue to stress the different capabilities and capacities of developed and developing country Parties (UNFCCC 2011).

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