A Study in Personal Carbon Allocation: Cap and Share

December 2008

Comhar
Sustainable Development Council

Comhar
Sustainable Development Council

A Study in Personal Carbon Allocation: Cap and Share

A report to Comhar SDC Sustainable Development Council, Ireland

By AEA Energy & Environment and Cambridge Econometrics

AEA Energy & Environment Authors:

Mark Johnson

Michael Harfoot

Courtney Musser

Tricia Wiley

Cambridge Econometrics Authors:

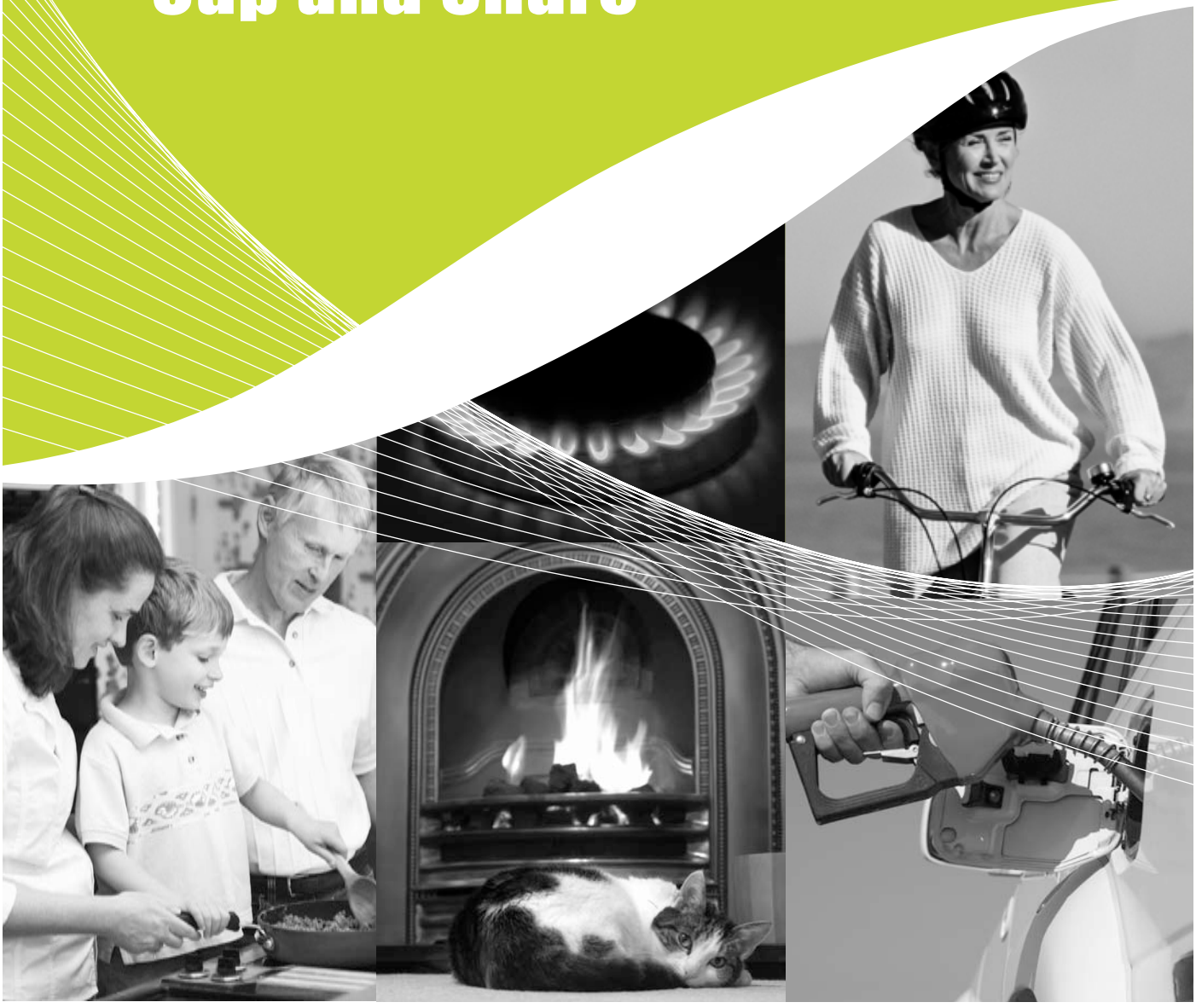
Hector Pollitt

Unnada Chewpreecha

Jamal Tarafdar

December 2008

A Study in Personal Carbon Allocation: Cap and Share



December 2008

Comhar
Sustainable Development Council

A Study in Personal Carbon Allocation: Cap and Share

Foreword

Climate change represents an enormous challenge to all of us in Ireland in the near future. We must reduce greenhouse gas emissions across all sectors in accordance with our European and international commitments. While some sectors such as power generation and large industry are included in the EU Emissions Trading Scheme (ETS), others, such as transport, residential housing and agriculture are not and new policy measures are needed to reduce emissions in these sectors also. In particular, individual actions will be needed to achieve the emissions reductions under discussion in Europe by 2020 in the non-trading sectors. Innovative and fair policies are necessary to stimulate the scale of the reductions required.

Cap and share is an idea proposed in Ireland by the Foundation for the Economics of Sustainability (FEASTA) which is based on the argument that each citizen would be given a carbon emissions allowance allocation, with the total of such allocations amounting to the desired cap.[1] Essentially, the scheme would operate similarly to a carbon levy but would address the problem of public acceptability since the cap is placed on upstream emissions from primary fossil fuel suppliers to the sectors included in the scheme and certificates would be issued to all adults entitling them to an equal share of the emissions permitted under that year's cap. These certificates could then be sold to the fossil fuel suppliers via an intermediary such as a bank or post office. By capping emissions upstream the price of emissions is built into the price of fossil fuels which are passed through to the consumer. The consumer has an incentive to use less fossil fuel than the average amount for which he is compensated through the sale of the certificates.

Comhar SDC commissioned research in 2007 on Cap and Share as a policy instrument to reduce greenhouse gas emissions from Irish residential and transport sectors which are not covered by the EU emissions trading scheme. The consultants AEA Energy and Environment and Cambridge Econometrics have carried out the work on this project. AEA considered in more detail the design issues concerning the Cap and Share scheme and reviewed the merits of the proposal relative to other personal carbon allocation approaches and more traditional measures such as carbon taxes and regulation. Cambridge Econometrics performed an economic analysis of the impacts such a scheme could have using the E3ME model. The results of this work are described in this report and these findings will form the basis for any recommendations to government that Comhar SDC will make in the future on the issue.

We are grateful for the assistance of our Cap and Share Steering Group in helping oversee the project, which consisted of David Browne (Department of Transport), Donal Buckley (IBEC), John Burke (Department of Finance), Kelley Kizzier (EPA), Richard Douthwaite (FEASTA), and Mark Winkelmann (DoEHLG). A very informative stakeholder workshop was held in August 2008 where the consultants presented the results of the project to policymakers, politicians, members of the voluntary sectors, and academics. Finally, we would like to thank the Department of Transport and the EPA who co-funded this project.

Frank Convery
Chairman Comhar SDC

1 More information at www.capandshare.org

Executive Summary

Introduction

The challenge of climate change demands a response from all sectors of the economy. Importantly, action on the part of individuals will be required if greenhouse gas (GHG) emissions are to be cut to the levels necessary to avoid the worst consequences of climate change. However, new challenges must be overcome to achieve a shift in individual behaviour. For example, the public must be engaged with any new policy and see it as a fair and worthwhile approach. Further, any measure that engages with the public can also involve complexities associated with interactions on an individual level, which in turn can bring significant costs. To be successful, however, innovative solutions will be required and in recent years a number of novel approaches to personal carbon allocation schemes have been proposed.

One such scheme, called *Cap and Share*, would require fuel suppliers to surrender tradable allowances relating to the emissions from the fuel they import. The allowances would be issued freely to individuals, who would then sell them via intermediaries to the fuel suppliers. This approach would engage with the public at a fairly simple level, whilst also shielding individuals from the impact of any fuel price rises occurring as a consequence of the scheme.

Comhar SDC asked AEA and Cambridge Econometrics to consider in more detail the design issues concerning the Cap and Share scheme, and to review the merits of the proposal relative to other personal carbon allocation approaches, and more traditional measures such as carbon taxes and regulation. They also asked for an assessment of the economic impacts of the scheme in comparison with a carbon tax. The design issues were examined by AEA and the economic analysis was performed by Cambridge Econometrics using its E3ME model. This report contains a combined executive summary for the two project elements.

Part 1: Policy analysis

The Cap and Share proposal

Cap and Share was originally developed by the Foundation for the Economics of Sustainability (FEASTA) and is a regulatory and economic framework for controlling the use of fossil fuels in relation to climate stabilisation. Accepting that climate change is a global problem and that there is a need to cap and reduce GHG emissions globally, the philosophy of Cap and Share maintains that the earth's atmosphere is a fundamental common resource. Consequently, it is argued, each individual should get an equal share of the benefits from the limited amount of fossil fuels that will have to be burned and their emissions released into the atmosphere in the period until the atmospheric concentration of greenhouse gases has been stabilised at a safe level.

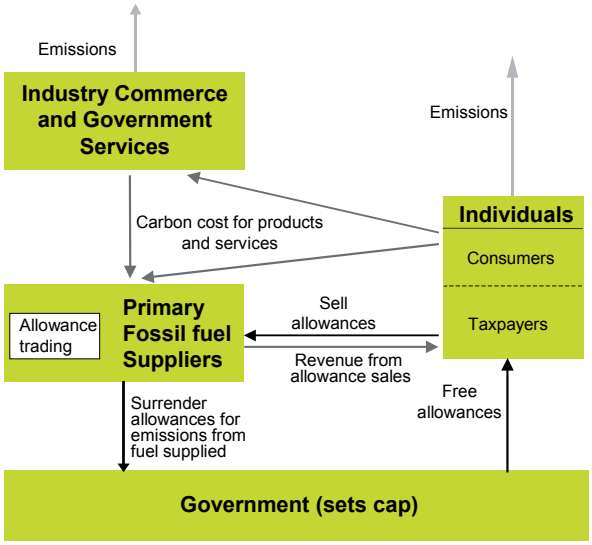
Applying the scheme at a national level, a cap would be set by an independent committee and all adults would receive certificates entitling them to an equal share of the emissions permitted under that year's cap. Certificates would then be sold, via banks or post offices, to those companies who import fossil fuels or extract them from the ground. Each of these primary fossil fuel suppliers would be required to acquire and surrender certificates equal to the emissions from the use of the fossil fuels that they introduced into the economy. By capping emissions at the upstream end of the supply system the price of emissions allowances is built into the price of fossil fuels, which then flows through the economy. However, whilst carbon-intensive products and services become more expensive, individual consumers obtain an income from the certificates that they sell and are therefore compensated. Furthermore, the higher the carbon cost the greater the compensation.

Products purchased from abroad will be affected by any activities taking place within Ireland using fossil fuels or energy derived from fossil fuels. Therefore, for all products/services, the use of fossil fuels in Ireland will be accounted for. The compensation

received by consumers is derived from emissions from fossil fuel use in Ireland and should therefore be consistent.

The Cap and Share approach is shown simplistically in the diagram on the following page. The red arrows show the flow of allowances. The blue arrows show the increased costs associated with goods and services under the scheme and the transfer of money when allowances are sold. For example the blue line between consumers and primary fossil fuel suppliers indicates an increased price for fossil fuels.

Cap and Share



Design issues

Scope

The Cap and Share scheme could in principle apply to the whole economy as a means of driving down emissions in all sectors. However, in practice there would be interactions with existing measures and it may be desirable to focus on certain emitting sectors.

Outside of the sectors already covered by the EU Emissions Trading Scheme (ETS), emissions from the transport sector represent the largest growing source of GHGs. Emissions from the transport sector are the fastest growing in both Ireland's and Northern Ireland's economies, rising by 160% over the period 1990 – 2005 in Ireland and by 144% in Northern Ireland over the same period. Transport sector emissions from the EU 27 as a whole increased by 127% from 1990 to 2005.

These factors suggest that the focus of a Cap and Share scheme should be emissions from the transport sector. A second further area of potential coverage is domestic use of energy, although the EU ETS already regulates emissions from the electricity sector.

The benefits of restricting the scheme to the transport sector would be:

- a focused move towards a more sustainable transport system,
- a simpler scheme initially and,
- the opportunity for learning before any further expansion.
  The advantages of wider initial implementation would be:
- economies of scale and,
- the opportunity to understand more about the interaction between the scheme and the wider economy.

There are pros and cons associated with implementing a Republic only scheme compared with a whole of Ireland Scheme:

- In a Republic-only scheme cross-border effects could be significant. Using the transport sector as an example, changes in the price differential between Northern Ireland and the Republic of Ireland initially would reduce fuel tourism and possibly reverse it. However, a scheme applied to the Republic would need only to interface with the EU Emissions Trading Scheme, which covers large industrial emitters and electricity generation, and the cap-setting process would be simpler.
- A Whole Ireland scheme seems feasible taking the example of the establishment of the Single

Electricity Market under the devolved powers of the Northern Ireland Executive. However, the situation for a Whole of Ireland scheme is more complex, since Northern Ireland, in addition to the EU ETS, operates the Climate Change Levy and is planning the Carbon Reduction Commitment, both regulating the business use of energy. Furthermore, consideration needs to be given regarding the setting of the cap given different emission reduction targets as well as the presence of parallel institutions and processes, for example using the National Insurance number for Northern Ireland in place of the Personal Public Service (PPS) system as a means of identifying individual participants, as discussed below.

Overall, a Republic-only scheme would be simpler to implement and we estimate that a reversal in fuel tourism would not occur before a carbon price of €120/tCO_2. It seems preferable therefore to introduce a Republic-only scheme in the first instance, with subsequent consideration to expansion.

Equity

Any trading scheme (or non-trading instrument) has the potential to benefit some participants at the expense of others. With the Cap and Share scheme these effects would be no more significant than any other mechanism that places a cost on carbon emissions. Under the proposal, lower income households, on average, would *benefit* since they have lower than average energy consumption and would receive emissions certificates worth more than the increased fuel costs they incur. However, due to variability within income bands, some low income households will be worse off, and may be less able to find energy savings or absorb increased costs compared with their wealthier counterparts.

Those living in rural communities could also be disadvantaged, relative to those in towns and cities, because they are likely to travel greater distances for basic amenities. They would also have less access to low carbon public transport alternatives. This is seen as a major challenge for climate policy in Ireland and raises issues that would apply for any mechanism that prices carbon, be it a carbon tax or trading scheme. Regarding domestic heating, those in rural communities are also likely to be disadvantaged, since the housing stock will generally be older and less efficient and access to gas (with a lower emissions factor than domestic oil) will be more limited.

Finally, the distribution of certificates to single-person households may not fully compensate them for the increased costs they would incur. A single-person household may have a similar consumption to a household with two or more adults. However, the single-person household would receive only one carbon entitlement.

There are a number of possible ways to address these equity concerns. In keeping with the principle of equal allocation, the preferred approach would be to address these equity concerns through alternative measures, such as increases in the Children's Allowance, the domestic heating allowance or funding for public transport. These measures could be funded through general taxation or through the auction of a proportion of the emissions allowances. The former would seem preferable since using income tax, for example, would be seen to align with the concerns being addressed, whereas reducing each individual's allocation would be seen to worsen the issue. A further possibility would be allocate more to those who would otherwise stand to lose, although this would appear to undermine the principle of the scheme.

Population coverage

The design of any trading scheme requires certain boundaries to be drawn, and this again leads to certain types of participant benefiting in comparison to others. A register of eligible individuals should be complied through a combination of the electoral roll and the Personal Public Service number system, to capture the majority of people. Making the scheme self-promoting and relatively simple to join are also seen as crucial features.

There is a question over the treatment of children, since they are consumers of energy but not necessarily purchasers. Literature regarding personal trading schemes generally suggests not allocating in full to children (although the principle of equal per capita allocation underpins the Cap and Share proposal). If there were no full allocation to children consideration would need to be given to the age at which individuals are considered an adult for the purpose of the scheme. Consideration should also be given to other mechanisms to support families regarding their increased carbon costs. Less-favoured alternatives would include partial allocation to children or allocation on a household basis.

Short-stay visitors, e.g. tourists, should not be included in the scheme, although long-stay residents that register for a PPS number could be included. If this were the case then consideration would need to be given to avoiding exploitation of the scheme by visitors who gain and sell certificates and then promptly leave. An eligibility period would seem the best way to address this.

Institutional arrangements

A Government body, most likely the Department of Environment, Heritage, and Local Government, would need to be responsible for setting the framework, the objectives and dealing with any policy-related issues. It would be responsible for developing the design aspects and consulting with other institutions, industry, the public and other interest groups.

Cap setting could either be carried out by Government or an independent body. In either case, however, the cap should be consistent with the national budget in the Climate Protection Bill and the strategy it sets for individual sectors.

The scheme would need to be run by a single administrative body. This would ensure consistent accountability for all aspects and clarity from the perspective of participants. It would also ensure the effects of any changes to approach could be managed throughout the process. The Environmental Protection Agency (EPA), as scheme administrator for the EU ETS would be the logical choice. It could also draw on its experience from being responsible for the National Emissions Inventory. The responsibilities of this body would be to:

- maintain the register of fuel suppliers;
- define the standards by which emissions must be reported and verified;
- produce guidance documents and;
- maintain the trading registry.

In addition to the above activities there would be a number of other functions for which the scheme administrator must maintain an overview, but which may be carried out by other bodies. These would include:

- maintaining a list of participating individuals and issuing them with certificates (for which the Department of Social and Family Affairs would have a role);
- determination and verification/audit of emissions (for which Customs and Excise would have a role);
- market regulation and;
- training and capacity building.

Transaction costs

The costs of designing the Cap and Share scheme in relation to other measures are discussed below, and are, in general, expected to be lower then the more complex personal carbon allocation options, but higher than a carbon tax. For the Cap and Share scheme the cost of administering the fuel suppliers is likely to be secondary to the costs associated with issuing certificates to the general public.

The cost to the members of the public is very sensitive to a number of design issues. Our simple bottom-up estimate, including the value of people's time, puts the transaction costs for a system where certificates are cashed in remotely in the range

8-11% of the value of the certificates. This range depends on income and assumes an allowance price of €20/tCO_2 and a bank direct transaction charge of 5%. Cost effectiveness improves at higher carbon prices, with transaction costs around 67% for a price of €50/tCO_2. However, if participants were required to cash in allowances in person then the costs could be significantly higher. To minimise transaction costs for individuals to a level that will be considered acceptable, consideration would need to be given to the following:

- Allowing on-line and postal facilities for converting certificates.
- Minimising the amount of material that an individual must understand, possibly making use of passive media such as television and radio broadcasts.
- Allowing individuals to delegate the authority to cash in allowances.
- Simplifying the requirements on banks and post offices to minimise their costs and the changes that they may charge for transactions.
- Considering the cost impacts when deciding whether to distribute certificates more frequently than yearly.

Finally, the administrative costs to those industries that would be required to register, trade and surrender allowances would be small in comparison with the costs to Government and the general population as a whole.

Legal aspects

On legal aspects the European Commission is unlikely to prohibit the scheme on the basis of it constituting State aid, primarily because the scheme as a whole would not give rise to a net benefit to any commercial undertakings. However, we do identify cases that may have relevance to Cap and Share where State aid has been upheld. Therefore it is not possible to be fully conclusive on this issue. Similarly, internal market rules should not be prohibitive.

Cap and Share compared with other measures

The policy options available to deliver emissions reductions vary considerably in their nature, from personal carbon allocation schemes to taxation to regulation. We have identified a set of key criteria and assessed each of the main options to gain an understanding of their relative merits. The results are illustrated in the following figure. Note that in this context, equity refers to the extent to which a mechanism results in a direct cost increase for individuals, since certain sectors may not be able to accommodate these costs. None of the schemes preferentially target certain groups of individuals for action, and therefore equity in this context would not differentiate the options.

Scheme	Cost Effectiveness	Public Engagement	Environmental Outcome	Equity	Simplicity
Personal carbon allocation schemes					
Cap and Share					
DTQs/TEQs[1]					
PCR[2]					
RAPS[3]					
Ayres Scheme					
Sky Trust					
Other mechanisms					
Carbon Tax					
Regulation					
Voluntary Schemes					
Fuel Excise Duty					

KEY: Relative performance against each criteria				
Strong				Weak

1 Domestic Tradable Quotas/Tradable Energy Quotas
2 Personal Carbon Rationing
3 Rate All Products and Services

On the basis of our simple multi-criteria and SWOT analyses the following conclusions can be drawn with respect to the personal carbon allocation schemes:

- The schemes that treat individuals as an emitting entity (Tradable Energy Quotas (TEQs)[1], Personal Carbon Rationing (PCR)[2], Rate All Products[3] and Services and the Ayres Scheme[4]) look the least appealing, because of their complexity and the resulting costs.
- Of those schemes, however, TEQs and PCR are less complex and costly.
- Most of the schemes can provide individuals, on average, with full compensation for increased carbon costs, with the exception being TEQs, which is the only scheme for which all of the allowances (or the value of them) are not allocated freely to individuals.
- The above suggests that PCR would currently be the favoured approach amongst the options for which individuals trade allowances. The decision between PCR, say, and the approaches of Cap and Share and Sky Trust is a balance between the improved public engagement of the first and the better cost effectiveness and simplicity of the latter two. Overall, currently, Cap and Share and Sky Trust appear favourable to PCR, although we have not assessed the full cost effectiveness of the last two.
- If Cap and Share and Sky Trust[5] were favoured, the decision between the two is quite finely balanced. Cap and Share would seem to offer better public engagement although the resulting costs of engagement at an individual level would probably make it more expensive to implement than the Sky Trust.

Regarding the non-trading options, a carbon tax or use of fuel excise duty appear preferable to direct regulation or voluntary schemes on the grounds of cost effectiveness and simplicity. They are also likely to be simpler and cheaper to implement than the trading approaches and offer the opportunity to raise revenue to achieve further environmental objectives (such as emissions reductions in non-traded sectors) that would otherwise have to be generated from other sources. However, overall the lack of public engagement, uncertainty over environmental outcome and no direct compensation for individuals, mean these non-traded options score less well in our analysis than Cap and Share and Sky Trust.

Conclusions for Part 1

Overall, we have highlighted a number of key design issues relating to the Cap and Share scheme, and suggested possible ways forward. In particular:

- A cautious approach would suggest implementation for the transport sector only in the Republic, with subsequent consideration to sectoral and geographical expansion.
- The scheme is not inherently inequitable, but measures would be needed to shield the vulnerable from increased costs. We suggest this be separate from the scheme itself.
- The scheme should be based on the PPS system and electoral role, with consideration given to the treatment of children. Evidence suggests not allocating to children, although again consideration will be needed for increasing support to families.
- The roles of various institutions have been defined, with a key element being the scheme administrator that would have an overview of the whole scheme. We suggest this be the EPA. We are suggesting that the Department of

1 Energy and the Common Purpose: Descending the Energy Staircase with Tradable Energy Quotas (TEQs), David Fleming, September 2007, http://www.theleaneconomyconnection.net/downloads.html#TEQs

2 Hillman, M., and Fawcett, T., How we can save the planet, Penguin Books, pp. 126 – 133, 2004.

3 Starkey and Anderson (2005).

4 Ayres, Robert, Environmental Market Failures: Are there any local market-based corrective mechanisms for global problems? (CMER, INSEAD, Fontainebleau, France, 1996).

5 http://www.capanddividend.org/files/WP150.pdf

Environment, Heritage, and Local Government puts in place the regulatory framework to enable Cap and Share to be implemented. Following that, the EPA would be the logical choice for the body/organisation to deal with the practicalities of the scheme.

- Transaction costs to individuals can be acceptably low, provided they can cash in their certificates remotely (on-line or by post). We make other suggestions for reducing transactions costs.
- Of the various personal carbon allocation approaches proposed, Cap and Share and the Sky Trust currently appear the most favourable.
- Furthermore, the lack of public engagement, uncertainty over environmental outcome and no direct compensation for individuals mean that non-traded options such as a carbon tax and direct regulation score less well in our analysis than Cap and Share and Sky Trust.

Part 2: Economic analysis

The aim of Part 2 of the study was to assess the likely economic (primarily macro, sectoral and income-distributional) and energy impacts of the introduction of a personal Cap and Share emission-trading scheme in Ireland, applied to the sectors, including road transport, which are not covered by the EU ETS.

The E3ME model (see www.e3me.com) was used to provide quantitative estimates of these impacts through a series of carefully-designed scenarios. Results for the scenarios with Cap and Share schemes were compared against the baseline used in the study and against equivalent carbon-based tax schemes. Different emission-reduction targets and an alternative set of assumptions about global oil prices were also tested to see how these affected the outcomes.

Both the Cap and Share schemes and the carbon taxes increased the effective cost of fossil fuels to end users not covered by the EU ETS (see diagram). Energy demand falls as a result of the higher price. There may be a further fall in energy demand from the signalling and awareness effects of the Cap and Share scheme but this was not accounted for in the modelling.

In the highest emission-reduction scenarios, the Cap and Share scheme was set to achieve a 30% reduction in CO_2 emissions in the non-EU ETS sectors by 2020, compared to 2005 levels. This is broadly equivalent to reducing emissions by 3% pa over this period. A high carbon price (over €300/tCO_2 at 2008 prices in 2020) was required to achieve this (see table). This outcome reflects the ambitious nature of the target but it is also partly driven by modelling assumptions, for example the limited alternative fuels for road transport and a lack of government regulation to help meet the targets.

Even with high carbon prices the economic effects of the schemes were found to be small, with only minor impacts on GDP and employment levels. Household consumption was lower compared to the baseline as higher fuel costs eroded real incomes (although spending on non-energy items increased) but Ireland's balance of payment improved due to lower levels of fossil-fuel imports.

The economic sectors that benefited from the Cap and Share scheme are those that produce consumer services and investment goods, including fuel-efficient vehicles. Manufacturing sectors that are not included in the EU ETS will face higher production costs.

Cap and Share can be considered highly equitable, with the allowances distributed evenly to households, regardless of income. This means that lower-income households are relatively better-off compared to the baseline. Low-income households also gain on average because they spend a smaller share of their income on transport fuels. However, rural households will lose out as they typically spend twice as much of their income on transport fuels as urban households.

The carbon taxes which were set to achieve the same levels of reductions in emissions as the Cap and Share scheme were found to have a positive

impact on economic activity. This was due to the revenue-recycling measures which accompanied the taxes (a combination of higher social benefits and lower income taxes). Low-income households (including pensioners) also benefited in the scenarios but not to the same extent as in the Cap and Share scheme. Rural households are affected by higher transport costs in the same way as in the Cap and Share scheme.

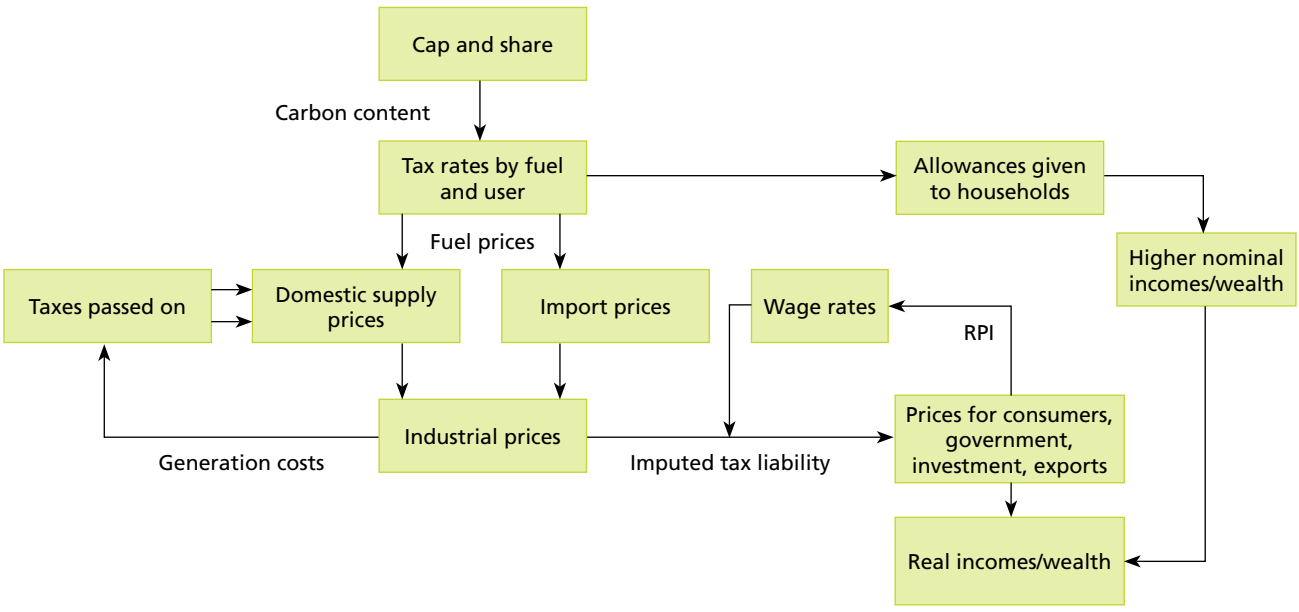
Lower emission-reduction targets and higher global oil prices resulted in a lower carbon price, as the targets are easier to achieve. For example, a 20% emission-reduction target required an allowance price closer to €160/tCO_2. However, the economic outcomes of the Cap and Share scheme were largely unaffected by these different assumptions.

Summary Scenario Results, 2020						
Scheme	**Cap and Share**	**Cap and Share**	**Cap and Share**	**CO_2 Tax**	**Cap and Share**	**CO_2 Tax**
Oil Prices	Standard	Standard	Standard	Standard	High	High
Target Reduction	30%	20%	10%	30%	30%	30%
Allowance Price (€08/tCO_2)	308.8	167.2	83.9	-	221.3	-
Carbon Tax Rate (€08/tCO_2)	-	-	-	329.0	-	239.6
Change in GDP (%)	0.0	0.0	0.0	0.9	0.1	0.6
Change in Employment (%)	0.0	0.0	0.0	0.0	0.0	0.0
Allowances issued per household (tCO_2)	11.9	13.7	15.4	-	11.9	-

Note(s): The target reduction is defined as % reduction in CO_2 emissions, in the non-ETS sectors in 2020, compared to 2005. Changes in GDP and employment are relative to a baseline with the same oil price assumptions as the scenario.

Source(s): E3ME.

The Impact of Cap and Share on Incomes



Contents

Part 1 – Cap and Share: Policy Options

Part 2 – Cap and Share: Possible Macroeconomic Effects in Ireland

Part 1:
Cap and Share:
Policy Options

AEA Energy & Environment
Authors:
Mark Johnson
Michael Harfoot
Courtney Musser
Tricia Wiley

1 Introduction

The challenge of climate change demands a response from all sectors of the economy. Importantly, action on the part of individuals will be required if greenhouse gas emissions are to be cut to the levels necessary to avoid the worst consequences of climate change. However, new challenges must be overcome to achieve a shift in individual behaviour. For example, the public must be engaged with any new policy and see it as a fair and worthwhile approach. Further, any measure that engages with the public can also involve complexities associated with interactions on an individual level, which in turn can bring significant costs. To be successful, however, innovative solutions will be required and in recent years a number of novel approaches to personal carbon allocation schemes have been proposed.

One such scheme, called Cap and Share, would require fuel suppliers to surrender tradable allowances relating to the emissions from the fuel they import. The allowances would be issued freely to individuals, who would then sell them via intermediaries to the fuel suppliers. This approach would engage with the public at a fairly simple level, whilst also shielding individuals from the impact of any fuel price rises occurring as a consequence of the scheme.

Comhar SDC have asked AEA to consider in more detail the design issues concerning the Cap and Share scheme, and to review the merits of the proposal relative to other personal carbon allocation approaches and more traditional measures such as carbon taxes and regulation. This report presents that analysis. A further report will describe economic analysis of the impacts such a scheme could have, which will be carried out by Cambridge Econometrics.

This report is divided into 4 main sections:

- Section 2 reviews experience with other emissions regulation, principally the EU Emissions Trading Scheme, to identify issues important to the scope of a Cap and Share Scheme and any lessons that could apply.
- Section 3 reviews the Cap and Share proposal along with other suggested personal carbon allocation schemes. It assesses the options against key criteria and develops a SWOT analysis.
- Section 4 reviews non-trading options following the same methodology as Section 3.
- Section 5 reviews the main design issues relating to the Cap and Share proposal. Where possible it makes suggestions on ways forward where there are choices to be made and highlights possible solutions to concerns that might remain.

Acknowledgment

The AEA project team would like to acknowledge the work of David Harrop in laying the foundations for this project. David tragically died before it was commissioned in full and we would like to dedicate this report to his memory.

2 Review of scope

The implementation of a trading scheme such as the Cap and Share scheme must take account of pre-existing systems in place. Firstly, to establish if the proposed system is required and, secondly, to determine what sectors of the economy the new scheme should target. In this context, the following Sections 2.1 – 2.4 discuss the scope of the European Union Emissions Trading Scheme in Ireland, in terms of the sectors covered by it and the importance of those sectors compared with the total Ireland's overall greenhouse gas emissions. Finally, Section 2.5 discusses other extant policies and regulations with which a new scheme must also interact.

2.1 EU ETS scope

The European Union Emission Trading scheme (EU ETS) has been designed in three phases. It commenced on 1 January 2005 with Phase I of the scheme that ran from 2005 to 2007. Phase II began on 1 January 2008 and will run until 2012. The EU ETS covers power generation, cement, glass, ceramics, and pulp and paper, which are termed "trading sectors". Additionally, the scheme covers emissions from large combustion installations, (larger than 20 $MW_{thermal}$), commonly found in the food processing and pharmaceutical industries for example. Operators of installations that are covered by the scheme are obliged to monitor and report emissions of greenhouse gases (GHGs) from that installation and to surrender allowances for the volume of those emissions.

To date allocations of allowances to those sectors and installations covered by the scheme have principally been made on the basis of past emissions, discounted to meet Kyoto targets. Prior to the commencement of each Phase of the scheme, Member States have been required to submit a National Allocation Plan (NAP), detailing the allocation of allowances over that period, for approval by the European Commission. In Section 2.2, the allocation of allowances in the Republic of Ireland and Northern Ireland will be discussed in the context of establishing the sectoral coverage of the Community trading scheme.

Directive 2003/87/EC, which established the EU ETS also set out the requirement for a review of the scheme. In 2006, the Commission published a Communication that established a review process and committed to produce a legislative proposal in 2007. The Commission's review of the EU ETS reported in January 2008 with implications for the future scope of Phase III and relevant proposals from that review are considered in Section 2.3.

2.2 EU ETS in Ireland

The allocation of allowances to installations in the Republic of Ireland is covered by Ireland's National Allocation Plan (NAP), which is administered by Ireland's Environmental Protection Agency (EPA). For those installations in Northern Ireland that qualify for the EU ETS, allowances are allocated according to the UK NAP, administered by the Department for Environment, Food and Rural Affairs.

2.2.1 Republic of Ireland

Ireland's NAP for 2008 to 2012[1] (Phase II of the EU ETS) was notified to the EU Commission in July 2006. The intended total quantity of allowances for this period was given as 22.638 Mt CO_2 equivalent per year. The Commission gave their approval to the plan as submitted, subject to 5 amendments, including a reduction to the overall quantity of allowances allocated[2]. Following a request from Ireland for further clarification of their decision, the EU Commission issued a revised decision in July 2007, in which the reduction to the overall quantity of allowances allocated was lessened. The total quantity of allowances to be allocated by Ireland is now 22.262 Mt CO_2 eq. per annum, which amounts

1 Environmental Protection Agency, *Ireland's National Allocation Plan 2008 – 2012*, 12 July 2006. See: http://www.epa.ie/downloads/pubs/air/etu/epa_ireland_nap_2008-2012.pdf

2 Commission Decision of 29 November 2006 concerning the national allocation plan of greenhouse gas emission allowance notified by Ireland in accordance with Directive 2003/87/EC of the European Parliament and of the Council.

to 31% of the projected national GHG emissions over that period, taking into account existing GHG reduction measures.

The Commission's decision, in response to the first submission of Ireland's Phase II NAP, to reduce the total allocation of allowances was due to Commission's opinion that Ireland's forecasted growth of transport sector emissions was overly conservative. Therefore, the proposed allocation of allowances to sectors within the Community trading scheme, based in part on that forecast, did not comply with Ireland's reduction commitment under the Kyoto Protocol.

There are 112 installations within the Republic of Ireland that qualify for the EU ETS. Table 2.1 shows the distribution of the allowances to these installations grouped into three sectors; power generation, cement and general (covering all other types of installations). The power generation sector is clearly the largest sector followed by cement and then all the remaining summed together. The largest sectors within the 'general' classification are aluminium and food processing, but it also includes breweries, brick manufacturers, pharmaceutical companies, universities, and hospitals. In addition, there are two oil companies whose operations in Ireland are covered by the EU ETS; Marathon Oil, which is the operator of the Kinsale Head Gas Field, and, Conoco Phillips, operators of the Whitegate refinery in County Cork.

Table 2.1: Ireland's proposed average annual sector allocations for 2008 – 2012[3]

Sector	Incumbent Allocation	Proportion (%)
Power generation	13,080,316	64.6
Cement	3,867,237	19.1
General	3,295,484	16.3
Total	**20,098,766**	**-**

Under a "*De-minimis* Threshold Rule" within Ireland's NAP, installations that only satisfy the $20MW_{thermal}$ EU ETS inclusion criteria as a result of aggregating very small emission sources (under $3MW_{thermal}$) have been excluded from the provisional NAP. However, the operators of these installations can request to remain within the scheme.

New entrants to the scheme will be allocated allowances from a New Entrant Set-Aside and no allocation will be proportionately greater than that which the existing installations in the same sector were allocated, nor will an allocation be greater than 87% of projected emissions. A set-aside will also exist for new high efficiency CHP, the allowances for this set-aside will be taken from the Power generation sector allocation.

The Irish Government intends to purchase a maximum of 18.035 million allowances through the Kyoto Protocol flexible mechanisms, emissions reduction units (ERUs) or certified emissions reduction units (CERs), for which the National Development Plane 2007-2013 provides the sum of €270 million. Across the different sectors, the use of ERUs and CERs is limited to 11% of the allocation to each installation for Power generation and the Cement sector, and 5% of the allocation to each installation in the General sector.

2.2.2 Northern Ireland

The UK's Phase II NAP was approved by the Commission on 29 November 2006[4]. Twenty three installations from Northern Ireland are included in that plan amounting to a total emission of 5.7 million tonnes of CO_2. Power Generation represents almost 80% of those emissions and Cement manufacturing 14% (Table 2.2).

3 Environmental Protection Agency, *Ireland's National Allocation Plan 2008 – 2012*: As notified to the Commission prior to Final allocation Decision, October 2007. See: http://www.epa.ie/downloads/pubs/air/etu/nap2%20january%202008.pdf

4 Commission decision of 29 November 2006 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by the United Kingdom in accordance with Directive 2003/87/EC of the European Parliament and of the Council. See: http://ec.europa.eu/environment/climat/pdf/nap2006/20061128_uk_nap_uk.pdf

As is the case in the Republic of Ireland, a voluntary *de minimis* threshold has been included in the UK's Phase II NAP; combustion units less than 3MW would be excluded from the calculation of aggregated installed capacity, units equal to or greater than that value would be included. If, using this threshold, the aggregated units exceed 20MW, all units would be included.

A New Entrant Reserve of allowances is in place for installations that start or extend operations between 2008 and 2012. Emissions projections for each sector within the UK's Phase II NAP take account of growth, including provision for new entrants, as the output growth assumptions reflect the demand for a particular product irrespective of whether it is produced by a new entrant or an existing installation. Contributions to the NER in each sector are deducted from the total allocation to that sector before distributing the remainder to existing installations.

The UK government forecasts that it is on course to emit less than its Kyoto Protocol target. It is therefore not intended that any use will be made of flexible mechanisms by the Government. The use of Kyoto project credits, CERs or ERUs, by installations is limited to 8% of the free allocation to each. This percentage limit amounts to approximately two thirds of the 'effort' required by UK installations in Phase II, where effort is calculated as the difference between projected business as usual emissions and the total allocation of allowances[5].

Table 2.2: Annual allocations to installations in NI grouped by sector[6]

Sector	Number of Installations	Allocation (tCO_2/year)
Cement	2	792490
Chemicals	1	116209
Glass	1	106592
Other Electricity Producers	1	12079
Others B	1	60174
Ceramics	1	24333
Services	3	41998
Others C	2	37677
Pulp & Paper	1	14811
Large Electricity Producers	3	4401506
Food and Drink	7	93610
Total	**23**	**5701479**

2.3 The EU ETS review

On 23rd January 2008 the European Commission proposed a Directive amending Directive 2003/87/EC[7]. Although a comprehensive review of the EU ETS is beyond the scope of this report, some of the relevant proposals from the Directive are presented below.

i. The scope of the scheme will be expanded to cover:
   a. CO_2 emissions from petrochemicals, ammonia and aluminium sectors;
   b. N_2O emissions from production of nitric, adipic and glyoxalic acid;
   c. PFC emissions from the aluminium sector.

ii. Installations with a combustion capacity above $20MW_{thermal}$ can be excluded if they have a capacity less than 25 MW and annual emissions less than 10,000 tCO_2.

5 Defra, *EU Emissions Trading Scheme Approved Phase II National Allocation Plan 2008 – 2012*, 2007. See: http://www.defra.gov.uk/environment/climatechange/trading/eu/phase2/pdf/nap-phase2.pdf

6 *Ibid.*

7 COM(2008)16 final, *Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community*, SEC(2008) 52 + 53, SEC(2008)85, January 2008.

iii. GHG emissions from road transport and shipping are not to be included and a comprehensive cost-benefit analysis is deemed necessary, in order to allow the Commission to decide on whether emissions trading is the most appropriate means to deal with these issues.

iv. The definition of combustion installation will be codified and will cover all stationary combustion apparatuses resulting in the release of greenhouse gases.

v. An EU-wide cap should be determined in the Directive and there should be an 8-year trading period to 2020 and a linear reduction in the cap to that point. The Directive should provide for automatic and predictable adjustments to the cap upon conclusion of an international agreement.

vi. The EU ETS should be able to link to other mandatory emissions trading systems capping absolute emissions.

vii. Auctioning should be the basic principle for allocation and should be applied to different sectors over different timescales. Of the allowances to be auctioned, 90% will be distributed to member states in proportion to 2005 emissions and the remaining 10% will be distributed according to per-capita income. A percentage of the revenue from auctioning allowances should be used to reduce greenhouse gas emissions, to adapt to climate change, for measure to avoid deforestation and for addressing social impacts such as increases in electricity prices in lower and middle income homes.

The inclusion of CO_2 emissions from the petrochemical, ammonia and aluminium sectors reinforces industrial sector coverage under the EU ETS. Within Ireland, the aluminium sector is mainly engaged in refining bauxite to alumina, which does not cause PFC emissions, therefore this expansion of scope will not affect Ireland significantly[8]. Defining *de minimis* criteria will make it easier for small installations to opt out of the EU ETS but the criteria already in place in Ireland's and the UK's Phase II NAP mean that small installations within Ireland and Northern Ireland already had the option to be excluded from the EU ETS. Setting an EU wide cap within the directive and defining a linear decline of that value to 2020 sends a clear, long-term signal about the pressures that will be experienced by those sectors included within the EU ETS.

Establishing auctioning as the principle for allocation sets a precedent for allocation methodologies in trading schemes. Of equal importance is the proposal to recycle auction revenues to aid greenhouse gas abatement efforts but also to address potential social imbalances in the impacts of the EU ETS.

The decision not to include surface transport emissions in the EU ETS is important for the scope of a personal trading scheme because transport shows the most significant growth of any sector in Ireland, as is discussed in the following section.

Summary

- The EU ETS is now operating Phase II of the scheme, which will continue to 2012. The allocation of allowances to installations in Ireland and Northern Ireland covered by the EU ETS is detailed in the National Allocation Plans (NAPs) for Ireland and the UK (for Northern Ireland).
- In both Ireland and Northern Ireland, the power generation and cement manufacturing sectors account for 80% and 90% of the allocation of allowances, respectively.
- Both Ireland and UK (for Northern Ireland) include a reserve for new entrants to the scheme and a de minimis threshold to prevent the inclusion of small emitters.

8 US EPA data on PFC emissions from primary aluminium production. http://www.epa.gov/methane/excel/AppendixD9_PFC_Primary_Aluminum_Tech_Adoption.xls

- The review of EU ETS has presented recommendations for Phase III of the scheme. Some important proposals and their implications are:
  - Expansion of scope to include more industrial emissions. The impacts of this extension may be small for Ireland and Northern Ireland emissions;
  - Establishing an EU wide cap and predictable, long-term reductions to 2020. The clear signal of a predictable cap will allow long-term abatement strategies to be implemented.
  - Surface transport is not to be included in the scheme. The review has recommended a detailed cost-benefit analysis to decide if the EU ETS is the most appropriate mechanism to deal with these emissions, leaving the scope open for another mechanism to cover this important sectoral emission source.
  - Auctioning is to be established as the principle for allocation with auction revenues recycled to aid GHG abatement and to address equity concerns resulting from the introduction of the scheme. This proposal sets a precedent for addressing equity imbalances created by the scheme, for example increases in electricity prices in lower and middle income households.

2.4 Sectors outside the EU ETS

It can be seen from tables 2.1 and 2.2 that the EU ETS does not cover all sectors of the Irish economy equally. Those sectors not covered by the Community scheme are considered below.

2.4.1 Republic of Ireland

In order to decide on the relative proportion of allowances allocated to each trading sector within Ireland's Phase II NAP, modelling was carried out to determine the share of national greenhouse gas emissions over the period 2008 to 2012[9]. Ireland's GHG emissions reported in 2003 are compared against the forecast 'base-case' emissions from ICF and BOC (2006)[10] in table 2.3. The 'base case' scenario takes into account the GHG emission reductions likely to be achieved by policies and measures already announced that directly and indirectly impact Ireland's GHG emissions profile.

The energy sector, which accounts for the greatest proportion of the sectoral allocation of allowances in Ireland's Phase II NAP, is forecast to be the most significant GHG emitting sector over the period 2008 – 2012 and was comprised 24% of reported emissions in 2003. The largest magnitude increases in emissions are forecast to occur in the Industry/Commercial/Services and the Energy sectors. However, the EU ETS covers many of the largest emitters in these two sectors and Ireland's allocation of allowances (table 2.1) represents 61% of the combined total of emissions from the Energy sector and the Industry/Commercial/Services sector. Excluding these two sectors, the next largest change is predicted to occur in the Transport sector from which annual emissions are expected to be over 1,000 Mt CO_2-eq greater in the period 2008 – 2012 in comparison with 2003.

Forecast emissions from the Agricultural sector, which represented the largest source in 2003, are over 2.4 Mt CO_2-eq lower in the 2008 – 2012 period, as a result of the full decoupling of subsidies from production. Within the agricultural sector, CH_4 and N_2O are the key greenhouse gases in Ireland[11]. Of particular importance are enteric fermentation (CH_4, with cattle being the largest source), manure management (mostly CH_4, with cattle again being the largest source) and agricultural soils (N_2O, where direct emissions make the largest contribution)[12].

9 ICF Consulting and Byrne O Cleirigh, *Determining the Share of National Greenhouse Gas Emissions for Emissions Trading in Ireland 2008 – 2012*, submitted to Department of Environment, Heritage, and Local Government, Heritage and Local Government, Ireland, March 2006.

10 *Ibid*.

11 Ireland National Inventory Report 2006, EPA (Michael McGettigan, Paul Duffy, Niamh Connolly and Phillip O'Brien), http://coe.epa.ie/ghg/nirs/NIR_2006_IE.pdf

12 *Ibid*.

It is not clear whether these emissions could be included in the scheme with the same standard of monitoring as CO_2 emissions from combustion in the transport sector, particularly since a top-down approach to emissions determination for the latter could not be applied to the former. In any case, the inclusion of agriculture would add a degree of complexity to the scheme, and given the projected fall in emissions in contrast to the rises expected from transport, it is by no means compelling that the inclusion of agriculture would be cost effective.

Table 2.3: Breakdown of Ireland's GHG emissions by sector[13]

Sector	2003		2008 – 2012		
	Emissions (Mt CO_2-eq)	Proportion of total	Emissions (Mt CO_2-eq)	Proportion of total	Emission change (Mt CO_2-eq)
Energy	16.30	24%	18.75	26%	2.45
Residential	6.61	10%	6.83	9%	0.22
Industry/ Commercial/ Services	11.27	17%	14.20	20%	2.93
Agriculture	20.08	29%	17.64	24%	-2.43
Transport	11.85	17%	13.03	18%	1.18
Waste	2.08	3%	1.83	3%	-0.25
Total	**68.19**	-	**72.28**	-	**4.09**

Based on this analysis, the transport sector represents the fastest growing sector not covered by the EU ETS. Further evidence comes from the growth rate of the total primary energy requirement in the transport sector, which was 169% over the period 1990 – 2006 (6.3% per annum), greater than any other sector of the Irish economy[14]. Provisional GHG emissions reported for 2006 show transport sector emissions 165% higher than 1990 values[15].

2.4.2 Northern Ireland

Recently reported greenhouse gas emissions for 2005 are lower, in total, than values for 1990 by more than 1 Mt CO_2-eq[16]. Considering the sectoral breakdown of emissions, it can be seen that as is the case in the Republic of Ireland, emissions from Agriculture and Power generation represent the largest proportion of the total emissions (table 2.4). Most notably however, emissions of GHGs in 2005 are reduced in all sectors except transport, compared with 1990 levels. The transport sector showed an increase of around 1.6 Mt CO_2-eq (144%).

Table 2.4: Breakdown of GHG emissions in Northern Ireland by sector[17]

Sector	1990		2005		
	Emissions (Mt CO_2-eq)	Proportion of total	Emissions (Mt CO_2-eq)	Proportion of total	Emission change (Mt CO_2-eq)
Energy Supply	5.49	25%	5.29	26%	-0.21
Residential	3.52	16%	2.86	14%	-0.65
Public	0.42	2%	0.13	1%	-0.29
Industrial Process	0.72	3%	0.35	2%	-0.37
Business	2.07	9%	1.63	8%	-0.44
Agriculture	5.34	24%	5.04	24%	-0.30
Transport	3.69	17%	5.32	26%	1.64
Waste Management	0.67	3%	0.36	2%	-0.31
Land Use Change	-0.05	0%	-0.31	-1%	-0.26
Grand Total	**21.88**	-	**20.68**	-	**-1.20**

Based on this analysis, it can be seen that in 2005, transport emissions, which are beyond the scope of the EU ETS, account for the same proportion of GHG emissions as the power generation sector. Further, transport is the only sector in Northern Ireland from which emissions rose over the period 1990 to 2005.

13 ICF Consulting and BOC (2006).

14 Howley, M., O'Leary, F., and O'Gallachoir, B., Sustainable Energy Ireland, Energy Policy Statistical Support Unit, Energy in Ireland 1990 – 2006, December 2007.

15 Environmental Protection Agency, *Ireland's Greenhouse Gas Emissions in 2006 (provisional)*, 2008. See: http://www.epa.ie/downloads/pubs/air/airemissions/ghg_provisional_20061.pdf

16 Jackson J., Li, Y., Passant, N., Thistlethwaite, G., Thomson, A., and Cardenas, L., *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland 1990 – 2005*, Report to Defra, AEAT/ENV/R/2500, August 2007. See: http://www.airquality.co.uk/archive/reports/cat07/0709180935_DA_GHGi_1990-2005_v2.xls

17 *Ibid*.

2.5 Other climate change regulation

The previous discussion has focussed on the EU ETS, which covers installations in the Republic of Ireland and Northern Ireland. It is important to note that in the Republic of Ireland the EU ETS is the only extant trading scheme. However, in Northern Ireland legislation is also in place for the Climate Change Levy and is proposed for the Carbon Reduction Commitment. Any further trading scheme, such as the Cap and Share scheme, would have to interact with such pre-existing policies.

Since April 2001, a climate change levy (CCL) has been applied to energy use in industry, commerce and the public sector. The levy applies specifically to gas, liquefied petroleum gas (LPG), electricity and other fossil fuels. However, it does not apply to fuels used by the domestic or transport sector, fuels used for the production of other forms of energy or fuels used for non-energy purposes. No levy is applied to oils and energy used by small firms, using domestic amounts of energy, are exempt. Special consideration is given to energy intensive sectors (the major energy intensive sectors are: aluminium, cement, ceramics, chemicals, food & drink, foundries, glass, non-ferrous metals, paper and steel) whereby agreements are negotiated with relevant sector trade associations on behalf of companies within the sectors concerned. Facilities identified within these agreements are eligible for an 80% discount on the Levy subject to progress against targets established by the Climate Change Agreements (CCAs).

Defra is in the process of developing the Carbon Reduction Commitment; a mandatory auction based cap and trade scheme in which participants will be required to purchase sufficient allowances either from the auction, the secondary market or through the safety valve to cover their annual energy use CO_2 emissions. Organisations will be covered by the CRC only if they have an electricity consumption from mandatory half hourly meters in excess of 6,000 MWh/year. Any half hourly metered electricity use will count towards the 6,000 MWh/year inclusion threshold irrespective of whether this electricity use is covered by CCAs. The CRC aims to target both direct CO_2 energy use emissions and indirect CO_2 emissions from electricity. However, direct emissions included in the EU ETS and CCAs will not be covered by CRC and organisations with more than 25% of their emissions in CCAs will be completely exempt from CRC. The scheme is due to commence in January 2010 preceded by a three-year introductory phase during which simple fixed-price sale of allowances will occur. Following this phase allowances will be auctioned.

Summary

- Within Ireland, the EU ETS is the only significant trading scheme, with which other policies aiming to reduce GHG emissions would need to interface.
- In Northern Ireland, the situation in more complex, with the EU ETS, Climate Change Levy (hence also Climate Change Agreements) and the Carbon Reduction Commitment in place. A 'whole-Ireland' policy would need to take these existing measures into account in its design.
- Outside of the sectors already covered by the EU ETS, emissions from the transport sector represent the largest growing source of GHGs.
- Emissions from the transport sector are the fastest growing in both Ireland's and Northern Ireland's economies rising by 160% over the period 1990 – 2005 in Ireland and by 144% in Northern Ireland over the same period.
- These factors suggest that transport should be the main focus of a new Cap and Share, or similar, policy.
- Regarding the inclusion of energy consumption, power generation is already within the EU ETS scheme. To avoid overlap it would seem logical to exclude electricity use from a new domestic or commercial scheme (because there is already a carbon signal to incentivise reductions).

However, the CRC in the UK sets a precedent for including electricity within a complementary scheme aimed at energy consumption.

- Emissions from the agriculture sector are significant in both the Republic of Ireland and Northern Ireland, although whether the Cap and Share proposal is suited to addressing these requires further consideration, since emissions are falling and generally arise from non-CO_2 sources that would require a different monitoring approach to CO_2 emissions from the transport sector.

2.6 Lessons from the EU ETS

The EU ETS has been operating for over three years and recently its operation has been comprehensively reviewed. Here we consider what lessons can be taken from the functioning of the EU ETS, in the context of implementing a personal carbon allocation scheme.

2.6.1 Trial phase

Phase I of the EU ETS is regarded as a trial phase of the scheme, during which difficulties of the schemes operation and the impacts of the scheme on the economy were identified. The recent review of the EU ETS took these issues into account before recommending new regulations for the design of the scheme in Phase III.

The Carbon Reduction Commitment is also intending to commence with a trial phase during which it is hoped that problems will be identified and resolved to produce a more effective and efficient scheme.

Designing a trial period into the implementation of a new emissions trading scheme is seen as an important element of the scheme's development and this should be taken into account when implementing a novel personal carbon allocation scheme.

2.6.2 Cap setting

In Phase I of the EU ETS, the total cap established was greater than that required under a business-as-usual scenario. Since there was a lack of scarcity, the allowance price fell close to zero and the scheme ultimately offered no incentive for abatement. The cause of this scenario can be attributed to the way the cap was determined:

- National emission caps were generally determined independently by each Member State in accordance with business-as-usual emissions projections and without any reference to an overall EU cap. This Member State driven approach combined with inconsistencies in approaches to deal with key parameters or uncertainties for the projections contributed to the adoption of high baseline scenarios;
- Many Member States did not have good quality emissions baselines on which to base their allocations. Accordingly, national allocations tended to err on the side of caution rather than risk disadvantaging national industries in international markets;
- Lack of planning and familiarity with the scheme resulted in some Member States not having their NAPs approved before the start of the scheme.

Ensuring that good quality emissions data is available in preparation for a new scheme and that those responsible for establishing the cap have the political will and are familiar with accepted methodologies should avoid unrealistically high business-as-usual projections. Awareness of the procedures and time constraints of the scheme would avoid late allocation of allowances that might impact on the operation of the scheme.

2.6.3 Investment opportunities

A criticism of the EU ETS has been that there has been insufficient certainty regarding the overall cap to make long-term investment decisions. Many sectors within the scheme have asset lives well in excess of 20 years and payback periods far longer than current EU ETS phase lengths. This was recognised in the proposal of COM(2008)16 to establish an early EU wide cap and forecast its rate of decline over the trading period 2012 to 2020. The length of the cap is clearly an important consideration when designing a trading scheme.

2.6.4 Emissions reporting

The release of market sensitive information by Member States and the Commission can have a significant impact for participants in the scheme. For example, the release in 2005 of verified emissions data showed that emissions were generally lower than expected and as a consequence less abatement would be required. The market response was a fall in the carbon price, which is to be expected in a properly functioning market. However, the method of release meant that the information was not available to all interested parties at the same time. Consequently, some were more vulnerable to losses on the market than others, leading to criticism of the way the data was released. The Commission set up a revised process for emissions reporting in 2006 and the same problem did not occur. Taking such guidelines into account would be advisable for all new emissions trading schemes in which reporting of emissions takes place.

Summary

Drawing lessons from the EU ETS we can conclude:

- There are benefits from operating a trial phase, or at least allowing flexibility on some design aspects during initial phases.
- The use of good quality baseline data is essential in determining a realistic cap and supporting a stable carbon market during early phases of a new scheme.
- There are benefits from setting a stable long term cap profile, since this provides greater certainty for the necessary investment in low carbon options to support reductions in all sectors.
- A clear programme for reporting market sensitive information and policy decisions is desirable, to avoid any market shocks.

3 Policy approach – personal carbon allocation options

Policymakers have a choice of policy instruments capable of achieving a reduction in carbon emissions. In Sections 3 and 4, we review the full range of available policy options that focus on changing individual behaviour and undertake a comparative assessment of the strengths, weaknesses, opportunities and threats of each scheme. Section 4 covers non-trading approaches to emission reduction and the present section covers the following personal carbon allocation schemes[18].

- Cap and Share
- Domestic Tradable Quotas/Tradable Energy Quotas
- Personal Carbon Rationing
- Rate All Products and Services
- Ayres Scheme
- Sky Trust
  (now commonly referred to as Cap and Dividend)

All the measures are assessed on the basis of the following criteria:

- Economic Efficiency
- Environmental outcome
- Equity
- Simplicity
- Political and public acceptability
- Consistency with other mechanisms/regulation

A brief definition of each is set out below.

18 The term "personal carbon allocation schemes" is used here rather than simply "personal carbon trading" to encompass those schemes (like Cap and Share) that do not require individuals to buy and sell allowances or surrender them in relation to the emissions associated with their purchases of energy or other goods and services.

Economic efficiency

The economic efficiency concerns the extent to which a given environmental outcome can be delivered at the least cost. The cost of achieving an outcome will be affected by where within the economy the reductions occur, be it reductions sought from all those covered by the mechanism or just those where the abatement costs are cheapest. Other concerns will include whether the mechanism rewards all abatement actions (for example whether measures in the transport sector encourage more efficient vehicle development, biofuels and less travel, or just one or two of these). Departures from ideal conditions could also be detrimental, for example the extent to which free allocation in a trading scheme could lead to a compliance culture where reduction opportunities are ignored. The costs of administering and participating in a scheme must also be taken into account.

An additional element is that of public engagement. All the schemes covered in this Chapter are mandatory. For that reason, the carbon emissions reductions they are designed to achieve should be guaranteed and not depend on public engagement. However, high levels of public engagement will ease the transition to a low carbon economy, as individuals will more likely be pro-active in seeking to reduce their own emissions, which may be cheaper than those to be made elsewhere in the economy. It will also decrease the administrative burden of 'educating' the public, a task which, to the extent it is not built into the scheme itself, would likely fall to Government at the expense of the taxpayers. On the whole, schemes which promote public engagement are preferable to those that do not, provided the associated costs are reasonable.

Environmental outcome

The ability of a mechanism to deliver a desired environmental outcome will be important. In this respect the difference between traded and non-traded schemes is most obvious, but other factors include whether a mechanism could suffer leakage (a reduction in activities covered and a

corresponding increase in those that are not) and whether the economic incentive is closely related to the environmental impact (the difference between a carbon tax and an energy tax for example).

Note that the criterion concerns the environmental outcome and does not cover environmental cost effectiveness (the quantity of emissions reductions achieved per unit of cost). This is considered as part of the overall economic efficiency of a measure.

Equity

The schemes and policies assessed in the present report are inherently equitable in that they apply the same approach to each individual (they do not, for example, target any particular sector to pay a disproportionate cost). However, since the introduction of a carbon policy will introduce new costs that certain sectors of society may not be able to afford, whilst others can, the review of each measure considers the extent to which, as a whole, the system compensates individuals for increased costs directly (as opposed to simply generating revenue for the exchequer). Lastly, Section 3.7 considers the generic issues relating to the distribution of costs and benefits.

Simplicity

In order for a measure to be effective simplicity must be a key concern. It must be easy for those participating to understand what is required of them and there should be minimal uncertainty over the benefit that will arise from carbon reducing activities.

Political/public acceptability

Measures that affect the general public directly and therefore demand a response from them will be particularly sensitive to how they are perceived. They will need to appear a just and effective way of meeting the environmental outcome, without creating perverse incentives or appearing to generate too much bureaucracy. In addition, public engagement promotes public acceptability, which in turn makes it more likely that a scheme will be politically acceptable in the long term.

Consistency with other mechanisms/ regulation

It is recognised that a coordinated approach to carbon policy is desirable and that carbon reductions need to be incentivised across the economy. When coupled with regulation of activities for other purposes, both environmental and non-environmental, there is potential for a complex and inconsistent policy landscape. The degree to which a new measure can be integrated with others will be important. The avoidance of overlap is the most obvious, but other factors will be the consistency of definition of regulated entities, calculation of environmental impacts (emissions factors), treatments of technologies (e.g. renewables) and so on.

In addition to these we considered legal feasibility of each option, as presented in available literature. However, this issue does not receive a great deal of attention and we have found no strong evidence that any of the options considered in this report should be ruled out on legal grounds. We do, however, consider in more detail the legal issues relating to Cap and Share in Section 5.

3.1 Cap and Share

Cap and Share was originally developed by the Foundation for the Economics of Sustainability (FEASTA)[19] and is a regulatory and economic framework for controlling the use of fossil fuels in relation to climate stabilisation. Accepting that climate change is a global problem and that there is a need to cap and reduce GHG emissions globally, the philosophy of Cap and Share maintains that the earth's atmosphere is a fundamental common resource. Consequently, it is argued, each individual should get an equal share of the benefits from the limited amount of fossil fuels that will have to be burned and their emissions released into the atmosphere in the period until the atmospheric concentration of greenhouse gases has been stabilised at a safe level.

19 www.feasta.org

A Study in Personal Carbon Allocation: Cap and Share

Applying the scheme at a national level, a cap would be set by an independent committee according to the latest guidelines and international agreements. Ideally, it would be set at least 5-10 years in advance. Under Cap and Share, all adults (see Section 5 for a discussion of the issues concerning allocation) would receive certificates entitling them to an equal share of the emissions permitted under that year's cap. Certificates would be distributed to individuals at regular intervals, and would then be sold, via banks or post offices, to those companies who import fossil fuels or extract them from the ground. (primary fossil fuel suppliers). Each of these primary fossil fuel suppliers would be required to acquire and surrender certificates equal to the emissions from the use of the fossil fuels that they introduced into the economy. By capping emissions at the upstream end of the supply system the price of emissions allowances is built into the price of fossil fuels, which then flows through the economy. However, whilst carbon intensive products and services become more expensive, individual consumers obtain an income from the certificates that they sell and are therefore compensated. Furthermore, the higher the carbon cost the greater the compensation.

The concept of Cap and Share covers both direct and indirect emissions, however, for this proposal, Cap and Share is considered for application only to direct emissions from individuals. Analysis against the criteria listed above is carried out in the following sections for Cap and Share applied to direct emissions only.

Cap and Share

Notes on Chart 3.1

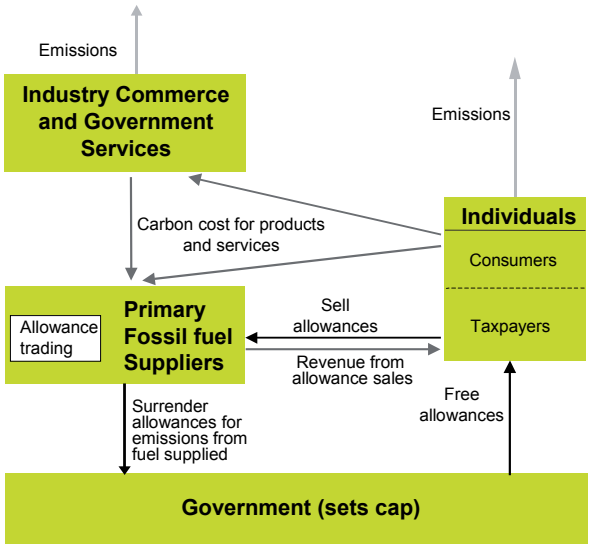
The red arrows show the flow of allowances. The blue arrows show the increased costs associated with goods and services under the scheme and the transfer of money when allowances are sold. This approach has also been adopted for diagrams illustrating other options later in this report.

The triangle of blue arrows shows that individuals pay the carbon cost for emissions either directly (in the case of purchases of petrol for example) or indirectly (in the case of goods and services provided by IC&GS).

Only the primary fossil fuel suppliers buy and surrender allowances. All other organisations (IC&GS) do not. To compensate for this, individuals gain revenue by selling their allowances to the PFFS.

Meanwhile the PFFS buy allowances (which they surrender in order to be allowed to introduce fossil fuels) and pass this cost on, in the form of the carbon cost, which they build in to the fuel price.

Chart 3.1: Description of Cap and Share Scheme



Economic efficiency

Cap and Share can be economically efficient, with potentially low set-up and administration costs.

The Cap and Share scheme considered here covers only direct emissions, therefore under such a scheme the cost of abatement would be spread mainly with the transport and domestic energy use sectors of the economy. It could be imagined that the incentive for abatement lies principally with the primary fossil fuel suppliers. However, by building the cost of abatement into the price of fossil fuels the whole of these sectors is exposed

to the elevated prices. It is reasonable to assume that the elevated cost would be passed on to the consumer creating a price signal in favour of low carbon products or services. As a result of this signal, the consumer would stimulate demand for lower carbon technology, and hence abatement, from these sectors. In such a way the incentive for abatement, for example in the transport sector, would be passed on to vehicle manufacturers through demand for more efficient vehicles.

Cap and Share as a scheme can be considered to be less costly than some other forms of personal carbon allocation. For example, set-up and operating costs are likely to be lower because the system would not require individuals to manage carbon budgets or surrender allowances associated with individuals purchases. Similarly, because only the emissions from primary fossil fuel suppliers will be regulated the administrative costs should be relatively low.

However, under Cap and Share individuals are not required to carry out a carbon budget, therefore the argument is raised that psychological engagement with the problem of climate change is less. Cap and Share has been referred to as an economic instrument that does not bring about the change in social norms that other more involved approaches might cause.

Environmental outcome

As a member of the carbon cap family, Cap and Share, as with the other schemes reviewed in this chapter, would lead to an assured environmental outcome.

Equity

The distribution of equal per capita emissions certificates make Cap and Share an equitable approach. The full compensation for individuals, on average, minimises adverse cost implications for vulnerable sectors of society.

Cap and Share is founded on the philosophy of equal rights for all to emit to the atmosphere. At the downstream end, it rewards individuals who consume electricity and fuel at below average levels, whilst those with greater than average carbon intensity will be penalised. This is consistent with the polluter pays principle. The introduction of Cap and Share would see full compensation to the population at large, with the value of certificates offsetting the increased costs of direct and indirect goods and services. It is more visibly equitable than a scheme in which some benefits lie with companies or in which revenues raised through the sale of allowances are simply treated as general taxation, since these last two would not necessarily see the value of the emissions falling to individuals on an equal per capita basis.

Simplicity

Cap and Share should be simple in design and relatively easy to implement, compared with some other personal carbon allocation schemes.

The imposition of a cap at the upstream end of the carbon flow through the economy is in practice much simpler than personal carbon allocation schemes employing downstream caps. As discussed under economic efficiency, monitoring and auditing of primary fossil fuel suppliers is relatively simple compared to the systems required to monitor and police the carbon transactions of each member of the population.

For members of the public, conceptually Cap and Share is more straightforward than some other personal carbon allocation schemes. In addition, there is no necessity under Cap and Share to understand carbon budgeting and trading processes. Individuals are required to understand only what the certificates are for and how they are processed. Having sold their allowances, they are no longer directly involved with the scheme.

Political/public acceptability

As a simple and un-intrusive scheme, Cap and Share is more acceptable than some other approaches.

It is anticipated that the Cap and Share proposal would engender a feeling of involvement in

solving the climate problem, since each of the certificates distributed to the population represents an entitlement to a share of the national carbon budget (if both direct and indirect emissions are covered by the scheme). However, there is no need to adopt a carbon budget and no obligation to have a personal carbon card. Furthermore, consumers do not face any explicit restriction on their purchasing decisions, other than existing limits set by price and their own financial constraints. Therefore, it could be argued that Cap and Share as a scheme would achieve greater acceptability among the public than other personal carbon allocation schemes.

Cap and Share is a relatively new concept that has yet to receive widespread attention and this unfamiliarity could present a drawback to its acceptance until more research into the concept has been performed[20], albeit similar arguments could be made regarding other personal carbon allocation options.

Consistency with other mechanisms/ regulation

Cap and Share would support existing mechanisms.

As discussed under other personal carbon allocation schemes addressing direct emissions, a Cap and Share scheme of this type could support existing measures in the transport sector, such as measures to increase vehicle efficiency standards, and in the domestic energy sector, through building regulations and appliance efficiency developments. As discussed in Section 3.7.2, the scheme would need to be consistent with the treatment of electricity generation in the EU ETS.

Summary of analysis

Cap and Share, based on the analysis above:

- Is economically efficient, with potentially low set-up and administration costs.
- Would lead to an assured environmental outcome.
- Would fully compensate for individuals, on average, therefore minimising adverse cost implications for vulnerable sectors of society.
- Should be simple in design and relatively easy to implement, compared with some other personal carbon allocation schemes.
- Is an un-intrusive scheme, potentially more acceptable than other personal carbon allocation approaches.
- Would support existing mechanisms.

The analysis of Cap and Share against the criteria in the previous sections is compared against other approaches in a SWOT analysis described in Table 4.1.

3.2 Tradable Energy Quotas

The Tradable Energy Quota (TEQ)[21] scheme operates by rationing the supply of fossil fuels (see Chart 3.2). A TEQ Budget is established (the Issue), setting a limit on annual carbon emissions over the next 20 years, which rolls forward week by week. A proportion of the annual Issue is distributed equally and at no charge to every adult. The remaining portion is sold by Tender, via banks and other outlets, to all other energy-users, including the Government. The Entitlement for individuals is calculated on the basis of households' direct consumption of fuel and electricity. This is taken for illustrative purposes below as 40%[22]. All fuels carry carbon ratings, and any purchaser must surrender carbon units to cover the rating of their purchase. All transactions may be carried out electronically and all carbon units are fully tradable.

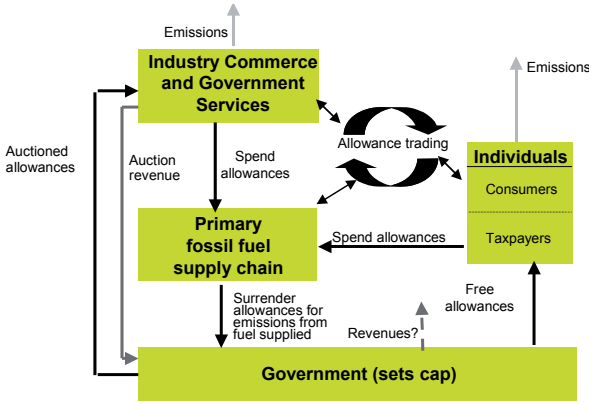
20 Matthews (2007).

21 Energy and the Common Purpose: Descending the Energy Staircase with Tradable Energy Quotas (TEQs), David Fleming, September 2007, http://www.theleaneconomyconnection.net/downloads.html#TEQs

22 Fleming uses the figure of 40% with reference to the consumption profile in the UK. A different figure may be applicable in Ireland.

Tradable Energy Quotas

Chart 3.2: Tradable Energy Quotas



TEQs grew out of Domestic Tradable Quotas (DTQs), and the two schemes are jointly analysed here as they operate using the same principles.[23] Recent academic literature on the subject, summarised below, refers to DTQs. While the term TEQs is used here, it should be read interchangeably with DTQs, as the analysis applies equally to both schemes.

Economic efficiency

Less cost-effective than an upstream approach, as administrative costs are high. However, they achieve greater public engagement.

Studies to date on the cost-effectiveness of TEQs have focused on the relative costs of implementing this kind of downstream scheme as compared to an upstream approach, assuming that both achieve comparable carbon savings. Simon Dresner argues that, from a distributional standpoint, there is little difference between auctioned upstream emissions trading, where the revenues are distributed equally among individuals, and a personal quota. However, he notes that administratively there is a significant difference. By making use of the existing tax system, the costs of an auctioned upstream tradable quota could be kept relatively low. By contrast, the administrative costs of a downstream personal quota system would be high, as each person would have to receive a secure 'carbon' card. In his opinion, the only reason for the additional expense and complexity 'is to get the public to think about the environmental impact of heating, using electricity and travelling.'[24]

Tyndall research has identified two additional potential benefits of TEQs as compared to an auctioned upstream tradable quota. The first is that the system may increase buy-in among the population to the task of reducing emissions and conceivably generate a greater sense of common purpose in relation to this task. It is further argued that individuals, when faced with the rationing of carbon, will develop their knowledge and expertise to maximise their gains under the system (i.e. by finding cost-effective measures to reduce their carbon emissions). The ability of TEQs to inspire and draw upon the ingenuity of all citizens may lead to a better and more cost-effective outcome than other instruments, where carbon calculations and trade offs are less visible.[25] The second is that, under this scheme, individuals are permitted to allocate their entitlements in the manner of their choosing (e.g. they could decide to offset). This latter point may not always prove a benefit in that too much offsetting within the scheme will lead to a scarcity of carbon units, which may in turn lead to an increase in prices.

Environmental outcome

The national cap guarantees carbon savings.

Unlike a carbon tax, which seeks to influence emissions indirectly through a price control, under a TEQ scheme, the annual cap on emissions is set each year. Consequently, the environmental outcome is assured. Embedded emissions (i.e. carbon emissions associated with the production and transportation

23 While there may be some differences in the scope of the two schemes, such as their respective treatment of electricity, it is beyond the scope of this paper to examine these differences in detail.

24 Dresner, S., *Distributional, Practical and Political Implications of Carbon Taxing and Trading*, paper delivered at workshop run by the UK Energy Research Centre, available at http://www.ukerc.ac.uk/Downloads/PDF/T/TandT_Simon_Dresner_economic_implications.pdf

25 *See generally* Tyndall Research 2005.

of goods) may not be reflected in the price where the good was manufactured outside of the Republic (i.e. in a country not covered by the scheme). This differs from the Rate all Goods and Services approach or Personal Carbon Rationing which are more comprehensive in their reach.

Equity

All individuals treated alike, yet potential for some not to be fully compensated for increased carbon costs, leading to impacts for vulnerable sectors.

Under the TEQ scheme, individuals are allocated carbon entitlements, at no charge, on an equal basis. However, the auction of allowances to commercial emitters means that, in the first instance, individuals would not be fully directly compensated for the increase in the costs of goods and services. The use of revenues by the Government could of course serve this purpose, but there is nothing about the design of the mechanism that guarantees this.

Simplicity

Like all downstream mechanisms which call for carbon accounting, a fairly complex administrative mechanism will be required. However, once in place, the automated accounting mechanism should be fairly simple to operate from the consumers' perspective.

From a conceptual standpoint, TEQs are relatively easy to understand. Each adult in the State is given an equal carbon 'allowance' and once she has expended that allowance, she must purchase additional units to cover the excess.

But simplicity here does not refer only to the idea. More important is the simplicity of the scheme in terms of its administration. Tyndall have considered the technical and administrative requirements of a TEQs scheme. These include:

- Building and maintaining a secure carbon database which can hold a carbon account for all eligible individuals and organisations.
- Enrolling individuals into the scheme and establishing and managing carbon accounts.
- Issuing and re-issuing carbon cards to individuals and organisations.
- Developing, installing and maintaining a system that can (i) enable the surrender of carbon units by carbon card and direct debit; (ii) allow both the remote and over-the-counter trading of carbon units; (iii) enable carbon statements to be obtained; and (iv) allow both the remote and over-the-counter transfer of carbon units between accounts.
- Developing systems to accurately carbon-rate various electricity mixes.[26]

Tyndall research has established that 'it is technologically feasible to build a TEQs scheme around the existing infrastructure for credit and debit cards. It advocates an approach known as 'electronic verification' to ensure successful administration of the TEQ scheme.[27]

However, it cannot be gainsaid that this downstream approach, involving millions of people, will require a far more sophisticated and complex mechanism to administer than would, for example, an upstream auction of tradable quotas.

Political/public acceptability

Public acceptability is likely to be good, as the scheme will be perceived as fair, particularly if the revenue from the sale of permits is recycled to consumers, as well as being reasonably easy to understand and use.

Tyndall suggests that the public acceptability of TEQ will depend on at least the following three factors: (i) the degree to which the scheme is perceived as fair, (ii) the degree to which it could be understood and (iii) how easy the public believe it would be to use.[28]

26 Tyndall Research 2005.

27 *Ibid.*

28 *Ibid.*

To take these factors one at a time. The equity aspects of the scheme were examined above. A person's perspective on the fairness of the scheme will depend very much on the model of distributive justice to which he or she subscribes. The Government will likely not be assured of convincing everyone of its intrinsic fairness. However, many perceive taxes to be unfair and yet there is general acceptance of the system of taxation, so this factor may not be critical to the scheme's success or failure.

The second factor Tyndall cites is whether the public understand the scheme. The scheme is undoubtedly fairly simple and intuitive. However, that is no guarantee that it will be widely understood. The Government will have an important role to play here in terms of educating the public about the benefits of the scheme and its overall objectives.

The third factor cited by Tyndall is probably the most important of the three – that of ease of use. It will not only be the public's perception that is important, it will be their initial experiences with the scheme. As the carbon transaction is likely to work in parallel with the cash transaction, it would require nothing extra in terms of a transactional commitment from the consumer. Rather, he or she would only notice that the cost of petrol or electricity was a little higher on account of the additional cost of the carbon content. As Tyndall notes, 'the process of surrendering units (via plastic card or direct debit) is convenient and familiar.' Even trading units of carbon would likely involve online, telephone or over-the-counter transactions, all of which are familiar to an average consumer. The easier and the more familiar the modes of transacting in this new currency, the greater the acceptability of the scheme is likely to be.

Consistency with other mechanisms/ regulation

As discussed in Section 3.7.2, the scheme would need to be consistent with the treatment of electricity generation in the EU ETS.

Summary of analysis

TEQs, based on the analysis above:

- Are less cost-effective than an upstream approach, as administrative costs are high. However, they achieve greater public engagement.
- Would guarantee carbon savings.
- Would not fully compensate individuals, on average, for increased carbon costs, leading to impacts for vulnerable sectors.
- Like other downstream measures, would require a fairly complex administrative mechanism, but once in place should be fairly simple to operate from the consumers' perspective.
- Would be perceived as fair, particularly if the revenue from the sale of permits is recycled to consumers, as well as being reasonably easy to understand and use.

The analysis of TEQs against the criteria in the previous sections is compared against other approaches in a SWOT analysis described in Table 4.1.

3.3 Personal Carbon Rationing

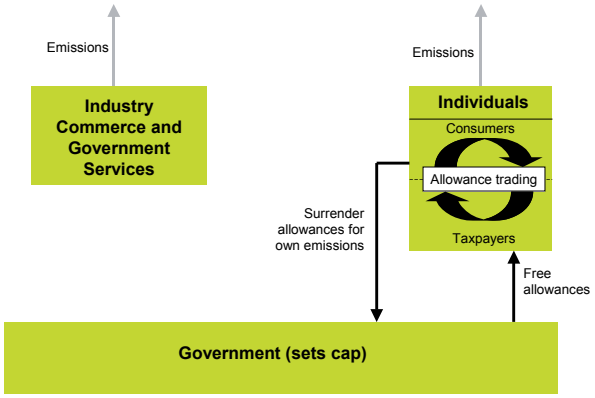
Personal Carbon Rationing (PCR) or Personal Carbon Allowance (PCAs) was introduced by Hillman and Fawcett (2004)[29] as a solution for the UK's role in a global agreement to reduce carbon dioxide emissions. It is a proposal for domestic carbon rationing and trading for individuals only. The carbon cap implemented would cover individual's direct emissions (all household energy use and personal travel, including aviation) and the cap would be reduced over time to reflect the national emissions reduction target, signalled well in advance. Ideally, equal rations would be allocated to all adults with exceptions to this allocation limited as far as possible. The system would be administered via an electronic card, issued to each individual, containing the annual carbon credits

29 Hillman, M., and Fawcett, T., *How we can save the planet*, Penguin Books, pp. 126 – 133, 2004.

for that person. The card would then be debited whenever energy or travel services are purchased. This proposal is considered similar to TEQs as applied to households, with the exception that air transport is rationed here. The scheme is illustrated in Chart 3.3.

Personal Carbon Rationing

Chart 3.3: Personal carbon rationing



Economic efficiency

Less cost-effective than an upstream scheme, PCR involves high set-up, administration and enforcement costs.

PCR requires that emission reductions are made in the energy or transport sectors. The cost effectiveness of seeking emissions reductions within these sectors would depend on the costs of abatement relative to abatements costs in other sectors. Since a separate policy would be required for other sectors and without trading between them, PCR would be inherently less efficient than a scheme with wide coverage.

Within the transport sector and domestic energy sectors, however, since end-users are the affected party there will be demand for abatement from all actors in the supply chain (compared for example with motor manufacturer emissions standards which would not impact end user behaviour). Fawcett et al. (2007) argue that this approach should be economically efficient as it will encourage lower cost carbon abatement to be undertaken first[30].

Regarding costs, there is a significant set-up and administration burden for this proposal, for example:

- Each individual would require a 'carbon currency' account;
- Banking infrastructure would need to be in place to enable transactions to be carried out using the envisioned 'carbon card';
- A trading system, accessible to the entire population, or agents operating on their behalf, would have to be established, such that emission allowances could be traded at the consumer level.

Participant costs would, initially at least, also be considerable as a significant amount of each individual's time would be taken up developing an understanding of the scheme and furthermore, monitoring and balancing their carbon accounts. The scheme does not cover emissions generated by organisations, it is assumed that another instrument will be implemented to address this and with that comes a further administrative burden.

Environmental Outcome

The national cap guarantees reduction in personal direct emissions creating the incentive for individuals to reduce the carbon-intensity of their lifestyles. Personal indirect emissions are not addressed by PCR.

The PCR scheme targets individual's direct emissions (in Ireland residential and transport sectors account for only 27% of total greenhouse gas emissions). Therefore, even a significant reduction within the sectors covered by PCR would have a much smaller impact on overall emissions than a scheme with economy-wide coverage. Nonetheless, a unit emission reduction is equivalent irrespective of what sector of the economy it arises from. And furthermore, PCR does have the potential to be more powerful than a simple economic instrument. By changing people's relationship with their carbon emissions

30 Fawcett, T., Bottrill, C., Boardman B., and Lye G., *Trialing personal carbon allowances*, UKERC Report No.: UKERC/RR/DR/2007/002, December 2007. See: http://www.eci.ox.ac.uk/research/energy/downloads/fawcettpca07.pdf

PCR could engender greater interest in and ability to reduce emissions potentially driving a change in social norms to favour lower carbon lifestyles[31].

Equity

The distribution of equal per capita emissions certificates make the scheme equitable. The full compensation for individuals, on average, minimises adverse cost implications for vulnerable sectors of society.

Simplicity

A fairly complex administrative system is required for PCR as is the case with other downstream schemes. From the individual's perspective, once established PCR should be fairly simple to operate.

Conceptually, this proposal is relatively straightforward. An equal per capita ration is allocated to each individual and that ration is debited when carbon covered by the scheme is purchased. Practically, the method of making carbon transactions is also straightforward. However, as was discussed under the heading economic efficiency, administration and set-up of the scheme is more complex and communication about the scheme and awareness raising about the surrounding issues would be critical.

Political/public acceptability

Public acceptability will be reasonable since it should be perceived as fair. However, concerns may be raised that the onus of emissions reduction is applied to personal emissions only.

This measure is aimed a individual's direct, personal emissions and it may be that PCR would be perceived as a just and effective mechanism for reducing such carbon emissions; the scheme does not appear to generate too much bureaucracy. However, it is likely be construed as intrusive and there is a concern that individual will question the emphasis on abatement of personal emissions whilst the rest of the economy remains unaffected by the scheme, since that unaffected sector of the economy accounts for a greater proportion of the overall emissions.

Consistency with other mechanisms/ regulation

Fawcett (2007a) point out that PCR would complement rather than replace existing policies, such as energy efficiency standards in appliances and transport, and building regulations. As discussed in Section 3.7.2, the scheme would need to be consistent with the treatment of electricity generation in the EU ETS.

Summary of analysis

PCR, based on the analysis above:

- Is less cost-effective than an upstream scheme, with high set-up, administration and enforcement costs.
- Guarantees an environmental outcome.
- Would fully compensate individuals, on average, minimising adverse cost implications for vulnerable sectors of society.
- Would require a fairly complex administrative system, as is the case with other downstream schemes. However, from the individual's perspective, once established PCR should be fairly simple to operate.
- May have reasonable public acceptability, compared with other options since it should be perceived as fair. However, concerns may be raised that the onus of emissions reduction is applied to personal emissions only.
- Could compliment other policies.

The analysis of PCR against the criteria in the previous sections is summarised in a SWOT analysis described in Table 4.1.

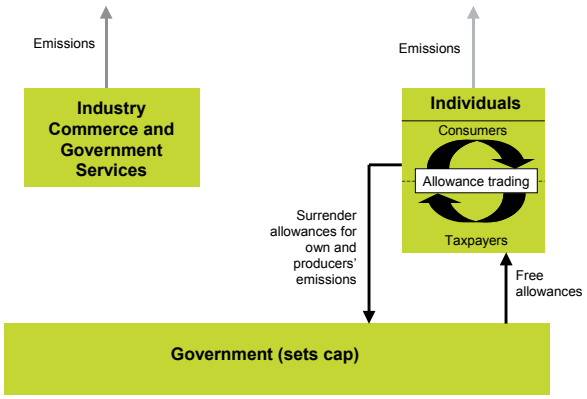
31 Fawcett, T., Your own tonnes of carbon; *Personal carbon allowances*, 2007a. See: http://www.eci.ox.ac.uk/publications/downloads/fawcett07-pca.pdf

3.4 Rate All Products and Services

This proposed personal carbon trading scheme aims to address all carbon emissions across the economy (see Chart 3.4). 100% of emission rights would be allocated and carbon ratings would be calculated for all products and services, not just fuel and electricity as is the case for many other proposed schemes[32]. Whenever an individual purchased any product or service, allowance units would be surrendered that would cover the emissions arising from the manufacture and transport of that product, or provision of a service. Therefore, individuals would surrender carbon units for both their direct and indirect emissions.

Rate All Products and Services

Chart 3.4: Rate all Products and Services



Economic efficiency

Too complex to implement in short to medium term.

At present, it is unfeasible to calculate the carbon rating of all products and services within an economy. In other words it cannot be shown to be cost effective; Starkey and Anderson (2005) suggest that the provision of a cost-effective and easy to use scheme of this type is unlikely to be achievable in the short to medium term, a view reiterated by Roberts and Thumin (2006).

However, as a long-term option proposed for a comprehensive approach to addressing climate change it has some merits. For this reason we assess the option against the remaining criteria below.

Environmental outcome

Potential far-reaching guaranteed environmental outcome.

Under the RAPS scheme, the costs of GHG reductions would be encountered across all sectors of the economy and the incentive to abate emissions would be passed through all sectors. On the issue of carbon leakage, whereby carbon intensive industries relocate to an economy within which there is no price attached to the carbon emissions produced, rating all products and services could take this into account. The carbon rating for a product or service would probably need to include all carbon emissions, irrespective of location, arising from provision of that product or service.

It could be argued that rating all products and services would provide the means of achieving the most widespread environmental outcome because under this proposal all goods and services available within the economy would be valued at their true environmental cost, in whole life-cycle GHG emission terms. The opportunities for emissions reductions would therefore be greatest.

Equity

The distribution of equal per capita emissions certificates make the scheme an equitable approach. The full compensation for individuals, on average, minimises adverse cost implications for vulnerable sectors of society.

Carbon rating all products and services is a highly equitable method of assigning the cost of carbon across the economy since everything is valued on the same basis. In addition, because of the comprehensive scope of the scheme, no sectoral advantage is gained at the expense of others. The scheme scores well on an equity basis since all of the scheme allowances are distributed freely and equally to all individual participants.

32 Starkey and Anderson (2005).

Simplicity

As has been touched upon under the discussion of economic-efficiency, RAPS is unfeasibly complex to implement at present.

Political/public acceptability

It is reasonable to assume that implementing a RAPS scheme would bring about a significant revaluation of living costs for a large proportion of the population to which it is applied. Given this assumption, it follows that there may be substantial opposition to such a large economic change. It could also be imagined that a certain amount of opposition would focus on the efforts that would have to be made to carbon rate those goods or services that result in low carbon emission levels.

Consistency with other mechanisms/ regulation

As discussed in Section 3.7.2, the scheme would need to be consistent with the treatment of electricity generation in the EU ETS.

RAPS, based on the analysis above:

- Is too complex to implement in short to medium term.
- Offers the potential for a far-reaching guaranteed environmental outcome.
- Would fully compensate individuals, on average, minimising adverse cost implications for vulnerable sectors of society.
- Could be unfavourable because of its widespread shift in the costs of goods and services.

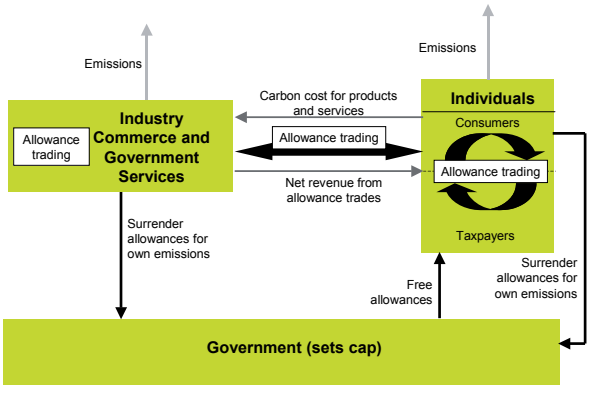
3.5 Ayres scheme

The Ayres scheme[33] was articulated in the mid-1990s and is the forerunner of many of the more recent tradable quota schemes discussed here. Under the Ayres scheme a national cap is set on carbon emissions. 100% of the resulting emissions quotas are allocated to individuals. Both individuals and organisations are treated equally under the scheme (organisations purchase their emissions quotas from individuals on a carbon market).

These tradable emissions quotas are then surrendered in connection with both the purchase and the manufacture/processing of all goods. The Ayres scheme is different to RAPS since organisations/industry would be responsible for surrendering emissions quotas sufficient to cover direct emissions associated with the manufacturing process. Individuals/consumers would be responsible for surrendering emissions quotas sufficient to cover any remaining emissions embedded in the final product. For example, a fuel supplier would be responsible for the emissions associated with the extraction, transport, refinement and supply of petrol, whereas the consumer would cover the emissions associated with 'consuming' the fuel (i.e. the carbon content of the fuel itself). Ayres advocates leaving to manufacturers the task of evaluating the carbon emission content of each product (based on a standardised methodology, subject to regular audits).

Ayres Scheme

Chart 3.5: Ayres Scheme



The similarities between the Ayres scheme and RAPS are such that much of the criteria analysis is equivalent and therefore the analysis above for RAPS may be considered applicable to Ayres. However,

33 Ayres, Robert, *Environmental Market Failures: Are there any local market-based corrective mechanisms for global problems?* (CMER, INSEAD, Fontainebleau, France, 1996).

the Ayres scheme could be considered to be more complex than the RAPS scheme since organisations would have to account for the emissions arising from their part in the provision of goods and services. It follows then that the most significant difficulty of the RAPS scheme, is that it is currently unfeasible to implement, is also applicable to the Ayres scheme.

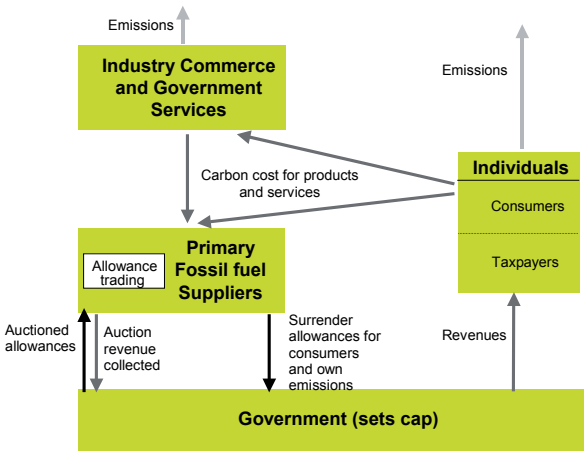
3.6 Sky Trust (now more commonly referred to as Cap and Dividend)

Under the Sky Trust proposal[34], a US initiative, all entities importing fossil fuel into the economy would be required to procure sufficient emission permits to cover the carbon content of the fuel. The Government or an independent trust would set an annual cap on emissions permits, which would decrease year on year. All permits would be auctioned, with auction proceeds flowing into a fund separate from the general treasury. This fund would distribute the auction proceeds in equal monthly dividends to all adults, mainly by transferring money directly into their bank and debit card accounts. Whilst there have previously been suggestions of a version in which some auction revenues are used to preferentially support lower income households, this is not assumed to be a part of the scheme assessed here, although distributional aspects are discussed in Section 3.7 in the context of issues common to all personal carbon allocation schemes.

Peter Barnes, founder of Working Assets, a socially-responsible investment fund, has become the leading advocate for a Sky Trust approach, following the publication of his 'Citizen's Guide' to carbon capping in November 2007.[35] While public debate in the US appears to be picking up on the idea, this has yet to be reflected in any Congressional proposals.

Sky Trust

Chart 3.6: Sky Trust



Economic efficiency

Cost-effectiveness is enhanced by low administrative costs (likely the lowest of any of the emissions trading schemes). This system also generates incentives to move to low-carbon goods, through price signal. Lack of public engagement in carbon accounting leads to less carbon savings from this sector. There is potential for government interference in revenue spend.

From an administrative standpoint, the Sky Trust scores well. By operating upstream to stem carbon emissions at the point of entry to the economy, Sky Trust only requires a simple mechanism to administer it. This is particularly apparent since the number of entities that would need to be regulated under this scheme is far fewer than the number required under many other schemes. Efficiency is also served as, under the scheme, the price of all goods and services will evolve to reflect the carbon price associated with their manufacture or delivery. This will make it easier for customers to identify low-carbon substitutes using the price signal. As the price of carbon increases, both industry and consumers will shift away from carbon-intensive goods and practices and towards low-carbon growth.

However, Sky Trust, as an upstream solution lacks the advantages of engaging more directly with the

34 http://www.capanddividend.org/files/WP150.pdf

35 Available at http://www.capanddividend.org/

public to educate them about carbon emissions (as, for example, in schemes requiring personal carbon accounting, where individuals are made aware of the carbon 'cost' of different options). Consequently, it is less likely that behavioural barriers would be overcome, potentially meaning that some low cost reductions are not realised, leading to lower overall economic efficiency.

Environmental outcome

The national cap guarantees carbon savings. The upstream cap permits comprehensive coverage of all sectors in the economy.

As a member of the carbon cap family, Sky Trust, as with the other schemes reviewed in this chapter, would lead to an assured environmental outcome. The amount of carbon is capped at a national limit each year and that amount would decrease year on year. Another benefit of the scheme is that it is designed to provide comprehensive, economy-wide coverage of all sources of carbon emissions.

Equity

Sky Trust is designed to compensate consumers for price increases for goods and services that are expected to accompany a national carbon cap. From an equity perspective, the scheme scores well in that the full value from the sale of permits is returned to individuals on an equal per capita basis.

Simplicity

A simple scheme, requiring administration of an upstream auction of carbon permits and disbursement of revenue, through monthly electronic transfers.

As discussed above, Sky Trust targets carbon emissions upstream. As the introduction to the scheme states: "This "up-stream" approach is much simpler and more efficient than a "down-stream" system. Carbon, like money, is ubiquitous in our economy, and applying a down-stream system would involve millions of small and mid-sized emitters. By contrast, there are far fewer companies at the head of the carbon stream."[36] On the revenue distribution side of it, the trust would distribute the money equally to all legal residents. This would be done by electronic transfer therefore staff costs would be relatively small.

Political/public acceptability

Public acceptability is likely to be high as a result of the generous compensation for rising prices, coupled with the simple logic underpinning the scheme.

In relation to TEQs, Tyndall suggested that public acceptability will depend on at least the following three factors: (i) the degree to which the scheme was perceived as fair, (ii) the degree to which it could be understood and (iii) how easy the public believed it would be to use.[37] The same factors will be used here to consider the acceptability of the Sky Trust.

The equity aspects of the scheme have been addressed. It is highly likely that, given the benefits that would accrue on an equal basis to individuals under the scheme, people would deem it to be fair (in particular in comparison with a system where emissions-based revenues went to the State). Although consumer prices would rise under the scheme, those who consume at below average levels would be fully compensated for the increase.

In relation to the second factor, that is, the ease with which the system can be understood, the Sky Trust is appealing in its simplicity. People are likely to accept higher prices if they can see that they are being compensated for them. It is likely that people will also understand and approve the concept of the Sky as a common heritage; an asset belonging to people rather than industry or Government.

The third factor is the public's perception of ease of use. Under Sky Trust, the public need not take any action – they will receive compensation automatically. To the extent they wish to maximise their gain on the revenue, they will be aware

36 Available online at http://www.cfed.org/focus.m?parentid=34&siteid=47&id=93

37 *See* Tyndall Research 2005.

that they can adopt measures to reduce their carbon emissions which should amount to lower expenditure. This follows as the price of goods and services will reflect the level of their carbon content.

On all three factors then, the Sky Trust scores well and is likely to experience a high level of public acceptability.

Consistency with other mechanisms/ regulation

As discussed in Section 3.7.2, the scheme would need to be consistent with the treatment of electricity generation in the EU ETS.

Summary of analysis

The Sky Trust, based on the analysis above:

- Would have relatively low administration costs, but relative lack of public engagement.
- Would guarantee carbon savings via the national cap.
- Would fully compensate individuals, on average, minimising adverse cost implications for vulnerable sectors of society.
- Is a simple scheme, requiring administration of an upstream auction of carbon permits and disbursement of revenue, through monthly electronic transfers.
- May have high public acceptability as a result of the generous compensation for rising prices, coupled with the simple logic underpinning the scheme.

The analysis of the Sky Trust against the criteria in the previous sections is compared against other approaches in a SWOT analysis described in Table 3.1.

3.7 Common aspects

This section reviews those issues which relate, or potentially relate, to all of the schemes discussed above:

3.7.1 Emissions coverage

Whilst some schemes have been promoted with particular emitting activities in mind, there is no reason in principle why the mechanisms proposed could not be applied to all sectors of the economy, since any obstacles relating to the requirement to monitor or calculate emissions should ultimately be surmountable. When assessing the design of the schemes it therefore does not seem logical to judge them on coverage. What's more, if a scheme were to cover only transport emissions, for example, then it would not necessarily be less effective at achieving reductions in that sector than one that also covered other sources.

That said, it is useful to note which sectors would be covered by the most common representation of each of the schemes discussed above:

- The Cap and Share scheme could be applied to any sector in principle, albeit the focus is commonly on transport for practical reasons regarding emissions growth in that sector and the lack of other regulation.
- TEQs is proposed to cover all fossil fuel sources.
- PCR is proposed to cover individuals' direct emissions.
- RAPS would cover all emissions within the economy.
- The Ayres scheme is proposed to cover all emissions within the economy.
- The Sky Trust (Cap and Dividend) would cover all fossil fuel sources.

3.7.2 Consistency with other mechanisms

The most significant area of overlap between a personal carbon allocation option and other regulation is in the treatment of electricity. The emissions associated with the generation of electricity are already covered by the EU ETS through the regulation of power stations, therefore any personal carbon allocation scheme that also

attributes emissions to electricity consumption would be double counting these. Solutions to the double counting issue, depending on the personal carbon allocation scheme being considered, would include:

- Exempting electricity generation from the EU ETS, where the new trading scheme covers all electricity consumed across the economy. This would be difficult to achieve politically since electricity generation is one of the main areas of the EU ETS and such exemptions are not permitted by the existing EU legislation.
- Exclude electricity consumption for downstream trading schemes (Ayres, RAPS, PCR, TEQs).
- Exclude fuel imported for the purposes of electricity generation in upstream measures (Cap and Share, Sky Trust).

3.7.3 Distribution aspects

The schemes above differ in terms of how much of the value of the emissions allowances are given directly to individuals and how much, if any, is treated as general taxation with a more nebulous outcome. However, common to each of the options is that they generally treat individuals equally, although there are two particular aspects relevant to each and worth noting:

- Most schemes see the value of emissions allowances distributed to adults. Although there is no specific reason in principle why children could not be treated in the same way, the treatment of children does raise equity concerns. Children do not make energy/fuel purchasing decisions and their purchasing in general will be small compared with that of adults. On the other hand, they do make consumption decisions, and their consumption would lead to an increased cost for parents in a personal trading scheme. In practice, the treatment of children, wherever the boundary is drawn, will raise equity concerns. However, these will not necessarily be any greater for personal trading schemes than for the non-trading approaches discussed in Section 4. The issue of allocation to children is discussed in the context of Cap and Share scheme design in Section 5.3.2.
- Distributional aspects and individual wealth. As with children above, the personal trading schemes treat everyone equally (and hence fairly) and do not necessarily disadvantage lower income households any more than non-trading options. Indeed, low income households are more likely to have lower energy bills and therefore profit compared to those on higher incomes. However, some on lower incomes with high energy needs will incur increased costs and will be less able to afford these compared with those with a higher disposable income. This raises the question of whether an uneven distribution of allowances, favouring lower income households is justified (see for example John Rawls, A *Theory of Justice* (Harvard University Press 1971). The design issues in relation to the Cap and Share option are discussed in Section 5.1. More generally the options for benefiting those on lower incomes, each of which would be detrimental to the simplicity of the schemes, include:
  - A greater than average distribution of allowances is given to those on lower incomes (with less going to those better off). This could be applied to all the schemes above, except the Sky Trust which does not allocate freely to individuals.
  - Paying some of the revenue from auctioning allowances directly to those on lower incomes, either as a cash transfer or an increase in welfare payments. This could apply to TEQs or Sky Trust, for which the adjustment would be to skew the basic revenue payments.

3.7.4 Environmental effectiveness

When viewed in isolation schemes which place a value on carbon emissions (the personal carbon allowance schemes discussed here and the carbon tax in the following section) should deliver the same environmental outcome for a given carbon price. However, the distribution of the value of emissions permits to individuals within allowance schemes might be viewed as a missed opportunity, since the sale of such permits, or revenue generated by taxation, could be used to achieve further emissions reductions. In this context the following should be taken into account:

- If government wished to support carbon reducing initiatives then the options of generating revenue from the sale of allowances compared with separate additional taxes could turn out to be similar. The revenues must be raised from somewhere and selling emissions permits would not necessarily have a lower economy-wide impact compared with taxes.
- If a trading scheme is to be introduced then the generation of revenue from the sale of emissions permits for the purposes of supporting further carbon reductions might be more politically acceptable, simpler and auditable, than raising revenues through a separate additional taxation measure.
- With trading schemes that cover the entire economy there should be no need for additional government financial support for low carbon options. Under a capped scheme there would be no environmental benefit from separate supporting measures since additional savings in one area would be offset by fewer savings in another (possibly with a net overall cost to the system).

3.8 SWOT Table

The Strengths and Weakness below are the main outcomes of the assessment against the criteria of economic efficiency, environmental outcome, equity and simplicity, since these relate to the design of the mechanism. The Opportunities and Threats are the outcomes of the assessment against the criteria of acceptability and consistency since these relate to the mechanism in a broader context.

Table 3.1 SWOT Table analysis of personal carbon allowance approaches*

Scheme/Instrument	Strengths	Weaknesses	Opportunities	Threats
Cap and Share	• **Administration costs are low relative to many other forms of personal carbon allocation schemes** • **Caps emissions with guaranteed outcome**	• Engagement of the public in understanding carbon emissions and driving changes to behavioural norms is less than many other personal carbon allocation schemes	• Simple and unobtrusive	• As a newly established concept, unfamiliarity might reduce acceptability
Tradable Energy Quotas/Domestic Tradable Quotas	• Comprehensive coverage of economy • **Scheme develops public awareness of personal carbon use which encourages individuals to act independently to reduce their emissions** • **Caps emissions with guaranteed outcome**	• **Relatively high administrative and transaction costs** • **To the extent that the revenues from the sale of TEQs are not recycled back to consumers they will bear the full cost of their indirect emissions** • The embedded carbon in imported goods is not covered under the scheme, thereby reducing its environmental impact	• Revenue raised from the sale of TEQs could be used to further support environmental initiatives and investment	• As a newly established concept, unfamiliarity might reduce acceptability
Personal carbon rationing	• Requires an understanding of carbon emissions from the economy and it is hoped this engagement will drive behavioural change. • Equal per capita rationing maintains equity and individuals whose contribution is average or below will benefit from the scheme • **Caps emissions with guaranteed outcome**	• **Set-up and administration costs are high.** • **The scheme is complex and would involve a significant amount of individuals' time.** • **Only covers personal direct emissions**	• A PCR scheme would compliment existing measures	• PCR would be intrusive and potentially unpopular • As a newly established concept, unfamiliarity might reduce acceptability

Scheme/Instrument	Strengths	Weaknesses	Opportunities	Threats
Rate all Products and Services/Ayres Scheme	• **All emissions across all sections of the economy are covered by the cap** • **Caps emissions with guaranteed outcome**	• **Requires a highly complex system of accounting for carbon content of goods and services, currently unfeasible**	• The scheme will raise public awareness, by highlighting the carbon emissions associated with goods and services	• Implementing a RAPS scheme would be very intrusive on current lifestyles and therefore relatively unpopular • Very substantial legislation would be required to support the scheme • As a newly established concept, unfamiliarity might reduce acceptability
Sky Trust	• **Administration costs are low relative to many other forms of personal carbon allocation schemes** • Individuals receive high level of compensation for additional costs due to rising prices • **Caps emissions with guaranteed outcome**	• **This upstream approach lacks the benefits from awareness raising that would arise under a personal carbon trading system**	• The simplicity of the scheme for individuals, combined with its compensation mechanism, will enhance its public acceptability	• State revenue collection and distribution raises the potential for Government interference in the scheme

* The more significant issues are highlighted in bold.

Chart 3.7 is a simplistic representation of how the various policy options rate against the most important factors that should be considered. It is based on the four primary criteria (economic efficiency, environmental outcome, equity and simplicity) used to asses the measures in this report. However, we have split economic efficiency into two elements: cost effectiveness and public engagement. This reflects the importance of public engagement in delivering efficient emissions reductions at an individual level (for example by improving awareness of the issues and options and by focusing individuals on their responsibility to cut emissions).

Equity is a subjective factor and there will inevitably be a spectrum of views on the most important elements. The following should be noted:

- The ability of a scheme to compensate individuals for increased carbon costs has been taken into account, with those that offer such compensation scoring well. It is debateable whether this need be an objective in principle, since one could argue that individuals should pay the costs associated with damage to the environment from the goods and services they consume. However, the introduction of a new policy that increases costs to consumers has the potential to disadvantage those who can least afford to pay, such as those on lower incomes. Consequently the ability of a measure to compensate individuals has been included in the figure as a practical consideration against the equity criterion. It would also prove important in gaining public acceptability.
- With the above in mind, schemes that generate revenue for Government, but do not specify how this would be used, score less well in our analysis.
- The treatment of equity is very simplistic and doesn't generally take into account the ultimate impact on individuals (such as workers) from placing the carbon costs on businesses.

The approach implicitly places equal weighting on each criterion. Depending on perspective alternative weightings might seem appropriate.

Chart 3.7: Comparison of Personal carbon allocation schemes

Scheme	Cost Effectiveness	Public Engagement	Environmental Outcome	Equity	Simplicity
Personal carbon allocation schemes					
Cap and Share					
DTQs/TEQs					
PCR					
RAPS					
Ayres Scheme					
Sky Trust					

Note: refer to discussion above figure for issues relating to definition of equity.

KEY: Relative performance against each criteria				
Strong				Weak

On the basis of our simple multi-criteria and SWOT analyses the following conclusions can be drawn with respect to the personal carbon allocation schemes:

- The schemes that treat individuals as an emitting entity (Tradable Energy Quotas, Personal Carbon Rationing, Rate All Products and Services and the Ayres Scheme) look the least appealing, because of their complexity and the resulting costs.
- Of those schemes, however, TEQs and PCR are less complex and costly.
- Most of the schemes can provide individuals on average with full compensation for increased carbon costs, with the exception being TEQs, which is the only scheme for which all of the allowances (or the value of them) are not allocated freely to individuals.

- The above suggests that PCR would currently be the favoured approach amongst the options for which individuals trade allowances. The decision between PCR, say, and the approaches of Cap and Share and Sky Trust is a balance between the improved public engagement of the first and the better cost effectiveness and simplicity of the last two. Overall, currently, Cap and Share and Sky Trust appear favourable to PCR, although we have not assessed the full cost effectiveness of the last two.
- If Cap and Share and Sky Trust were favoured, the decision between the two is quite finely balanced. Cap and Share would seem to offer better public engagement although the resulting costs of engagement at an individual level would probably make it more expensive to implement than the Sky Trust.

4 Policy approach – non trading options

Policymakers have a choice between types of instruments that can be used to achieve a reduction in carbon emissions. As well as the trading alternatives discussed in the previous section the suitability of a Cap and Share scheme also needs to be assessed in relation to the relative strengths and weaknesses of non-traded policy tools.

This section builds on our analysis from Section 3 and compares the main non-traded approaches. The OECD (1989)[38] group the instruments that can be used to encourage a reduction in pollution into the three categories of regulation, economic instruments, and voluntary and responsibility raising measures. The Stern Review (2006)[39] also looked at the tools available to policy makers, and identified cap and trade, a carbon tax and regulation as the ways to establish a carbon price and deliver a reduction in emissions. Most of the recent literature evaluating the policy tools that can achieve a reduction emission tends to focus on the market-based instruments[40], comparing traded schemes to carbon taxes. This has provided some useful insight, and the following analysis has been compiled from research and literature published by the Royal Society, Defra, the Tyndall Centre and other academics.

The assessment below provides descriptions and analysis of a carbon tax, regulations[41], voluntary schemes, and increases in fuel excise duty. This is followed by a brief discussion of other policies. Finally a SWOT analysis of the main options and a summary chart are provided to enable the instruments to be easily compared.

The options are assessed using the following criteria, which were defined previously in Section 3:

- Economic Efficiency
- Environmental outcome
- Equity
- Simplicity
- Political and public acceptability
- Consistency with other mechanisms/regulation

4.1 Carbon tax

A carbon tax is a charge by the government placed on energy sources that emit carbon dioxide; it reflects the carbon intensity of the fuels used. It can be implemented in various ways and can be placed on individuals or companies, and they can also be imposed on specific fuels or sectors. For example Sweden's carbon tax is on the use of oil, coal, natural gas, liquefied petroleum gas, petrol, and aviation fuel used in domestic travel, whereas the manufacturing industry pays a reduced rate and certain high-energy industries are fully exempted from the tax.

It is a price-based instrument that provides certainty about the cost of compliance with the policy but does not set the level of emissions. The carbon tax increases the cost of products/services whose consumption gives rise to emissions and provides an incentive for individuals to select lower carbon alternatives, provided they are cheaper once the cost of the tax is taken into account. Depending on the market's responsiveness to price the level of the tax should result in an adjustment to the level of demand of those goods and services which are subject to a carbon tax and provide an incentive to move towards new technologies.

38 OECD (1989) Economic Instruments for environmental protection. OECD Paris.

39 Sir Nicholas Stern (2006) Stern Review on the Economics of Climate Change HM Treasury & Cabinet Office London. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

40 Market based instruments tackle pollution reduction without setting technology or methodology they instead establish price signals that affect the behaviour of market participants.

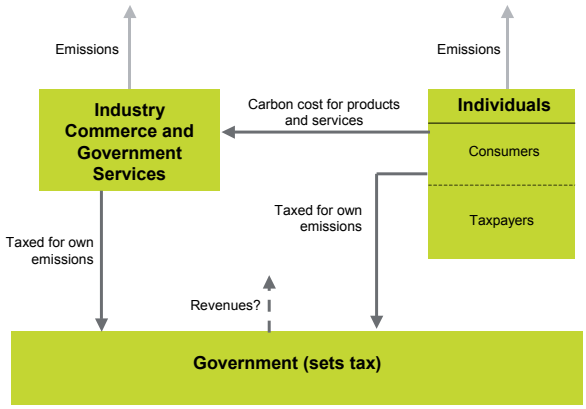
41 Regulations are legal orders imposed by the government, for example requiring compliance to a certain standard or the imposing of a certain technique.

A Study in Personal Carbon Allocation: Cap and Share

The Royal Society (2002)[42] looked at the implementation of carbon taxes in Finland, Norway, Sweden, Denmark and the Netherlands, they found that in all countries due to competitiveness concerns tax rebates, exemptions or reductions were introduced.

Carbon Tax

Chart 4.1: Carbon tax



Economic efficiency

A carbon tax is considered more efficient than regulation, has relatively low administration and transactions costs and provides an incentive for innovation in low carbon technologies.

Defra (2006) observe that in theory a carbon tax should achieve the same economic efficient outcome as a trading scheme if the costs of compliance are known, allowing it to be set at an appropriate level. However it can be near impossible to set the tax at the right level to determine the environmental outcome, as discussed below. A strength in comparison to regulation identified by Hanley (1997)[43] is that the benefits for those who invest in abatement systems are greater under taxation than regulation, thereby providing a greater incentive for innovation.

The costs of administration for a tax are dependent on how the tax is applied, however tax schemes are usually associated with low administration and transactions costs, Fitz Gerald et al (2001)[44] comment that in Ireland the administration for excise taxes is already in place, well understood and cheap to run. They also have the ability to reduce windfall profits that can arise in industrial sector level trading schemes.

The revenues from the scheme could be recycled to offset the regressive nature of the tax, and offer a reward for improved behaviour and more environmentally friendly consumption decisions. The revenues can also be hypothecated for example in the case of transport for investment in public transport or research into low carbon alternatives, improving economic efficiency. However there could be an overall decrease in economic efficiency due to government intervention in the market. Attempting to pick winning technologies and using the revenues to subsidise certain low carbon alternatives might not lead to the cheapest most efficient options being used.

Finally, taxes have the potential to offer greater level of investment certainty for industry since, although vulnerable to change, they should provide a less risky incentive framework than emissions trading schemes. However this certainty in the tax level is at the expense of achieving a guaranteed environmental outcome. The difficulty in achieving a certain reduction in emissions is discussed in more details under the paragraph on acceptability.

Environmental outcome

A certain level of emissions reduction is not certain, due to the difficulty of setting the tax at the appropriate level.

A carbon tax does not guarantee that an emission target will be met; it requires adjustment over time to set the level of the tax appropriately to move towards a target level of emission reduction.

42 Royal Society (2002) Economic instruments for the reduction of carbon dioxide emissions. Royal Society.

43 Nick Hanley, Jason Shogren, Ben White. Environmental economics in theory and practice. Macmillan Press (1997).

44 J. FitzGerald, D. McCoy, and J. Hore (2001) "Are Tradable Emission Permits the Way to Go?" Green and Bear it? Implementing Market-based Policies for Ireland's Environment, ESRI conference, Dublin 2.

However, this is extremely difficult because it requires government to have full information about abatement costs and the variability in other factors, such as economic growth, technology development and commodity prices.

As discussed in Section 3.7.4 above, a carbon tax presents the opportunity of revenue raising that could be used for further emissions reducing initiatives. A further factor relating to taxes is that the overall cost to individuals would be a greater than trading schemes in which allowances are distributed for free, thereby creating a greater driver for achieving emissions savings.

Equity

Carbon taxes tend to be regressive potentially disadvantaging the more vulnerable members in society. Recycling the revenues to compensate those adversely affected is an option, however this might not be transparent to the public.

Taxes are perceived to have a negative effect on the general public and particularly on the more vulnerable members of society. They are often seen as regressive and have triggered angry reaction from lobbies; in the UK both a fuel tax and a pesticides tax were unsuccessful tax policies due to the reaction from lobby groups.

The revenues from the scheme could be recycled to offset the regressive nature, by compensating those in fuel poverty and more vulnerable members of society. However even if government states that the revenues are to be hypothecated there might be a lack of transparency of the compensation and it is likely to be viewed with some scepticism.

EPA (2004)[45] analysis that looked at the gainers and losers from the introduction of a carbon tax in Ireland found that households that emit more than average carbon dioxide and in particular those that use solid fuels will lose from a carbon tax even if a compensation scheme is designed.

45 Scott S and Ekins J (2004). Carbon Taxes: Which Households Gain or Lose? (2001-EEP/DS7-M1) Final Report prepared for the Environmental Protection Agency EPA 2004.

Simplicity

Taxes are an instrument government and the public are familiar with, and generally considered to have fewer complexities than those involved with a trading scheme.

A tax avoids some of the design issues associated with a trading scheme and can be simpler, a carbon tax would introduce complexities with emissions calculations and reporting. Taxes are an instrument the public is familiar with and which they understand. Governments and departments are familiar with the administration and requirements of a tax and the associated costs.

Political/public acceptability

The public are generally adverse to taxes and there is a distrust regarding the use of revenues.

Taxes can be highly contentious and become unpopular when more stringent emission reductions are required that will lead to a higher tax rate being applied. Siveter (2006)[46] in his research found that people's perception of taxes was that they were revenue raising, regressive, and had little impact on luxury goods.

The price elasticity, the responsiveness of demand to price, in some sectors can mean there is little or no change in the behaviour. For example due to the low price elasticity on transport it is unlikely that an increase in price will have a large demand reduction effect until the tax level reaches a significant level. It would be politically very difficult to set a carbon tax sufficiently high enough to affect demand. Drenser (2005)[47] found in his research that the public are unlikely to accept constant increases in a carbon tax.

46 Siveter, Robert (2006) An investigation into the feasibility and effectiveness of personal carbon trading in tackling carbon dioxide emissions.

47 Dresner, S (2005) Distributional, Practical and Political Implications of Carbon Taxing and Trading, paper delivered at workshop run by UK Energy Research Centre. Paper and workshop details available at http://www.ukerc.ac.uk/TheMeetingPlace/Activities/Activities2005/0511TaxingTrading.aspx

The costs of abatement would be the same as under a trading scheme however the compensation mechanism is weaker under a tax, and there tends to be stronger opposition to the introduction of taxes. This is reflected in the Royal Society (2002) paper that observed that the 1992 European Commission proposal for a tax partly failed due to the opposition from businesses even when the design of the tax include exemptions for energy intensive industries.

Taxes are subject to political interference and government may become subject to public pressure from particular pressure groups that may lead them to relax or remove the tax for political reasons, for example in the case of energy cost increases or an economic recession. As mentioned previously, there is a great deal of mistrust that revenues are not used effectively and can add to the longer-term scepticism regarding the real intention behind carbon policies.

Consistency with other mechanisms/ regulation

Taxes can encourage individuals to take advantage of other initiatives, and the revenues raised could be used to support other policies.

The EPA (2004) study looked at the introduction of additional measures to support the carbon tax, estimating that approximately 240,000 households were classified as 'energy inefficient', and advocating policies that together with the tax should encourage the insulation of houses, and improvements to heating systems used. This could include the switching to gas and renewables such as heat pumps. The creation of perverse incentives would also have to be considered, for example the EPA (2004) advise that if a carbon tax is introduced existing measures to preserve peat lands would need to be enhanced to ensure burning turf as a fuel doesn't became more attractive. However this would apply equally to the introduction of any other carbon measures.

Summary of analysis

Carbon taxes, based on the analysis above:

- Are considered more efficient than regulation, have relatively low administration and transactions costs and provide an incentive for innovation in low carbon technologies.
- Could also be considered more efficient than all other policy measures due to potentially lower implementation costs.
- Have the potential for revenues to be used to enhance the environmental effectiveness of the tax, via complementary investments, such as smart metering, eco-driving training, and home insulation grants.
- Do not assure a certain level of emissions reduction due to the difficulty of setting the tax at the appropriate level.
- Tend to be regressive potentially disadvantaging the more vulnerable members in society. Recycling the revenues to compensate those adversely affected is an option, however this might not be transparent to the public.
- Are an instrument government and the public are familiar with, and generally considered to have fewer complexities than those involved with a trading scheme.
- Are not popular with the public, who also have distrust regarding the use of revenues.

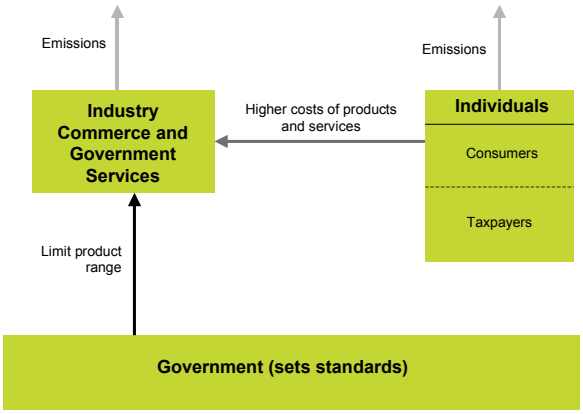
A SWOT analysis is presented in Section 4.6 with Table 4.2 summarising the strengths, weaknesses, opportunities and threats from the introduction of a carbon tax.

4.2 Regulation

Regulations are legal orders imposed by the government, for example requiring compliance to a certain standard or the imposing of a certain technique. They leave very little flexibility and those who the regulations are imposed on face legal penalties if they fail to comply.

Regulation

Chart 4.2: Regulation



Regulatory measures have been historically used to address problems of pollution. It is the preferred instrument when there are dangerous substances, where monitoring is difficult or there is a best available technique requirement. Examples of regulatory frameworks include the Integrated Pollution and Prevention Control and Large Combustion Plant Directives.

Economic efficiency

Regulations tend to be considered economically inefficient due to their lack of flexibility.

Regulations can be economically inefficient in achieving the reduction in emissions due to the lack of flexibility and coverage of the regulation. They also provide less of an incentive for participants to innovate beyond what is required by the regulation and to look at minimising costs in the long run.

Also under many situations setting the level of the regulation can be difficult particularly with a new measure where there is a lack of information, Hanley (1997) observe that regulations can result in over control for a particular target. Regulations will also involve costs related to the cost of policing, inspection and enforcement.

Environmental outcome

Guarantee that relative targets and standards will be met, but do not assure absolute environmental impact. They do not provide an incentive for investment in low carbon alternatives or further action.

There is certainty of meeting relative targets or standards (for example if a minimum standard were set for motor vehicle emissions/km performance) although they do not guarantee an absolute reduction in emissions. Those involved are provided with a clear framework and will know what to expect enabling them to better base on which to make future investment decisions. However relative targets are significantly different to absolute emission targets; even if relative targets are achieved absolute emission levels could still be increasing.

Furthermore, regulations may restrict innovation, as there is no incentive to go beyond the level of the regulation even if feasible or invest more in further measures. If placed on the public it might act as a disincentive to take any further action by creating the attitude that meeting the requirements of the regulation is a sufficient contribution.

Equity

Regulations would apply to each individual equally, however there would be no compensation for the associated costs.

If introduced retrospectively then there could be significant cost implications for those that would struggle to afford it. Forward looking changes on the other hand might be viewed as more acceptable since the cost impacts would to some extent be a matter of personal choice. For example the requirement for a minimum standard of vehicle emissions for new vehicles would introduce fewer equity concerns than demanding the replacement of all existing vehicles that fail to meet the threshold.

Simplicity

Design and administratively likely to be straightforward, however collectively to cover all the relevant activity areas could require a very complex regulatory landscape.

There are no complex design issues and the administrative costs should be reasonably moderate, especially if they are using existing frameworks and departments that deal with similar regulations. However imposing regulations on a number of

specific areas might mean that collectively the amount of regulation to reduce emissions becomes very complicated.

Political/public acceptability

Potential risk for regulatory capture and heavy lobbying may mean softer regulations to gain public acceptance.

Governments are subject to lobbying when designing the regulation and this might have the effect that the resulting legislation is compromised due to the political sensitivities at the time rather than achieving the long term objective it was envisaged to achieve. Pearce (2001)[48] observed that regulatory capture was a greater risk with regulations in comparison to market based instruments. Lobbies would seek to influence the implementation of the regulations with the aim of making them softer, and may also look for favour with the body given the responsibility for overseeing the regulation.

Consistency with other mechanisms/ regulation

Regulations would likely complement other emissions control legislation.

Summary of analysis

Regulations, based on the analysis above:

- Tend to be considered economically inefficient due to their lack of flexibility.
- Guarantee that relative targets and standards will be met, but do not assure absolute environmental impact.
- Do not provide an incentive for investment in low carbon alternatives or further action.
- Offer no compensation for increased costs.
- Can be administratively likely to be straightforward, however collectively to cover all the relevant activity areas could require a very complex regulatory landscape.
- Have the potential risk for regulatory capture and heavy lobbying.

A SWOT analysis is presented in Section 4.6 with Table 4.2 summarising the strengths, weaknesses, opportunities and threats from the introduction of carbon regulation.

4.3 Voluntary schemes

Voluntary systems can take many different forms. They provide a way to engage people who have so far been disinterested in taking action to reduce their carbon emissions. They tend to involve the voluntary reporting of emissions and a strong incentive to continue to be involved in the scheme. An example for the industrial sector in the UK is the Climate Change Agreements (CCAs), which provide an 80% exemption from the Climate Change Levy (see Energy Tax in Section 4.6 for description) for businesses within certain sectors that agree challenging targets for improving their energy efficiency or reducing carbon emissions.

Defra (2007)[49] when assessing the most appropriate mechanism to tackle the emissions from non-energy intensive business and public sector organisations looked at a voluntary scheme as an alternative to the mandatory Carbon Reduction Commitment (CRC). In the voluntary proposal participants would report their energy use as well as other information to make a comparison relative to a benchmark. The objectives of the scheme would be to focus attention on energy use and improve the availability of information. It would involve the recording and reporting of information on their energy use. Other UK examples of a voluntary scheme is the Hospitable Climates scheme organized by the Institute of Hospitality and the Carbon Trust, this is an initiative based on advice and best practice sharing.

48 Pearce DW (2001) What have we learned from the UK's experience with market based instruments? In S Scott and D McCloy (Eds) Green and Bear it? Implementing Market Based Instruments for Ireland's Environment, Dublin: ESRI, 2001.

49 Defra (2007) Updated partial regulatory impact assessment on the Carbon Reduction Commitment.

Economic efficiency

Voluntary schemes are not considered to be economically efficient, costs of scheme might be quite high in comparison to other options.

The absolute costs will similar to a mandatory scheme, yet in the case of a low participation rate the scheme could be perceived to be very inefficient if making an assessment on a cost per tone of carbon saved basis compared with alternative policy options. Voluntary agreements might be more effective if they are placed on producers as consumers can only change behaviour if there are sufficient options available and they may only have a limited influence on the production process or actions in the short run. These schemes by their nature would not involve binding commitments; therefore there would be considerably less risk to participants in comparison to other mandatory schemes.

Environmental Outcome

Voluntary schemes will not guarantee a level of reduction in emissions.

The level of overall emissions and even the proportion of overall emissions covered by the scheme is not guaranteed and provide no certainty or a sufficient incentive to reach a particular reduction in emissions. If the price of being involved increased over time participants in a voluntary system would want to leave. If this were possible the total emissions covered by it would be reduced as the price of carbon increases. Defra (2007) observe that they would be subject to the expense of setting up and running a system, but without the benefits in terms of emissions controls and market efficiencies if the scheme was a mandatory cap and trade system. This was a factor in adopting a mandatory CRC rather than a system of voluntary reporting.

Equity

Likely raise equity issues; only attracting those who already have a certain level of environmental awareness, disposable income and time to participate.

A voluntary scheme will not include people reluctant to participate or those not interested in understanding the scheme, which leads to issues associated with self-selection. It might only attract those who are very environmentally conscious, who have the disposable income and time to participate. It may have a very limited effect on the level of awareness and behaviour of the wider public. Participation indicates there is already a certain level of appreciation of the benefits, wider issues and some understanding of their carbon footprint. Defra (2007)[50] looked at experience from the Environment Agency[51] and energy-led collective voluntary energy efficiency schemes where participation from the targeted industry was only 20% or less.

Simplicity

Voluntary schemes would have many of the same design issues associated with a mandatory scheme, there are probably many unknown issues and complexities that will arise when delivering even a voluntary schemes.

Political/public acceptability

It could provide useful data and experience, however a negative experience with a voluntary scheme may harm public acceptability of a mandatory one.

A voluntary scheme might be politically acceptable as it can potentially provide some useful data and experience on how people manage their carbon allowances without mandating any involvement. The scheme might be useful if a mandatory scheme is being considered but there is no existing baseline information.

A voluntary scheme with low participation, high cost or low environmental outcome could damage the public's perceptions of carbon reduction policy in general and the type of scheme adopted in particular.

50 Defra (2007) Updated partial regulatory impact assessment on the Carbon Reduction Commitment.

51 Environment Agency for England and Wales.

Consistency with other mechanisms/ regulation

It may provide an opportunity to correct any operational issues before introducing a mandatory scheme, however it might not be appropriate to use as an exact model.

A voluntary trading scheme would provide an opportunity for participants to familiarise themselves with the principles and government to gain an understanding of any operational issues or public perception barriers before applying a fully mandatory scheme.

However, a successful voluntary scheme may not provide an exact model of how the public will react to a mandatory scheme. It is likely that the voluntary scheme could be used as a baseline analysis for a mandatory scheme however there might be a number of issues regarding self selection of participants and coverage which may mean the voluntary scheme is not the ideal model to base a mandatory scheme on.

Summary of analysis

Voluntary schemes, based on the analysis above:

- Are not considered economically efficient as the costs of scheme might be quite high in comparison to other options.
- Will not guarantee a level of reduction in emissions.
- Is likely to raise equity issues; only attracting those who already have a certain level of environmental awareness, disposal income and time to participate.
- Provide useful data and experience, however a negative experience with a voluntary scheme may harm public acceptability of a mandatory one.
- May provide an opportunity to correct any operational issues before introducing a mandatory scheme, however might not be appropriate to use as an exact model.

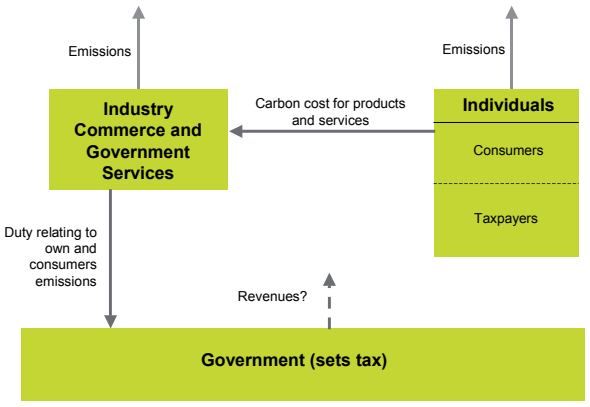
A SWOT analysis is presented in Section 4.6 the table summarises the strengths, weaknesses, opportunities and threats from the introduction of a voluntary trading scheme.

4.4 Fuel Excise Duty

For the transport sector an increase in fuel excise duty could be considered. Fuel excise duty is a tax placed on any liquid fuel used to power vehicles. Increases in the tax should encourage the purchase of more fuel efficient vehicles and more fuel-efficient driving. Both of which should result in a reduction in carbon emissions from the transport sector over time. The mechanism is illustrated below.

Fuel Excise Duty

Chart 4.3: Fuel Excise Duty



The UK's Fuel Duty Escalator (FDE) provides a useful example to assess the strengths and weaknesses of adopting such an approach. The FDE was introduced as an environmental tax designed to specifically reduce carbon dioxide from the transport sector, however it could be used as a mechanism for reducing emissions from heating fuels. It was first announced in 1993 and was a commitment to raise the duty by 3 per cent per annum in real terms. The aim of the tax was to incentivise changes in behaviour to conserve fuel and to incentivise more carbon efficient vehicles. It was expected to continue until 2002 but due to the strength of the road haulage lobby the automatic levy was cancelled in 1999. In 2000 the FDE was

modified to rise with the rate of inflation and was combined with investment in the road network. Following oil price increases in 2000 that caused fuel prices to increase this triggered protests and the government announced reductions in real rates of fuel in the 2001 budget.

Pearce (2001)[52] provides a full critique of the political issues and design aspects of the fuel duty escalator, he comments that the FDE failed due to the regulatory capture and the poor design. Some of the points raised in the evaluation against the criteria of an increase in fuel exercise duty will be similar to those associated with a carbon tax.

Economic efficiency

It does not target the carbon content of the fuel specifically, therefore it is unlikely to be the most efficient method to reduce carbon emissions. However, a framework already exists.

The costs of administration should be moderate as the transaction mechanism and framework already exists. The revenues raised from the increases from the duty could be used for investment in public transport or research into low carbon alternatives. It does not specifically target the carbon content of the fuel. It instead encourages less overall use and therefore may not be the most efficient way to reach a specific carbon reduction target, if this were the ultimate objective.

Environmental outcome

It does not guarantee a carbon reduction target will be met.

The increase in the duty will not guarantee that emissions will be reduced to a certain level. The price elasticity is very high on transport so it is unlikely to have a large demand reduction in this sector. Similarly to a carbon tax instrument politically it would be very difficult to increase the duty by a level required to reduce the demand.

Equity

It raises equity concerns as it could be potentially regressive, impacting more on the consumption of vulnerable individuals in society.

Depending on the design, the scheme could be perceived as regressive. There could possibly be certain individuals who are dependent on a level of fuel use and others for which it could be a large proportion of their overall energy costs. These individuals, who are likely to be the more vulnerable in society will feel unfairly treated while those who are relatively wealthy will be able to continue to consume at previous levels.

Simplicity

Should be fairly uncomplicated to implement as uses an existing framework.

The policy would not involve the number of design issues that are required for implementing a new trading scheme. The increase in duty could be announced with the government's budget and revised annually.

Political/public acceptability

Annual increases in fuel duty could trigger opposition from the public and road transport lobby groups.

Fuel duty is a tax the public are familiar with and which they understand. Governments and departments are familiar with the administration and requirements of the duty and the associated costs. However increases in the duty could be highly unpopular, particularly with those who are dependent on their private transport for business and if the duty continued to rise annually.

The government may become subject to public pressure that may lead them to relax or remove the increase in the duty for political reasons, particularly if fuel prices were to escalate due to wider global issues.

52 D.W. Pearce (2001) "What have we learned from the UK's experience with market based instruments?" In S. Scott and D. McCoy (Eds) Green and Bear it? Implementing Market Based Instruments for Ireland's Environment, Dublin: ESRI, 2001.

Interaction with other regulation and policy

If the policy is unsuccessful or unpopular this could act as a barrier to the implementation of carbon polices on the transport sector.

The policy may result in an aggressive public reaction, and if it is unsuccessful this could act as a barrier to implementing carbon policies in the future, as they would develop a strong lobby against additional burdens on the transport sector.

Summary of analysis

Fuel Excise Duty as a measure to cut emissions, based on the analysis above:

- Is not likely to be the most efficient method to target a reduction in carbon emissions.
- Does not guarantee a carbon reduction target will be met.
- Raises equity concerns as it could be potentially regressive, impacting more on the consumption of vulnerable individuals in society.
- Should be fairly uncomplicated to implement as the policy already exists.
- Could trigger opposition from the public and road transport lobby groups.
- If unsuccessful or unpopular this could act as a barrier to the implementation of carbon polices on the transport sector.

A SWOT analysis is presented in Section 4.6, with Table 4.2 providing a summary of the strengths, weaknesses, opportunities and threats from an increase in the fuel excise duty.

4.5 Other policies

This section considers further policies to cut emissions, albeit not assessing them to the same level of detail as the previous measures. Road pricing could address greenhouse gas emissions, although it would have other drivers. Subsidies for low carbon alternatives could serve as measures to complement the options considered above. Energy taxes are also considered below, although many of the issues are similar to those associated with a carbon tax.

Demand management strategy – road pricing

Policies such as road pricing would be an example of demand management measures. Road pricing tends to be aimed at reducing congestion rather than climate change, although the objective is to incorporate all the external costs of congestion, climate change, air quality, noise and safety into the charge to road users. The objective of a road pricing scheme is to encourage people to change their travel behaviour, through a change in either the time and route of their journeys from congested and environmentally sensitive times and places, for example from peak times in city centres to less congested times and places. It may also encourage a fall in the overall level of car-use, either by switching from car to other transport modes or by reducing the amount travelled.

Road pricing policies have met with a large amount of public opposition when proposed in the UK, and are associated with technology issues regarding high costs for operating and monitoring. The Institute of Public Policy Research (IPPR)[53] has conducted research examining current public attitudes towards road pricing in the UK. They found the current perception in the UK[54] is that it is unfair, as the public assumes it penalises

53 http://www.ippr.org/research/teams/project.asp?id=1785&pid=1785

54 http://www.ippr.org/publicationsandreports/publication.asp?id=455

those on low incomes and those living in rural areas, who are more reliant upon their cars. They also observed that it is felt to be ineffective, with the assumption that people will carry on driving regardless. However they concluded that there is scope to increase public acceptability by presenting road pricing as part of a package and providing information on its effectiveness. IPPR also found that public attitudes remain a major barrier to its introduction. They investigate how attitudes towards road pricing are likely to change over time and set out how scheme design and communications could be used to improve public acceptability of road pricing. Their proposals[55] include that the scheme should be flexible, simple and the revenues should be hypothecated.

Pearce (2001) observed that pricing people off the road is unhelpful if they do not have an alternative to switch to, suggesting that this policy would also require investment in public transport. If the revenues from the scheme are hypothecated these could be used to subsidise such improvements in public transport.

The University of Leeds[56] has looked at road charging in urban areas, they have found that policies should significantly reduce car use and delays, potentially encouraging more use of public transport. However they also identify there is a risk that traffic would simply be diverted to areas outside of the boundary or to other times of day, therefore shifting the issue rather than ensuring a reduction in emissions or congestion. Careful design is essential to avoid these issues. The shift towards public transport would be very dependent on whether demand for peak time road use is price inelastic, because individuals might have a strong preference for private transport or suitable routes on public transport are not available there might not be a large movement towards public forms.

There have been some concerns regarding impacts on the economy as increased transport costs could create inflationary pressure, and result in a loss of competitiveness, for smaller businesses that rely on passing trade.

Leeds University also identify the main barriers to implementation as being the complexity of the scheme and the technology, with public acceptability of the policy and whether the necessary legal powers are in place to resolve key issues. A road-pricing scheme would aid in tackling the emissions from road transport however it is not as direct an instrument as a carbon tax. Its main benefit might be from a reduction in congestion, particularly in busy cities such as Dublin.

Demand management policies do not guarantee to meet a level of emissions reduction, are potentially costly, and may raise equity issues as they can be regressive. From an environmental perspective they are good second best alternative policies to pricing emissions directly through a tax or trading scheme, and can be combined with subsidising public transport to achieve a larger environmental outcome.

Subsidising low carbon alternatives

An alternative policy option would be to make the low carbon alternatives more attractive; using the example of transport again this could be through subsidising public transport. If the cost of public transport were significantly lower than using a car, with improvements in service and extra capacity this may encourage individuals to use public transport.

It is likely there will be individuals who would continue to use their private transport irrespective of the price reduction, and for some if there is no incentive not to use their private car, as they already own one they may not be tempted to use public transport. Factors like flexibility, frequency, convenience, safety, and travel times might be deciding factors for individuals when deciding on their mode of transport.

55 http://www.ippr.org/uploadedFiles/research/road_pricing_evidence_report.pdf

56 http://www.socscinet.com/transport/konsult/private/level2/instruments/instrument001/l2_001b.htm

Clinch and Kelly (2001)[57] reviewed the attractiveness of public transport as a way to reduce congestion in Dublin, against the four factors of journey time, comfort, access, and price. They found that public transport was very competitive with private cars on journey time and price, however in terms of comfort and access it would likely always be at a disadvantage.

Subsidising public transport could result in an increase in the use of public transport but this might not be necessarily shifted from car use, as existing users may just use the services more instead of walking or cycling. The associated costs could be very high particularly if capacity through infrastructure improvements were needed to cope with the increased demand.

Ensuring low carbon alternatives exist will be important to obtain a reduction in emissions, however rather than the main tool these might be a crucial supporting measure to the introduction of either a tax or trading scheme. As subsidising low carbon alternatives does not guarantee any reduction in carbon emissions and may not be the most economic efficient use of funds.

Energy Tax

Many of the aspects will be similar to those highlighted for a carbon tax. Depending on the design of the energy tax it is unlikely to produce the same carbon reduction as a pure carbon tax, but will have broadly the same characteristics of a carbon tax outlined above. If it was a flat tax on fuels, not reflecting the relative carbon intensity of the different fuels, it would provide little incentive to switch to cleaner fuels and less private investment in low carbon alternatives. However it would still act as an incentive to reduce overall demand, and interest in energy efficiency.

The Royal Society (2002) comment that where fossil fuel taxes have been used, even when their purpose has been to reduce overall greenhouse gas emissions, these are neither as effective or efficient as a carbon tax.

An example of an energy tax would be the UK's Climate Change Levy (CCL). The CCL was introduced in November 2000 and was levied on industry only applying to the use of coal, gas, electricity and non-transport LPG, the revenues are recycled back to industry and used to stimulate energy efficiency schemes. Energy-intensive industries can face a lower CCL rate if they adopt Climate Change Agreements (CCA), which require them to adopt energy efficiency measures to achieve targets based on certain criteria.

If the overall objective is to secure a reduction in carbon emissions a pure carbon tax might be a more effective measure to adopt in contrast to an energy tax.

4.6 SWOT Table

Table 4.2 below is a SWOT analysis of the main non-trading instruments that can be used to reduce carbon emissions, following the same approach as for the trading options in Section 3.

57 JP Clinch and JA Kelly (2001) Economics of Traffic Congestion in Dublin. Department of Environmental Studies, University College Dublin. http://www.ucd.ie/gpep/gpepinfo/publications/workingpapers/01-09.pdf

Table 4.2: SWOT analysis of non-traded options

Scheme/Instrument	Strengths	Weaknesses	Opportunities	Threats
Carbon Tax	• **Can lead to an economic efficient outcome reducing carbon emissions at low cost** • **Can provide an incentive for innovation** • **Low administration and transaction costs** • The environmental outcome of the scheme could be enhanced through the effective recycling of the significant revenues raised by the scheme	• Potential carbon leakage risk • **Does not guarantee carbon reduction target will be met** • Difficult to set at the right level to achieve environmental aims • Can be regressive, having negative effects on vulnerable members in society • **Public suspicion surrounding the actual use of revenues** • **Low engagement with public on environmental objectives**	• An instrument the public and government are familiar with • Revenues can be recycled to offset the regressive nature	• Taxes are subject to political interference • **Pressure from lobby groups**
Regulation	• **Certainty of meeting relative targets or standards** • No complex design issues • Administratively should be straightforward	• **Economically inefficient due to lack of flexibility and complexity of resulting regulatory framework** • **No guaranteed environmental outcome**	• Parties are very familiar with regulation • Regulation may provide businesses with certainty for the time period	• **May restrict innovation, with no incentive to go beyond what is required by regulation** • In the designing the legislation there might be a large amount of lobbying and risk of regulatory capture
Voluntary Schemes	• Allows engagement with the public and increases awareness of their energy use, without the risk of binding commitments	• **Does not guarantee a reduction in carbon emissions** • Cost analysis based on £/CO_2 compared with costs of other policies might be very expensive • Self selection	• Greater acceptability and provide useful data and experience • **Opportunity for public to familiarise with the scheme and for bodies responsible to correct any operational issues before scheme is made mandatory**	• **Not the same level of commitment and this could damage the public's perception of carbon policies** • Not an ideal model for a mandatory scheme due to self-selection issues and differences in scale and coverage

Scheme/Instrument	Strengths	Weaknesses	Opportunities	Threats
Increase in Fuel Excise Duty	• **Moderate administration and transaction costs** • Any revenue raised could be used for investment in public transport and low carbon technologies	• **Does not guarantee carbon reduction target will be met** • Price elasticity in transport sector, means duty would have to significantly increase to affect demand • Potentially regressive, impacting more on the consumption of the more vulnerable individuals in society	• Fuel duty already exists and the public are familiar with the concept	• **Hugely unpopular with the road haulage lobby, and there could be public pressure to relax the increases in duty when they reach a level that start to impact on demand**
Road Pricing**	• Any revenue raised could be used for investment in public transport and low carbon technologies • **Can be used to target other issues, such as congestion and localised air pollution**	• **Does not guarantee carbon reduction target will be met**	• Has been proven at regional level so could utilise existing technologies • Can be most effective where public transport alternatives exist	• **Potentially large public opposition** • Localised schemes could simply divert car use rather than reduce it

* The more significant issues are highlighted in bold.

** Road Pricing has not been assessed to the same level of detail as the other options shown in this table or analysed in Section 3.

4.7 Overview of types of policy options

The SWOT analysis in Table 4.2 above reviews the main non-trading instruments that can be used to ensure a reduction in carbon emissions, as proposed by Stern (2006) and OECD (1989)[58]. There are certain strengths in the use of economic instruments such as taxes as opposed to regulatory or voluntary options. Pearce (2001)[59] advocates the use of market based instruments as being superior to regulations, as they allow compliance with cost minimisation and have the potential to spur technological change that further reduces the cost of compliance.

The Royal Society (2002)[60] found that economic instruments are preferable to regulation unless regulation is required due to the specific nature of the pollutant. However there is much debate surrounding whether the preferred instrument is a tax or a trade instrument. Existing literature indicates that the instrument that should be used depends on whether the desired outcome is a fixed abatement cost or level of emissions. Oxera (2003)[61] also observe that whether taxes or trading instruments lead to the optimum outcome is dependent on the relationship between the level of emissions and abatement costs.

Economic instruments such as carbon and energy taxes are effective at incentivising mild changes in behaviour, however where larger changes are required and the abatement costs are high then trading schemes are a more effective policy tool. Trading schemes involving individuals are relatively new and the associated costs and public acceptability are likely to be key issues. Siveter (2006) commented that evaluation of any trading scheme would require an accurate assessment of the costs. If these prove to be high then a more simple carbon tax, which is supported by existing, administration infrastructure may tip the efficiency argument in favour of a tax.

4.8 Conclusions

The analysis of the various options indicate that there are clearly different merits associated with the use of trading schemes and taxes, and it will be vital to align the objectives with the scheme which can best deliver these. Continuing the summary table presented in Section 3 for the individual traded options we can include the non-trading options as shown below.

Scheme	Cost Effectiveness	Public Engagement	Environmental Outcome	Equity	Simplicity
Personal carbon allocation schemes					
Cap and Share					
DTQs/TEQs					
PCR					
RAPS					
Ayres Scheme					
Sky Trust					
Other mechanisms					
Carbon Tax					
Regulation					
Voluntary Schemes					
Fuel Excise Duty					

KEY: Relative performance against each criteria				
Strong				Weak

Regarding the non-trading options, a carbon tax or use of fuel excise duty appear preferable to direct regulation or voluntary schemes on the grounds of cost effectiveness and simplicity. They are also likely to be simpler and cheaper to implement than the trading approaches. However, overall the lack of public engagement, uncertainty over environmental outcome and no direct compensation for individuals mean these non-traded options score less well in our analysis than Cap and Share and Sky Trust.

58 OECD (1989) Economic Instruments for environmental protection. OECD Paris.

59 Pearce DW (2001) What have we learned from the UK's experience with market based instruments? In S.Scott and D.McCloy (Eds) Green and Bear it? Implementing Market Based Instruments for Ireland's Environment, Dublin: ESRI, 2001.

60 Royal Society (2002) Economic instruments for the reduction of carbon dioxide emissions. Royal Society http://royalsociety.org/document.asp?tip=1&id=1385

61 Oxera 2003 paper Pizer 1999 and 1999.

5 Cap and Share constraints and design issues

5.1 What sectors are likely to be particularly affected by the scheme?

Any trading scheme (or non-trading instrument) has the potential to advantage some participants at the expense of others. Whilst the principle of Cap and Share is to compensate members of the public for the increased costs that arise, some sectors of society and some commercial operations could be adversely affected by the scheme. This section reviews the potential impact of the scheme and makes the following findings:

- **Low income households** will generally benefit from the scheme, as they are less likely to consume fuel at levels above the average. However, whilst this is true of the average there will be some low income households with high demand that will be worse off compared with the population as a whole. What's more it is likely that poorer households will be in less of a position to reduce their emissions because they will have less existing wastage and will be less able to make capital investments needed to support savings. Finally, they would be in less of a position to accommodate increased fuel costs.
- **Rural communities** are generally more car-dependent and less able to substitute away from the car towards public transportation, cycling or walking, as the distances to local amenities tend to be greater. This is seen as a major challenge for climate policy in Ireland and raises issues that would apply for any mechanism that prices carbon, be it a carbon tax or trading scheme.
- **Single-person households** will likely face similar increases in domestic heating bills under the scheme as the average two-person household, but will only benefit from one set of carbon certificates (assuming children are not included in the scheme).
- **Transport-related businesses** may fare poorly under the scheme, as they will not receive any compensation for the increased costs they will have to bear. Moreover, they may not be in a position to pass on increased running costs to their customers and the elasticity of demand may lead to a reduction in demand for certain services.

We have highlighted possible approaches to addressing these concerns, of which measures separate to the scheme would appear preferable to distortions to the scheme's design intent.

The purpose of this section is to review whether certain sectors of society would be particularly affected by the Cap and Share scheme. However, it is important to define the baseline against which this assessment can be made. Action to tackle climate change generally costs money and it is not constructive to assess the equity impacts of a reduction measure in terms of the costs incurred by those affected relative to a business-as-usual scenario. Rather, one must consider whether a particular scheme disproportionately affects certain sectors relative to the average of those affected.

With this in mind, it must be remembered that the Cap and Share scheme is inherently equitable for those directly involved, since the number of allowances distributed to individuals will be the same, and more generally the conditions generated under the scheme will apply to all of them in the same way. This leaves two issues that warrant consideration regarding the Cap and Share proposal:

- Firstly, would any sectors bear costs greater than the national average due to demand for goods and services covered by the scheme for reasons

that may not be within their control (at least in the short to medium term). The presence of such differentials does not imply that the scheme shouldn't be implemented (since the alternative policies to cut emissions may have similar impacts), but rather highlights the potential need for supplementary actions in the short to medium term to avoid detrimental impacts on certain peoples' quality of life.

- The second issue is where the boundary is drawn between those that would receive free allocations and those that would not. This design issue needs consideration to avoid disadvantaging some groups relative to others.

Before reviewing these issues it is important to consider the extent to which the *full* value of the emissions certificates will be realised by the general public, since there are two elements that could see individuals, on average, receiving a lower income from the certificates than the corresponding fuel related cost increases.

- Firstly, banks and post offices could charge a handling fee, related to the costs they incur. This is largely unavoidable if the transfer of certificates from individuals to intermediaries is to be treated as a free market process. An alternative approach could be for the Government to agree a charge with the banks that it will pay for each certificate cashed in, on condition the bank does not also charge the individual. However, in this case the cost of the service would still ultimately be paid for by the taxpayer. The cost implications of charges are considered in Section 5.6 below.

- Secondly, fuel suppliers will be looking to purchase allowances in large numbers to cover their emissions, i.e. much greater than the value of an individual's certificate. Consequently, there is added value in the aggregation service provided by banks and post offices, for which they could capture some of the value of the emissions rights. Such a phenomenon has been seen with the sale of Renewable Obligation Certificates to electricity suppliers in the UK. In this case the population as a whole would not be fully compensated for the cost increases resulting from the scheme, although it is difficult to quantify the size of this effect.

The Cap and Share scheme may be applied to any activity not covered by EU ETS. This analysis will consider its application to transport and domestic heating. In particular, the following issues will be reviewed.

- Low income vs higher income population
- Rural and remote communities
- Single-person households
- Transport-related businesses

5.1.1 Low income vs higher income population

This section considers the low-income population in relation to middle and high-income groups. Reviewed in turn are the effects of including transport fuel, domestic fuels, the impact on prices for other goods and services and finally the ability of poorer households to reduce consumption.

A recent study for Defra[62] examined the distributional implications of personal carbon trading in the UK. It examined the DTQ scheme in which 40% of allowances are issued for free to each adult (to correspond to direct emissions), with the remaining 60% auctioned. However, by setting the cap at the level of total personal emissions the analysis centres on relative differences in emissions, such that the average allowance surplus/deficit across all households is zero. In this respect the analysis may be broadly applicable to the overall economic impact of Cap and Share

62 Distributional Impacts of Person Carbon Trading, Report for Defra, J. Thumim and V. White, University of Bristol School for Policy Studies, March 2008, http://www.defra.gov.uk/environment/climatechange/uk/individual/carbontrading/pdf/pct-distributional-impacts.pdf

scheme (assuming carbon costs are ultimately borne by individual consumers/taxpayers). Regarding income effects, the study found that only 8-9% of all households would be low-income (bottom three income deciles) losers. Although this study examined the UK position, it might be expected that similar results would apply in Ireland.

Increase in the price of transport fuel

The Cap and Share scheme will set a cap on annual carbon emissions from transport fuel. In a scenario where this carbon price is passed through to the price of fuel, the scheme will rely on the price mechanism to mediate demand and stimulate the development and use of low carbon technologies. It follows that under Cap and Share, as the cap decreases, the price of transport fuel will increase, since cheaper abatement options will be adopted earlier, with more expensive ones following. The rise in price will be moderated by the cheaper availability of new technologies (e.g. biofuels).

Demand for commodities such as fuel is often said to be 'inelastic'[63], at least in the short term Cars are commonly used for commuting to work, the school run, food (and other) shopping and visiting friends/relatives.[64] While it is difficult to see how individuals could reduce their need for these essential activities, there are ways in which people could adjust their behaviour to reduce car use in connection with them. For instance, those who have access to some form of public transportation could chose to substitute away from car-use in favour of buses, trams or trains. Car sharing is another abatement option, as are walking and cycling, when the distances involved are relatively small.

Of particular interest is the way in which the low-income population might be affected. There is evidence to suggest that those in lower-income bands are less likely to drive than their wealthier counterparts. A recent survey on car-use carried out by the Scottish Government reported that while 78% of those in the highest income quartile used a car every day, only 29% of those in the lowest income quartile did so. Similarly, while 95% of those in the highest income quartile lived in a household with a car, the figure for the lowest income quartile was 43%.[65]

This suggests that poorer households are more likely to benefit financially from Cap and Share in respect of travel costs, compared with higher income groups, as they are less likely to use a car. This is because their carbon certificates will more than compensate them for any additional costs they may bear from increased transport fuel prices. In the longer term, however, there will be incentives and options for heavy users of transport fuel to reduce their consumption (buying more efficient cars, working closer to home etc) such that the differential between high and lower income households regarding the costs of the scheme would be reduced. For the minority of low-income households where the above-average emissions are a function of car-use (these are mostly rural households), Tyndall[66] recommends improving rural transport, locating amenities closer to households, putting in place rural car clubs, etc.

63 The term 'elasticity' describes the relationship between price and the demand or supply of a particular commodity. The more consumers are able to mediate demand for a good as prices rise, either by consuming less of it, or by substituting other goods, the more 'elastic' demand is said to be. Conversely, where consumers are unwilling or unable to reduce their demand and/or substitute goods are not available, demand is described as 'inelastic'.

64 This is supported by a recent survey carried out on behalf of the Scottish Government. Of the three, commuting emerged as the most significant journey type (i.e. responsible the most miles travelled). National Centre for Social Research (NatCen) Scotland, 'Attitudes to Car Use and Modal Shift in Scotland' available at http://www.scotland.gov.uk/Publications/2004/03/19062/34293#b43

65 National Centre for Social Research (NatCen) Scotland, 'Attitudes to Car Use and Modal Shift in Scotland' available at http://www.scotland.gov.uk/Publications/2004/03/19062/34293#b43

66 Starkey, R. and Anderson, K., *Domestic Tradable Quotas: A Policy Instrument for Reducing Greenhouse Gas Emissions from Energy Use*, (Tyndall Centre Technical Report No. 39, December 2005) (hereafter "Tyndall Research 2005").

Increase in the price of domestic heating

In contrast to most applications of transport fuel, the provision of adequate domestic heating, especially in the winter time, is often essential. This is especially important for households with children and elderly, who may be particularly vulnerable to inadequate heating. For that reason, it is important to consider whether poorer households are particularly affected relative to those on higher incomes. Under Cap and Share, a household with below average demand for domestic heating would benefit relative to those with higher demand.

It might be expected that those on lower income would have lower energy bills, since they can less afford wastage. However, studies show that the majority of the 30% of above-average emitters in low-income households are pushed over the limit by emissions associated with their residential services. This may arise from a combination of factors such as poorly insulated housing, carbon-intensive heating system and greater heating requirements during the day when fewer people are in full-time employment.[67] Tyndall suggests working through existing fuel poverty programmes to address these anomalies. In this respect, the role of energy efficiency improvements as a means of cutting energy consumption is important. The capital investment required to improve home insulation or the efficiency of a boiler for example may leave some on lower incomes less able to afford these improvements. Whilst they may be equally likely to be disadvantaged under an alternative scheme, this does highlight that in placing a carbon cost on domestic heating there would be justification for increasing state support for energy efficiency measures in poorer households.

Price rises for goods and services

Over time, as transport fuel prices rise, Cap and Share is likely to lead to a general increase in prices for goods and services, especially those that depend on transport fuel as an input (i.e. most consumer goods). As above, it is likely that low-income people will consume at less than the average level and will benefit financially from the scheme.

Ability to absorb additional costs/ maximise value of allowances

As described above low-income people will in general consume at less than the average level and will benefit financially from the scheme. However, there will be some who consume at above average levels and will have to pay more as a result of the scheme. While consumption levels of fuel, heating services and other goods are often a function of choice and can, in principle, be shifted (which, after all, is part of the incentive system underpinning the logic of the Cap and Share scheme), there may be good reasons why certain low-income individuals are not able to reduce their consumption levels (for example due to the capital investment required for home energy efficiency measures discussed above). Consequently one can expect a certain subset of poorer income households to be both adversely affected relative to the average and in less of a position to cut consumption. Whilst this would be expected from any scheme that puts a carbon cost on energy consumption, consideration would need to be given to the type and level of state support for poorer households upon a decision to implement a Cap and Share Scheme.

It is also possible that individuals may chose not to cash in their credits immediately but speculate on the carbon market or take out market products that may be offered by financial intermediaries. These actions are a matter of choice and the prospect of such activities emerging would not appear to be an equity concern. However, it may be that the charges levied for access to such facilities deter those on lower incomes seeking to maximise the value of their credits. For Government to interfere in these arrangements (for example by capping charges) would seem counter to the market principles, however, there would be scope for a code of practice for such offerings, perhaps setting guidelines on the presentation and accessibility

67 Tyndall Research 2005.

of information relating to charges and penalties. Government could also offer impartial advice on the issues surrounding carbon trading to help educate those less familiar with the subject. Finally, the scope for speculation would be limited by permits only being valid for relatively short compliance periods of a year of less.

5.1.2 Rural and remote communities

In rural and remote communities, the population is particularly car-dependent. Basic services (i.e. post office, supermarket, schools, hospitals) are more likely to be located at some distance from peoples' homes, and public transport networks may be sporadic or lacking altogether (as they tend to be very costly to maintain). For this reason, residents of these communities are more likely to have an above-average level of car use, as the distance travelled to meet their basic requirements will be greater than it would be for their urban counterparts. They may also find it more difficult than their urban counterparts to reduce their demand for car use, even as the price of transport fuel increases (as fewer alternatives exist, e.g. public transportation links). Accordingly, this group will likely bear a disproportionate cost under the scheme, as compared to their urban counterparts, as the compensation they receive will only cover their car use up to the average level.

Interestingly, recent work for Defra examining personal carbon trading in the UK found that the tendency for urban/fringe households to have allowance surpluses (and village/isolated households to have deficits) was primarily related to heating rather than transport energy use. The reason for this was the older less efficient housing and heating systems in rural areas coupled with the lower ambient temperatures. Importantly, access to the gas network will be more limited for rural communities, who will therefore make greater use of oil for heating. This will further mean the emissions from the domestic sector will likely be greater in rural communities than in the urban environment.

The long run impacts of the scheme on rural communities in general are likely to remain to some extent since it is unlikely that the public transport system could be developed to offer cheaper alternatives for everyone. However, at an individual level the public would have a choice about whether to live in rural or urban communities or purchase more efficient cars and the increased costs associated with travel will simply become one of many factors in that choice.

Overall, however, the impact on rural communities is seen as a major challenge for climate policy in Ireland and raises issues that would apply for any mechanism that prices carbon, be it a carbon tax or trading scheme.

5.1.3 Single householders

Under the scheme, those with below-average consumption of the carbon-capped good will benefit financially (through the compensation mechanism), while those with an above-average consumption will pay extra. A very significant inequity may emerge where a household comprises only one adult (but may have one or more children), as compared to a household with two or more adults. The latter household may have a similar consumption, on average, as the former. However, depending on the policy approach with respect to children (discussed below), the single-householder may only benefit from one carbon entitlement as opposed to two. This is an important factor since, unlike some of the impacts described earlier, the cost implications for single householders would largely be a function of scheme design and would remain in the long run.

5.1.4 Transport-related businesses

Transport-related businesses, such as road haulage companies, coach companies, delivery vans, taxis, etc., will fare particularly poorly under the scheme as it is only individuals rather than companies who will receive compensation for any increase in costs. These businesses as a whole would be expected to pass on the bulk of their increased running costs to

their customers. However, where certain activities compete with those of lower energy demand (for example taxis in relation to buses) or where the elasticity of demand may lead to a pronounced reduction in demand for certain services businesses may suffer reduced profits. This is a natural response to any measure that seeks to disincentivise energy use and is not something one could aim to design out, however, the short term impacts on commercial sectors could lead to reduced capital for investment and could be detrimental to employment. Such impacts could be minimised through a well signalled intention to introduce the scheme and by having relatively modest reduction targets during the early years. We consider that options to allocate emissions to commercial operations would undermine the principle of the scheme and in some circumstances could lead to windfall profits.

The application of the scheme will also provide other businesses with a strong financial incentive to improve the efficiency of their operations, as any reduction in the demand for fuel will bring down operating costs. However, companies that depend on road transport to provide their services (e.g. flower delivery, gardeners, caterers, etc.) may have less opportunities for savings. In addition, farmers, who depend heavily on fuel to power their farm machinery and typically operate with fairly tight margins, may find it difficult to absorb these higher costs and remain profitable. However, it is also possible that these additional pressures could support the development of more sustainable, smaller-scale farming practices which do not require the same levels of fuel inputs.

5.1.5 Addressing distributional concerns

The studies and analysis considered above suggests a need to introduce measures to address distributional concerns, even though on average those most vulnerable to increased costs are likely to benefit under the Cap and Share Scheme. This is because a significant minority could be worse off and less able to accommodate the increased costs. In general, support via separate measures is preferable to distorting the design intent of the Cap and Share proposal. However, potential measures for Government, both within and outside the Cap and Share mechanism would include:

Within Cap and Share:

- Issue more allowances to poorer households.
- Issue more allowances to rural communities (in relation to the extent of public transport).

Outside Cap and Share:

- Increase domestic heating allowance in line with increase in fuel prices from Cap and Share.
- Provide increased subsidy for home energy efficiency investment.
- Increase financial support for public transport.
- Coordinate and support rural car-club initiatives.
- In the longer term encourage amenities to be located nearer to centres of population.

5.2 Would a Cap and Share scheme be consistent with the principles of the EU 'internal market'?

State aid, that is, "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods" is prohibited under the EC Treaty. This section considers whether the Cap and Share scheme could be characterised as State aid and whether it would be prohibited on that basis. It makes the following findings:

- It appears that the Cap and Share scheme would not constitute prohibited 'State aid' under Article 87(1) of the Treaty. However, it is not possible to be definitive as the case law shows that facts that are analogous, or arguably analogous, to the situation under Cap and

Share have been held to satisfy each of the four elements required to demonstrate State aid. It is therefore possible that the Commission and/or European Court of Justice could construe the scheme as constituting State aid.

- The European Commission is unlikely to prohibit the scheme on this basis as it has long recognised an exception to State aid in instances where it is granted for 'environmental protection'. Moreover, it tolerates free allocation within the EU ETS, which could be considered to raise similar issues to Cap and Share.
- The Commission recently promulgated a new set of 'Community Guidelines on State aid for Environmental Protection' which recognise aid involved in tradable permit schemes as valid when certain criteria are met. Cap and Share satisfies all but one of these requirements on its face. Further quantitative assessment of the scheme would likely indicate that the remaining element is also met.

The rules of the internal market are designed to protect the freedom of movement of goods, services, labour and capital. This section also explores whether any of these four freedoms may be compromised under Cap and Share. It makes the following findings:

- Cap and Share applies equally to all market participants, whether incorporated in the Republic of Ireland or in any other Member State.
- At least initially, there may be some indirect advantage from the scheme to fuel suppliers who operate in Northern Ireland, as less residents from the North may chose to cross the border in search of lower fuel prices. This market distortion would be detrimental rather than beneficial to fuel supply companies in the Republic, but would require further consideration.
- The potential for anti-competitive behaviour by larger supply companies cross subsidising activities in the Republic and Northern Ireland or manipulating carbon prices may warrant further investigation. However, a robust regulatory framework should prevent such behaviour.

The EU has established a set of regulations that govern and promote the efficiency of the internal market. In broad terms, these regulations protect the free movement of goods, persons and capital, to ensure a competitive market, as well as seeking to promote harmonisation of laws within the EU, to the same end[68].

In considering whether Cap and Share is consistent with the principles of the EU internal market, there are a number of issues that warrant consideration. The first is whether the Government's transfer of valuable carbon certificates to its citizens, at no charge, is consistent with the EU's rules on State aid. The second is whether the scheme, by imposing an additional cost of conducting business on fuel suppliers, unjustifiably impinges on freedom of movement and competitiveness within that sector.

5.2.1 State Aid

The approach to assessing consistency with State aid rules considers the following:

- The definition of State aid
- An analysis of whether the Cap and Share proposal could be construed as State aid
- Consideration of exceptions to State aid

The definition of State aid

The EC Treaty prohibits State aid, which is defined in Article 87(1) as "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort

68 *See* Davies, Gareth 'European Union Internal Market Law' (2nd ed. London 2003).

competition by favouring certain undertakings or the production of certain goods, in so far as it affects trade between Member States".

Prohibited State aid has been defined in the relevant case law, as any aid which:

1. Is granted by the State or through State resources.
2. Favours certain undertakings or production of certain goods.
3. Distorts or threatens to distort competition.
4. Affects trade between Member States.

State aid rules only apply to aid that fulfils all four elements[69]. Note that while the prohibition on State aid does not exclude the transfer of resources to individuals, it is concerned with whether the ultimate impact distorts competition. Consequently, it is not possible to dismiss State aid as a concern for Cap and Share in the first instance. The following analysis considers each of these elements of State aid in turn to determine whether Cap and Share is capable of fulfilling the definition.

Aid granted by the State or through State resources

Under Cap and Share, the Government grants an annual entitlement of carbon credits, at no charge, to its citizens. The first question to consider is whether the entitlement grant can appropriately be characterised as 'aid' in that no resources, as such, have been transferred from the State. The case law indicates that even by waiving revenues to which it would otherwise be entitled a State effectively transfers resources[70]. The Commission's assessments of the British, Dutch and Danish emission trading schemes "supported the view that the gratuitous allocation of allowances implied a transfer of State resources according to Article 87(1) EC."[71] However, whether the European Court would uphold the Commission's approach is unclear. Some legal scholars have drawn a distinction between proceeds resulting from the sale of allowances and those arising from tax exemptions. As regards the latter, the Government is waiving revenue to which it is otherwise entitled. In contrast, no principle of law mandates payment for CO_2 emissions.

Favouring certain undertakings or the production of certain goods

This element comprises two separate queries, which will be dealt with in turn. The first, whether the measure in question confers an advantage on an undertaking at all. The second, whether that advantage is selective, that is, does it favour certain undertakings or the production of certain goods?

For an undertaking to qualify as a recipient of State aid it must carry on an economic activity of some sort. In addition, to fall within the prohibition, aid must confer an economic advantage on the recipient[72]. Recent case law of the European Court of Justice has held that measures likely to favour certain undertakings, either directly or indirectly, are to be regarded as conferring an economic advantage[73]. Similarly, the Commission, in its review of the NAPs during the second trading period under the EU ETS, held that "the allocation free of charge to certain activities confers a selective economic advantage to undertakings'.

Of course Cap and Share is distinguishable from the EU ETS in that the former does not grant for free valuable entitlements directly to industry. In Cap and Share industry must purchase and then surrender sufficient allowances to cover its emissions and then surrender them in relation to its emissions.

69 *See generally* Department for Business Enterprise and Regulatory Reform, 'Guidance for state aid practitioners', (October 2007) available at www.berr.gov.uk/bbf/state-aid

70 De Sepibus, J., 'The European emission trading scheme put to the test of state aid rules', (NCRR Trade Working Paper No 2007/34) available at http://www.nccrtrade.org/images/stories/publications/IP6/de%20Sepibus_EU%20ETS%20state%20aid.pdf (hereafter 'De Sepibus 2007').

71 *Ibid*. p.8.

72 See Collins, A., and Quigley, C., 'EC State Aid Law and Policy', (Oxford 2003) (hereafter 'Quigley'), pp. 18 – 22.

73 See Case C-280/00, *Altmark Trans GmbH v Regierungspraisidium Magdeburg*, 24.7.2003, par. 84.

Therefore it does not appear possible that the industry could benefit from the scheme. This would seem to make it a fairly open and shut case.

However, it is worth recalling that the certificates are issued to compensate consumers for the higher fuel prices expected under Cap and Share. As such, the additional income is intended to be spent purchasing fuel for transport or domestic heating (although there is, of course, no guarantee that it will be used in this way). It could be argued, therefore, that this enhanced purchasing power of consumers is of indirect benefit to suppliers. This can be viewed in two ways:

- Consumers could purchase quantities of fuel that they might not otherwise be able to afford. However, by its very nature the Cap and Share scheme limits the consumption of fossil fuels through the limit on the associated emissions.
- With greater consumer purchasing power fuel suppliers might be able to recover more of the cost of purchasing the allowances through charging a higher price for fuel. Whilst the details of this interaction are beyond the scope of this study, it must again be noted that the suppliers would not be able to recover more than their total costs and therefore could not profit from the scheme.

Noting the above, however, it is useful to examine relevant examples of case law and their potential applicability to the Cap and Share proposal:

- The European Court of Justice has recognised that benefits granted directly to individuals may be regarded as aid granted indirectly to an undertaking that carries on an economic activity. One example involved the German Government granting tax relief to individuals who invested in companies situated in Berlin. The Court held that this constituted State aid on the grounds that the tax revenue foregone by the Government enabled the investors to take up holdings in these companies (i.e. money that would otherwise have gone to the treasury in the form of taxes was foregone to ensure investment in the companies)[74]. This set of facts is not entirely apposite, as the tax exemption was premised on the individual's investment in the specified companies and the measure can result in a net benefit to the companies involved. In Cap and Share, there is no guarantee that the income foregone by the Government would be channelled as income to fuel suppliers, and in any case they should not benefit overall from the scheme.
- As discussed above, with Cap and Share fuel suppliers would not receive a net benefit, although the increased purchasing power from free allocation to individuals could be viewed as some compensation for costs that they incur under the scheme. An analogous situation arose before the European Court of Justice in which Greece abolished a preferential interest rate on loans for exports and sought to 'compensate' the exporters' by granting them an interest repayment. The ECJ rejected Greece's argument that the measure was economically neutral as compared to the previous system in place, finding that the measure, viewed independently from its predecessor, nonetheless favoured certain undertakings (namely Greek exporters) and therefore constituted prohibited State aid[75]. This case would suggest that the European Court might be inclined to take a similar view in this case, i.e. that an economic advantage had been conferred under the scheme.

A subsequent question arises in the case law, namely whether any alleged 'State aid' is selective. Aid may be selective even where it concerns a whole economic sector[76]. The Cap and Share scheme cannot be seen to 'favour certain undertakings'

74 *See* Quigley, p. 23 (citing Case C-156/98, *Germany v Commission* [2000] ECR I-6857, para. 26).

75 *See* Case 57/86, *Greece v Commission* [1988] ECR 2855, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:61986J0057:EN:HTML

76 *See*, in particular, Case C-75/97 *Belgium v Commission* [1999] ECR I-3671, paragraph 33.

within the sector(s) covered, as all suppliers of fuels will be treated equally under the scheme. Nor can it be said to 'favour the production of certain goods' as fuel suppliers are at a net disadvantage under the scheme as compared to other sectors of the economy which are not directly affected.

Distorts or threatens to distort competition and affects trade between Member States

These last two conditions are generally considered together. According to the case law of the European Court, they are fulfilled where "financial aid strengthens the position of an undertaking compared with other undertakings competing in intra-Community trade." Recently, in its assessment of the second German NAP, the Commission stated that "assigning more public resources in the form of free allowances to one group of existing installations distorts or threatens to distort competition with another group of existing installations and has also cross-border effects given EU-wide trade in all sectors covered by the Directive."[77]

From an objective standpoint, it is hard to envision how Cap and Share would distort competition or affect trade between Member States. The scheme would not provide a net advantage to the sectors involved relative to the status quo, therefore nor could it advantage them relative to those outside the scheme.

Recognised exceptions to State aid

As discussed above, even where a particular measure is deemed to be State aid under the EC Treaty, a number of exceptions exist to the prohibition on this form of assistance, including assistance given for environmental protection. This exception has been recognised for over 30 years. The most recent Commission Guidelines on the matter date from 23 January 2008[78] and include an analysis of the compatibility of tradable permit schemes with the prohibition on State aid:

3.1.12 Aid involved in tradable permit schemes

139. Tradable permit schemes may involve State aid in various ways, e.g. when permits and allowances are granted for less than their market value and this is imputable to Member States.

140. State aid may be declared compatible with the common market within the meaning of Article 87(3)(c) of the EC Treaty, provided that the conditions in point 140 and 141 are fulfilled. By derogation point 141 does not apply for the trading period ending on 31 December 2012 for tradable permit schemes in accordance with Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC57 (hereafter "EU ETS"):

(a) the schemes shall be set up in such a way as to achieve environmental objectives beyond those designed to be achieved on the basis of Community standards that are mandatory for the undertakings concerned;

(b) the allocation shall be carried out in a transparent way, based on objective criteria and on data sources of the highest quality available, and the total amount of tradable permits or allowances granted to each undertaking for a price below their market value shall not be higher than its expected needs as estimated for the situation in absence of the trading scheme;

77 *See generally* De Sepibus 2007.

78 *See* Community Guidelines on State Aid for Environmental Protection (12 January 2008), available at http://ec.europa.eu/comm/competition/state_aid/reform/environmental_guidelines_en.pdf

(c) the allocation methodology shall not favour certain undertakings or certain sectors, unless this is justified by the environmental logic of the system itself or where such rules are necessary for consistency with other environmental policies;

(d) in particular, new entrants shall in principle not receive permits or allowances on more favourable conditions than existing undertakings operating on the same markets. Granting higher allocations to existing installations compared to new entrants should not result in creating undue barriers to entry.

141. The Commission will assess the necessity and the proportionality of State aid involved in a tradable permit scheme according to the following criteria:

(a) the choice of beneficiaries must be based on objective and transparent criteria and be granted in principle in the same way for all competitors in the same sector/relevant market if they are in a similar factual situation;

(b) full auctioning must lead to a substantial increase in production cost for each sector or category of individual beneficiaries;

(c) the substantial increase in production costs cannot be passed on to customers without leading to important sales reductions. This analysis may be conducted on the basis of estimations of inter alia the product price elasticity of the sector concerned. These estimations will be made in the relevant geographic market. To evaluate whether the cost increase from the tradable permit scheme cannot be passed on to customers, estimates of lost sales as well as their impact on the profitability of the company may be used;

(d) it is not possible for individual companies in the sector to reduce emission levels for the price of the certificates to be bearable. Irreducible consumption may be demonstrated by providing the emission levels derived from best performing technique in the European Economic Area (hereafter "EEA") and using it as a benchmark. Any company reaching the best performing technique can benefit at most from an allowance corresponding to the increase in production cost from the tradable permit scheme using the best performing technique, and which cannot be passed on to customers. Any company having a worse environmental performance shall benefit from a lower allowance, proportionate to its environmental performance.[79]

The Cap and Share scheme would appear to satisfy all of the aforementioned requirements (even go beyond them in some respects as the allowances would be offered at market price, rather than at a value below that). While it seems apparent that Cap and Share is likely to meet the requirement in paragraph 141(c), that: "the substantial increase in production costs cannot be passed on to customers without leading to important sales reductions", it may be valuable to undertake a more rigorous economic analysis to determine the precise nature of the expected relationship between price and sales.

Assuming this criteria is adequately met there is a high likelihood that the Cap and Share scheme would be exempted from the prohibition on State aid. This is reinforced by the Commission's decision on a UK emissions trading scheme which included the provision of grants to companies in return for absolute emissions reductions for which they bid in an auction. The Commission held that the scheme was compatible with the environmental aid exception to State aid, on the basis that the grants were a necessary incentive in the absence of any EC scheme[80]. Given that carbon emissions from the various sectors under consideration are not currently covered under EU ETS (or any other EC scheme), the Commission would likely come to a similar conclusion for Cap and Share.

79 *Ibid*. paras 139 – 141.

80 *See* Quigley, p. 189, fn 102 (citing *Thirty-First Report on Competition Policy* (2001), pt. 388).

However, it is worth noting that the Commission has determined that 'the duration of aid schemes should be subject to reasonable time limits'.[81] The fact that the indirect compensation scheme proposed under Cap and Share also runs counter to the 'polluter pays' principle in that it compensates consumers for their emissions costs (in the expectation that firms would pass on these costs) on to their customers, also suggests that the Commission's tolerance for such a scheme might be limited[82].

Conclusions

Based on the foregoing, it appears that the Cap and Share scheme would not constitute prohibited 'State aid' under Article 87(1) of the Treaty. However, it is not possible to be definitive as the case law shows that facts that are analogous, or arguably analogous, to the situation under Cap and Share have been held to satisfy each of the four elements required to demonstrate State aid. It is therefore possible that the Commission and/or European Court of Justice could construe the scheme as constituting State aid.

However, there are two compelling factors to suggest that, despite this case law, the Commission and the ECJ might be disinclined to make a finding that Cap and Share is prohibited. The first is that there are a number of recognised exceptions to State aid, including aid involved in tradable permit schemes. The second is the existence of the EU ETS. This scheme works in a way that is not dissimilar to Cap and Share in that valuable entitlements are distributed, by the Government, to industry, at no charge. Therefore, if EU ETS is permitted, Cap and Share, for similar reasons, should be permissible. To date, there has been no official consideration of the State aid rules to EU ETS. To the extent that EU ETS is condoned by the European Commission, Cap and Share has a good argument for going ahead.

81 *See* Community Guidelines on State Aid for Environmental Protection (23 January 2008), para. 71, available at http://ec.europa.eu/comm/competition/state_aid/reform/environmental_guidelines_en.pdf.

82 *Ibid*. para. 8.

5.2.2 Freedom of movement and competitiveness of the market

The essence of the European Community is the freedom of movement of goods, services, labour and capital. The attainment of these four freedoms depends on a fully competitive market. Cap and Share will affect all fuel suppliers in the market equally. There will be no advantage to an Irish company as opposed to a company from another European Member State as the carbon allowances will be available to all fuel suppliers, and all suppliers will be required to surrender allowances for fuel supplied in the Republic of Ireland.

One area of possible concern relates to fuel supply companies that operate in the Republic of Ireland but have a share of the market in Northern Ireland, in a system that only includes the Republic. As petrol prices rise in the Republic under Cap and Share it is foreseeable that fewer individuals will travel south for their fuel and in the event of prices in the Republic exceeding those in Northern Ireland the direction of fuel tourism could reverse. One indirect consequence of the scheme, therefore, might be to increase the profitability of fuel suppliers in Northern Ireland. This market distortion would be detrimental rather than beneficial to fuel supply companies in the Republic, but would require further consideration.

A further consideration is that in order to increase their competitiveness in the Republic, supply companies might be tempted to use the increased profits from their business in Northern Ireland to offset the additional costs of operating in the Republic, thereby enhancing their competitive position in the Republic. It is clear that firms with operations in Northern Ireland (especially those operating near the border) would reap an incidental advantage from the scheme. It should be considered whether this advantage could be said to represent a prohibited interference with competition or whether it would merely be regarded as an acceptable by-product of differences that commonly exist between one country's regulatory and tax regime and another's.

A final area for consideration is potential anti-competitive behaviour relating to the buying and selling of allowances by fuel suppliers to manipulate the carbon and hence fuel price. The likelihood and feasibility of this scenario may warrant further investigation, although there is nothing to suggest that this outcome could not be prevented by a robust regulatory framework. More stringent prevention measures would include restrictions on allowance trading, although this would appear inconsistent with the market principles of the scheme.

5.3 What proportion of the population would be covered in the scheme?

The design of any trading scheme requires certain boundaries to be made, this inevitably leads to certain participants benefiting in comparison to others. This section looks at who should be included in the scheme, reviews the design features that could minimise distortions, and makes the following findings:

- **The register of eligible individuals** compiled through a combination of the electoral roll and the Personal Public Service number should capture the majority of people. However making the scheme self-promoting and relatively simple to join will be crucial.
- **Treatment of resident children** will be dependent on the government's priorities. Literature generally suggests not allocating in full to children (although the principle of equal per capita allocation underpins the Cap and Share proposal). If there were no full allocation to children consideration would need to be given to the age at which individuals are considered an adult for the purpose of the scheme. Consideration should also be given to other mechanisms to support families regarding the increased carbon costs. Less favoured alternatives would include partial allocation to children or allocation on a household basis.
- **Visitors** for very short periods should not receive any allocation, but there is a case for long staying visitors, say over 1 year, to receive an allocation. Consideration would need to be given to the timing of such allocations to avoid visitors claiming certificates shortly

5.3.1 Compiling the register of eligible individuals

Under the Cap and Share proposal the tonnage of CO_2 emissions from fossil fuels used in the sectors to be controlled would be calculated in the baseline year. This amount would be divided by the number of people on a register, with each person receiving a certificate covering their share of emissions

A register of individuals who are eligible to receive the certificates would need to be compiled. It would be essential to track the changing circumstances of members of the population. If the scheme were to cover adults over the age of 18 then a register complied through a combination of the electoral roll and the Personal Public Service number (PPS) should capture the majority of adults[83].

The PPS is a unique reference number that is essential for transactions with public bodies and can be used to accurately identify the individual in the administration of public services. Most citizens have a PPS number, it has been automatically issued to those born since 1971 and those who have been in employment since April 1979. Other residents can obtain the number voluntarily. The process for applying for a PPS is relatively simple and therefore should not act as a barrier. A designated Social Welfare Office can issue a PPS; this requires completion of an application form and proof of identity. Making the scheme self-promoting and relatively simple to join will be an important factor. The number is important for an increasing number of interactions with the state, and used in relation to education, health, housing, social welfare and tax services.

83 http://www.welfare.ie/topics/ppsn/moreinfo.html

There are clear monetary benefits from involvement in the scheme. In the sectors covered by the scheme the carbon cost will be incorporated into the price of the goods and services and those who are not allocated certificates will not be compensated for the increase in costs. If there is effective marketing and communication of the scheme and the public understand how it works, then it can be assumed that those who are entitled to receive a certificate but don't have a PPS number, will seek to be involved rather than being placed at a financial disadvantage. Individuals who are likely to voluntarily join the scheme would be those who do not have a PPS number, because they were born or worked prior to the commencement dates, and not in receipt of any benefits.

A Tyndall study by Starkey and Anderson (2005)[84] considers methods for compiling a register for a PCA scheme in the UK. They review an ID card scheme, electronic verification and use of the electoral register. In the Cap and Share context these would not provide the same coverage as the PPS, and an ID scheme would involve additional costs. Defra (2006)[85] examined the UK position and reached a similar conclusion suggesting the use of the National Insurance register that is very similar to the PPS.

5.3.2 How residents should be treated

If certificates were only provided to adults aged 18 and over who have a PPS number this may raise a number of equity issues regarding the treatment of children. Other similar issues arise concerning residents in institutions and vulnerable individuals. The social implications must be considered in the development of any individual trading scheme, and various researchers have looked at this issue.

Children

Existing research

An important principle of the Cap and Share scheme is that each person has an equal right to the benefits of limited fossil fuel resources and by implication should receive equal emissions allowances. This would suggest that children should receive a full allocation. However, existing literature has examined the distributional issues relating to allocations to children under personal carbon trading schemes.

Under a scheme with allocation only to adults, households with children may not be fully compensated for the full increase in their fuel costs. The Defra (2006)[86] study looked extensively into the issue of whether allocations should be given to children. There are a number of academics that are against allocations to children and dependents, arguing that children are not participants in the market as they are not in employment or make energy purchases, therefore they should not be given an allocation. In most cases children will not be the ones purchasing the energy and they feel it is reasonable that certificates should be only given to those who make purchases of energy.

The Defra study also looked at the alternative view that as dependents consume energy they should be included in the allocation. They consider the suggestion that dependents could be given half an allowance, the implications of which were reviewed by Starkey and Anderson (2005)[87] who draw on the analysis of Ekins and Dresner (2004)[88]. They found that under a Domestic Tradable Quotas (DTQs)[89] scheme awarding half an allowance to each child results in moving the benefit from households without children to those with children, having only

84 Starkey and Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre.

85 Simon Roberts and Joshua Thumim (2006) A Rough Guide to Individual Carbon Trading. Centre of Sustainable Energy and Defra.

86 *Ibid*.

87 Richard Starkey and Kevin Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre.

88 Dresner S and P Ekins (2004) The distributional impacts of economic instruments to limit greenhouse gas emissions from transport, Policy Studies Institute, London, 2004.

89 Note that unlike Cap and Share, DTQs/TEQs would not distribute 100% of allowances to individuals for free.

a redistribution effect. Overall the total number of households made worse off by the scheme will be similar whether children receive an allocation or not, because the total allocation available will be fixed by a cap. This suggests that if the aim of the scheme is to minimise those who are made worse off by the scheme then issuing allowances to children will have very little overall impact. However, Defra (2006) suggested there needs to be further analysis taking into account wider fuel poverty factors, to refine the findings by Ekins and Dresner (2004).

In a subsequent Defra study[90] the question of allocation to children was reviewed, with analysis for the UK showing that a one third allocation to children would minimise disproportionate effects and, it was argued, would represent a reasonable compromise between the arguments in favour of full and zero allocations.

Overall, whilst the principle of Cap and Share points to allocating to children, there appear to be distributional reasons for not offering a full allocation. Furthermore, recognition that energy purchasers will in practice be accountable for the resulting carbon emissions would imply no allocation at all to dependents. Finally, giving children an allowance may appear to endorse energy consuming behaviours, such as more parents doing the school run, since they may feel that the they have been given a right to emit. It is therefore important to consider the potential options for a not giving a full allocation to children.

The options and implications of not giving a full allocation to children

The adoption of an adult-only approach would raise the issue of to what age parents should take responsibility for their children's allocation and emissions. Setting the age at 18 would disadvantage 17 year olds who hold a full drivers licence who will have to pay the increases in the fuel price but are ineligible for the scheme. A possible solution to explore might be to design a process that allows 17 year olds who hold a driver's licence to participate in the scheme either through them opting to join or through an automatic qualification that should be relatively simple as the PPS number is needed in order to hold a drivers licence. Allocation to 16 or 17 year olds was also highlighted as a possibility by Starkey and Anderson (2005): if the age was set at 18 this would mean those aged 16 and 17 living independently would not be compensated for the increase in energy prices. (However lowering the age limit to 16 would provide a windfall to those 16 year olds who live at home).

With a system that allocates only to adults, Government would want to consider additional compensation to parents. Matthews (2007)[91] recognises that allocating the certificates only to adults above 18 will lead to criticism that the scheme is unfair to large families but suggests that adjustments should be made through other targeted means, such as through existing measures like Child Benefit (the Children's Allowance).

Another option that could be considered would be to provide parents with a greater allocation. Tyndall proposes that allocating units to parents (for personal carbon trading schemes in general) would be one route to countering fuel poverty. Note that the distributional implications of this proposal are similar to that for allocation to children discussed above. Research carried out by the Policy Studies Institute[92] has demonstrated that a scheme where parents are allocated additional units reduces the number of households with children made worse off. However, it also demonstrates that the total number of households falling into fuel poverty

90 Distributional Impacts of Person Carbon Trading, Report for Defra, J. Thumim and V. White, University of Bristol School for Policy Studies, March 2008, http://www.defra.gov.uk/environment/climatechange/uk/individual/carbontrading/pdf/pct-distributional-impacts.pdf

91 Laurence Matthews (2007). Memorandum to the Environmental Audit Committee Inquiry into Personal Carbon Allowances " Cap and Share".

92 *See* Ekins, P. and Dresner, S., *Green taxes and charges: reducing their impact on low-income households* (Joseph Rowntree Foundation, York 2004).

remained the same overall (as more households without children 'overspend' their reduced carbon allowance)[93].

A further option would be a partial allocation to children. As noted above, Defra[94] find for the UK that a one-third allocation to children would be a reasonable compromise between the factors involved.

Residents in institutions

Another group highlighted in the Starkey and Anderson (2005)[95] Tyndall paper was eligibility of those who are long term residents in institutions (such as hospitals, care homes or prisons), and whether they should directly receive their allowance or should it be given to the institution. The institution will face higher fuel costs and will be making some of the energy consumption decisions on behalf of the individuals and indeed will make decisions regarding communal facilities. However, a consistent approach to the proposed treatment of children with respect to energy choices would be not to allocate to the individual but rather compensate the institution. The implications of this and the proportion of people affected will require further examination.

Household allocation

An alternative might be to apply the scheme to households rather than at the personal level, however the issues regarding the size of the cap for larger families may still apply and need to be resolved. This might lead to the added complication of those renting, or sharing. It would also raise the issue of who would receive the certificates; it would probably be the home owner however if there were a number of adults living in the same house they could argue for their fair share when the certificates are issued. A household approach may also require an allocation methodology, using a type of benchmark that recognises different types of households. The disaggregated benchmarks might be based on the number of bedrooms, or local tax bands, which might result in more people feeling unfairly treated and could be very bureaucratic.

There is a general consensus there needs to be some concession for those with dependents. The most appropriate mechanism for the compensation will be dependent on the government's priorities. If clarity and equity are core objectives allocating half the value of a certificate to children seems the best option. If maintaining the simplicity of the scheme is essential then it would be advisable to use the most direct mechanism to compensate those who will be disadvantaged, however careful consideration will be needed of all the options.

5.3.3 How visitors should be treated

As discussed above, the scheme should apply to all residents in Ireland who have a PPS number, which would mean that tourists would not be automatically entitled to a certificate. Consideration needs to be given to whether tourists or longer staying visitors should be included.

Tourism

This again is an issue that has been considered within the context of other schemes, however there is not as much research on the available options. Tourists staying only for short periods (for example in hotels and bed and breakfast accommodation) are unlikely to be eligible for a PPS number as proof of an Irish address is required. If Ireland alone were imposing a carbon cost on certain sectors then higher fuel prices might act as a disincentive to visit Ireland if visitors were not compensated for the higher prices. This could potentially have implications for the tourism, however this should be relatively minor. There are many reasons such as exchange rates, cultural and higher costs of living

93 *See* Tyndall Research 2005.

94 Distributional Impacts of Person Carbon Trading, Report for Defra, J. Thumim and V. White, University of Bristol School for Policy Studies, March 2008, http://www.defra.gov.uk/environment/climatechange/uk/individual/carbontrading/pdf/pct-distributional-impacts.pdf

95 Richard Starkey and Kevin Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre.

that cause price differences between countries. In relative terms fuel prices in Britain and Germany tend to be much higher than Ireland. There seems very little reason to compensate those who are visiting Ireland for tourism. If the scheme were to be adopted on a global or EU scale residents would receive a certificate in their home country, and it would remain unnecessary to allocate to tourists.

Longer staying visitors

In principle the scheme should be designed to ensure those resident in Ireland for the duration of a trading period are eligible for a certificate, since they would be living similar lifestyles to national residents. The requirement to register for a PPS number should ensure that business visitors are able to participate because the PPS system should effectively capture anyone in the tax system. To not allocate to long staying visitors could act as a disincentive for multinational companies to the location of workers in Ireland, since further incentives would be required to encourage employees to relocate. However, as discussed above for tourists, this is unlikely to be a major concern for the economy as a whole, since other factors will have a greater effect on the relative costs of living between countries. The timing concerns relating to allocation to visitors are discussed below in Section 5.3.4.

Partners and family who will be resident for the same duration, but not necessarily working and claiming benefits may not under the current proposal be eligible. This may not be an issue that affects a large number of people or might just be accepted, as another factor affecting the cost of living in a country. It might be a commercial business choice, if they require employees and their families to relocate the increased cost of living might have to be incorporated in any remuneration deals.

5.3.4 Eligibility within a year

Any scheme involving the free distribution of certificates on a periodic (e.g. yearly) basis needs to identify rules for changes of eligibility during the period for which the certificates are issued. Whilst not critical to the design of the scheme we identify a number of issues that would require consideration.

Reaching eligibility age. It would seem unnecessarily complex to make provisions for issuing partial certificates to individuals at the time they reach the eligibility age. However, those individuals could argue that they would be disadvantaged by waiting until the following year before receiving an allocation. A scheme involving more frequent allocations could allow for certificates to start to be issued to qualifying individuals part way through the year, although this would create some uncertainty over the total cap, since the total cap is equal to the annual individual allocation multiplied by the number of participating individuals.

Death. If the cap is determined at the beginning of the year and allocated quarterly, say, the design of the scheme would have to take into consideration an individual dying prior to one or more of their quarterly allocations. It does not seem logical to allocate to the estate of the deceased. In this case symmetry between those reaching eligibility age and those dying would be best achieved by allocating certificates to newly eligible individuals at the next planned issue point, even if this were part-way through a year (such as in a quarterly allocation system). This would also ensure allocations were similar to actual demand.

Visitors. The potential allocation to long-staying visitors becoming eligible for a PPS number to receive allocations raises questions about gaming and fairness. There could be a risk that temporary residents may take advantage of the scheme by registering for a PPS number at the beginning of a phase to simply cash in their certificates and leave. This incentive could be minimised through the timing and frequency individuals receive their certificates, or possibly applying an eligibility period, for example only allocating certificates to individuals who have been eligible for 3 months.

5.4 What administrative and institutional arrangements would be necessary for the operation of the scheme?

There are a number of institutions and processes that will be crucial in the operation of the scheme. This section attempts to capture all the relevant institutions that would be involved in the scheme and the processes that will have to take place. It identifies the issues and options that will need to be considered and makes the following findings:

- A Government body would need to be responsible for setting the framework, the objectives and dealing with any policy issues. It will be responsible for developing the design aspects and consulting with other institutions, industry, the public and other interest groups. The department to do this should be that responsible for climate policy, namely the Department for Environment.
- Cap setting could either be carried out by Government or an independent body. In either case, however, the cap should be consistent with the national budget in the Climate Protection Bill and the strategy it sets for individual sectors.
- The scheme would need to be run by a single administrative body. This would ensure consistent accountability for all aspects and clarity from the perspective of participants. It would also ensure the effects of any changes to approach could be managed throughout the process. The Environmental Protection Agency, as scheme administrator for the EU ETS would be the logical choice. It could also draw on its experience from being responsible for the National Emissions Inventory. The responsibilities of this body would be to: Maintain the register of fuel suppliers; define the standards by which emissions must be reported and verified and produce guidance documents and; maintain the trading registry.
- In addition to the above activities there would be a number of other functions for which the scheme administrator must maintain an overview but which may be carried out by other bodies. These would include: Maintaining a list of participating individuals and issuing them with certificates (for which the Department of Social and Family Affairs would have a role); determination and verification/audit of emissions (for which Customs and Excise would have a role); market regulation and; training and capacity building.

5.4.1 Institutional arrangements

Policy development

A government body will need to be responsible for setting the framework, the objectives and dealing with any policy issues. It will be responsible for developing the design aspects and consulting with other institutions, industry, the public and other interest groups. The department to do this should be that responsible for climate policy, namely the Department for Environment.

Cap setting

A body will need to have clear responsibility for setting the cap. Whether this be a government department or an independent body (such as the Commission on Climate Change established under the Climate Protection Bill[96]) is largely a political decision. The benefits of independence are that the caps could remain objective and unaffected by any short-term political drivers. The Cap and Share cap would be inextricably linked to the national carbon budget since the Cap and Share scheme would be a mechanism contributing to the achievement of the national target. The Bill was debated in October 2007 and the detail of how the national budget and greenhouse gas strategy are to be designed are still to be finalised, however it would be important for the Cap and Share scheme to be consistent with these two elements.

96 http://www.foe.ie/download/pdf/oireachtas_climate_bill_2007_42.pdf

- The Bill in its current form proposes a national greenhouse gas emissions budget that will specify a national annual target figure, which is based upon at least a three per cent reduction in greenhouse gas emissions for each year from 2010 to 2050.
- The Bill will include a national greenhouse strategy that will set strategies for individual sectors based upon achieving specified reductions in them for the following year and 2050.

Administration of the scheme

The scheme would need to be run by a single administrative body. This would ensure consistent accountability for all aspects and clarity from the perspective of participants. It would also ensure the effects of any changes to approach could be managed throughout the process. The Environmental Protection Agency, as scheme administrator for the EU ETS would be the logical choice. It could also draw on its experience from being responsible for the National Emissions Inventory[97]. The responsibilities of this body would be:

- Maintaining the register of fuel suppliers. Fuel suppliers would be the regulated entity required to surrender allowances each year. The scheme administrator would be responsible for maintaining an accurate register of those companies.
- Defining the standards by which emissions must be reported and verified and produce guidance documents.
- Maintaining the trading registry. The purpose of the registry would be to establish accounts within which participants can hold allowances. Any party wishing to buy or sell allowances would therefore be required to have an account (in an unrestricted market this could include banks, other traders, fuel suppliers, even members of the public). It would allow the responsible body to reconcile the allowances with the verified emissions. To avoid the requirement for each member of the public to have a registry account they should be issued with uniquely identifiable certificates equivalent to a certain number of allowances (rather than the allowances themselves). When these certificates are cashed in with the bank or post office, these organisations would be credited the corresponding number of allowances to their own registry account by the scheme administrator. An alternative approach would see banks and post offices licenced to generate allowances corresponding to the number of certificates they purchase, with a system being necessary to check and reconcile the allowances issued with the certificates purchased.

In addition to the above activities there would be a number of other functions for which the scheme administrator must maintain an overview but which may be carried out by other bodies.

- Maintaining a list of participating individuals and issuing them with certificates. If the basis for eligibility is the PPS number system then it logically follows that the administrator of this system , which is currently the Department of Social and Family Affairs[98], be responsible for compiling the list of those individuals who will receive a certificate. However, certificates will require a unique number which will be verifiable before the scheme administrator can release allowances into the account of banks or post offices. The scheme administrator will therefore need to be responsible for this list of numbers and it may therefore be logical that it is responsible for issuing certificates. Starkey and Anderson (2005)[99] in their report for the Tyndall Centre looked into the issues of creating

97 http://www.epa.ie/whatwedo/climate/nationalemissionsinventories/

98 http://www.welfare.ie/topics/ppsn/index.html

99 Richard Starkey and Kevin Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre.

a database for Domestic Tradable Quotas (DTQs) and their research found that the costs of this should be low and relatively simple.

- Participation of fuel suppliers. Fuel suppliers will need to surrender allowances corresponding to their calculated emissions each year. There are a number of ways by which these emissions estimates can be determined, in theory:
  - It has been proposed that Customs and Excise use fuel import data to determine the emissions attributable to each fuel supply company, which they would then report to the scheme administrator. In this respect they would act as monitor, verifier and reporter, using data originating with the fuel suppliers. A potential concern with this approach is the extent to which fuel import duty data is properly reflective of the emissions occurring in the sectors covered by the scheme. Fuels entering the country would have a variety of uses and it is possible that some would be outside the intended scope of the scheme (for example being used in power generation and international aviation).
  - Given the above concerns an alternative approach would be to require fuel suppliers to provide data directly associated with the sectors covered. On the basis that they are selling to these markets this should be possible in principle. Such an approach would then require an independent verification or audit process, which could be overseen by either the scheme administrator (EPA) or Customs and Excise. The audit approach would minimise administrative costs perhaps similar to that proposed in the UK Carbon Reduction Commitment. Under that proposal participants would submit their own emissions reports but would be required to produce evidence packs that would be subject to a random 20% audit by a competent authority or its agents. However, the decision on the level of scrutiny would involve consideration of the costs in relation to the value of the total emissions and it may be that with relatively few organisations to check a full verification is preferable.
- Market Regulation. It might be advisable for government to appoint an authority in Ireland to oversee the transaction process. It might come under the current financial services regulator for the transaction requirements, or the EPA as they have experience with the EU ETS.
- Training and capacity building. The information provided and services offered would need to be consistent and up-to-date therefore central coordination by the scheme administrator would seem preferable. However, it may be that the communication activities themselves may be carried out by other agencies or bodies. This is discussed further below.

Intermediaries

Financial intermediaries will be needed to facilitate the exchange of certificates. They would be involved in transactions with the individual certificate holders by purchasing the certificates and trading the allowances created, with them ultimately being sold to the organisation responsible for surrendering allowances.

Under the Cap and Share proposal individuals may be required to trade the certificates in person allowing any checks against the register and provide some form of proof of identification. However, if the certificate has each individuals name on it and an identification number, it should be possible to lodge them to the bank in that name without the individual being there in person. The role of intermediaries could be opened to include banks and post offices to ensure there is sufficient competition. Banks and post offices are well placed to act as intermediaries, already having similar trading processes and systems in place.

Starkey and Anderson (2005)[100] support the view that the existing banking structure is a good option to utilise, and Roberts and Thumim (2006)[101] highlight that the advantages of the banks are that they are familiar with reporting systems, subject to a regulator, and already familiar with identity verification.

In order to minimise the administrative costs of the scheme and ensure it is not completely dependent on government support, banks seem a suitable intermediary to facilitate the trades for individuals. Their role would be very similar to the cashing in of a foreign currency note, converting the certificates into cash given the carbon rate for that day of trading, with the bank taking a fee for handling the transaction. Clear guidelines and technology must be compatible for trades across banks, however this should not be too problematic as banks already transfer money between accounts.

The banks and post offices meeting certain regulatory requirements would be able to handle the transaction of certificates, and may depending on the design of the scheme make a profit from purchasing at a low price and selling to buyers at another, and charging commission. An incentive for banks would also be using the scheme to attract new customers. Additional services which could be offered by banks could include:

- A simple allowance exchange facility
- Support and advice for customers to invest in energy efficiency measures (possibly through loans)
- Access to the market for allowances to respond to individuals' increased interest in this area
- Financial services offered to companies who would be affected by the scheme (such as those businesses with extensive transport activities who might want to minimise there exposure to carbon prices)
- Access to CDM projects which could be sold to emitting organisations if these credits were to be valid under the scheme

5.4.2 Training and Capacity building

Training and capacity building will be essential for public acceptability and understanding; this was one of the main issues that came out of the SWOT analysis.

Trials

Matthews (2007)[102] observes that pilots and trials may help identify administrative issues and provide an indication how groups and individuals may respond. However he recommends that development of simulation games and trading systems and role-play rather than regional pilots might be more suitable.

UKERC (2007)[103] has extensively looked into the issue of trialing the PCA's, the issues are directly relevant to the trialing or piloting Cap and Share. Table 5.1, below provides an overview of the pros and cons of trialing the scheme, taken from the UKERC study. The key barriers with the introduction of a PCA scheme were identified as being a lack of social and political acceptability, the same issues which might be a barrier to Cap and Share.

100 Richard Starkey and Kevin Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre.

101 Simon Roberts and Joshua Thumim (2006) A Rough Guide to Individual Carbon Trading. Centre of Sustainable Energy and Defra.

102 Laurence Matthews (2007). Memorandum to the Environmental Audit Committee Inquiry into Personal Carbon Allowances " Cap and Share"

103 Tina Fawcett, Catherine Bottrill, Brenda Boardman, and Geoff Lye (2007). Trialling personal carbon allowances - UKERC

Table 5.1 Pros and Cons of a trial (adapted from UKERC (2007))

Pros	Cons
Provides research evidence - collection of quantitative data on the carbon profile and socioeconomic data of participating individuals or households.	Validity of results, data from a pilot can't be used to draw conclusions on a mandatory and national scheme
Provide a better understanding of the social context of the scheme. It assesses the attitudes and experience with scheme	The IT systems might not be sufficiently developed, if this leads to poor public experience of the systems this could may could lead to public distrust of them
Assess the behavioural responses to the scheme	Other research methods could provide valuable results
Assess the publics' capacity to act and how they respond to a lower carbon society. Identify the barriers, opportunities, help and how these vary	

The Defra (2006) study recommends against undertaking a pilot of personal carbon allowances[104]. In the more recent UKERC study they review what are the objectives of conducting a trial, the advantages and disadvantages and come to the conclusion that a trial, although complex would be provide insights in to personal carbon trading. They estimate the approximate costs would be between £500,000 and £950,000, and may take between two and three years. An option they consider is the introduction of the scheme into one sector, for example transport.

The pros and cons of trialing the scheme will also have to be looked at carefully, however existing research provides some support for the introduction in one sector, for example the transport sector discussed in more detail in section 5.8.

Awareness, advice and information

Ireland has a successful record of communicating issues relating environmental issues, winning the EU award for best practice in communicating environmental issues for "Notice Nature" the Department of Environment, Heritage, and Local Government's biodiversity awareness campaign. Notice Nature[105] is a public awareness and stakeholder engagement campaign that aims to increase understanding in Ireland of the value of biodiversity to human well-being, and the importance of protecting it.

There are valuable lessons learnt from this campaign that could be used to successfully deliver the marketing of the Cap and Share scheme, and communicate the importance of reducing carbon emissions and the action individuals can take. The issue how to best educate the participants will require further consideration as it will be a crucial factor in the success of the scheme.

Effective communication and information will be crucial. There is potential for individuals to lose money if they sell their allowances at a different time to when they incur carbon costs in the goods and services they buy, or indeed if they fail to sell them at all. Impartial advice and information is therefore required at an individual level, this could be provided by the new body, the banks, post offices, other existing advice providers or a new designated advice service. This should be particularly targeted at those who are more likely to have difficulty understanding the scheme or maybe may be left disadvantaged by not participating (for example the fuel poor and elderly).

A quarterly allocation would increase the public's awareness and ensure they become familiar quite quickly with the process of having to sell their certificate by a certain date or risk losing its value. However, there would be a trade off between improved learning and introducing more transactions costs for the individual through more frequent transactions.

The fuel suppliers who are required to purchase and surrender allowances must receive training, ensuring they understand their obligations and have

104 Simon Roberts and Joshua Thumim (2006) A Rough Guide to Individual Carbon Trading. Centre of Sustainable Energy and Defra.

105 http://www.noticenature.ie/

a realistic view of audit expectations. Information and advice must be easily accessible, with guidance on the Internet similar to the EU ETS with contacts if they have further questions. Evidence with the EU ETS (specifically a high level of compliance) suggests that this awareness training can be successful.

The following are suggestions of the types activities that could be used to inform general public, and build capacity in institutions and in the bodies responsible for administering the scheme:

Table 5.2: Awareness-raising measures for Scheme

General Public
• Advertising campaigns to raise awareness of scheme in principle (TV, Radio, press)
• Mass mailshots providing a description of the process (including timelines)
• A website with frequently asked questions
• Trained staff at post offices or the local office of Social and Family Affairs, who can help during an introductory phase
Institutions
• Seminars
• Guidance documents
• Regular policy and performance updates
Administrators
• Seminars
• Guidance documents and web pages
• E-mail help-line
• Training on the use of systems

5.4.3 Other design considerations

Abuse of market power

Consideration needs to be given to whether the abuse of market power by banks is a threat, since with Cap and Share the natural sequence is for all allowances to pass through banks (or the post office). The concern would arise if banks were to restrict supply in order to elevate prices. This abuse of market power could also occur in any other carbon trading scheme but is highlighted for Cap and Share because the natural sequence is for all allowances to pass through banks. As an abuse of power it is only a threat if a large proportion of allowances pass through a single institution or if multiple institutions act together.

Conversely, it could be argued that it is unlikely banks would hold on to allowances to elevate the price because the market price would naturally stimulate sellers if it rose, with the net result that the price remains at a similar level. This again is provided there are multiple banks and there is no collusion. A regulatory body (for example CBFSAI described below) overseeing the transaction process and banks wanting to maintain their own reputations may be an approach to ensuring collusive behaviour is avoided.

Further options for reducing the risk of the abuse of market power include:

- Licensing banks for the purposes of exchanging certificates with the general public and set up conditions regarding anticompetitive behaviour. It would then be necessary to carry out a periodic review and revoke the licenses of any offenders.
- Encouraging/allowing any organisation to purchase certificates from individuals; thus improving liquidity and reducing the proportion of trades that occur through banks.
- Limit the number of allowances each intermediary could hold, although this would raise concerns over heavy handed market regulation.

A brief overview of the Irish retail banking sector

The high street banks and the institutions that currently offer retail services are probably best placed to act as an intermediary in the Cap and Share Scheme. This section provides a brief overview of the retail banking sector and outlines the level of competitiveness amongst those offering retail banking services in order to establish whether there should be a sufficient level of competition in the market to avoid an abuse of market power or collusive behaviour. A more in depth market analysis would be required to accurately highlight the degree of risk associated with the abuse of market power or collusive behaviour.

Regulation

The Irish Financial Services Regulatory Authority forms part of the Central Bank and Financial Services Authority of Ireland (CBFSAI) and has the responsibility for the financial sector regulations and consumer protection, this covers over 1000 financial entities in Ireland. They monitor and report on competitiveness in the financial sector. This ensures a stable financial system and contributes to the reputation of the sector.

The Irish Banking Federation (IBF)[106], which is a representative body for the banking and financial services sector in Ireland have found in their research[107] that the Irish banking sector is open and competitive. A number of foreign banks have entered the market through setting up subsidiaries or by acquisition. The arrival of new competitors has driven product and service innovation in the market and in recent years has enhanced customer choice and competition.

Main players

Retail banks and building societies provide services to personal and business customers in Ireland. They deal with the majority of an individual's daily transactions and provide a range of savings and investment products.

The retail banks have more than 900 branches and sub-offices throughout Ireland, and the main retail banks that have a strong high street presence are presented in the following table. The five largest banks in Ireland are Allied Irish Bank (AIB), Bank of Ireland, National Irish Bank, Ulster Bank and Permanent TSB Bank, and there are also two main building societies.

The retail banking in Ireland is dominated by the main clearing banks which provide a full range of financial services, they tend to have branches nationwide and provide services across all sectors. However, there are a significant number of smaller banks and building societies that also compete with the major banks for retail customers, their branch network is less extensive though.

106 http://www.ibf.ie/

107 http://www.ibf.ie/pdfs/Competition_Feb08.pdf

Table 5.3: Main Banking Groups and Building Societies in Ireland

Banking Group	
Allied Irish Banks Group	Considered the largest bank in the country. Has the largest branch network in Ireland with branches in most towns and services can be accessed through post offices. Offers internet banking.
Bank of Ireland Group	Second biggest bank in the country – offices in many towns, however the coverage is not quite as extensive as AIB. Offers internet banking.
Ulster Bank	An extensive branch network across all counties in Ireland and offers online banking.
Permanent TSB	An extensive branch network across Ireland, provides internet banking services.
National Irish Bank	Around 20 branches. Offers online banking.
Bank of Scotland (Ireland)	Around 20 offices and expanding. Provides internet banking services.
ACC Bank	Around 30 brand offices.

Building Societies	
EBS (Building Society)	An extensive network, with over 50 branches and provides online services.
Irish Nationwide (Building Society)	Many branches across Ireland

The Central Bank website[108] publishes a list of the institutions which have been issued with a license to conduct banking business in the State under Irish Legislation. The current list which is up to date as of February 2008 has over 50 authorisations granted to different institutions. The regulator oversees the more than 80 banks and 400 credit unions.

There are other institutions that are currently offering banking services and could fulfil the role as an intermediary in the scheme. An Post[109], along with the postal service also offers banking services

108 http://www.ifsra.ie/data/rf_files/Register%20of%20Credit%20Institutions%20as%20at%2029%20February%202008.pdf

109 http://www.anpost.ie/AnPost/MainContent/Personal+Customers/Money+Matters/An+Post+Financial+Services/financial_services.htm

for AIB customers, who are able to lodge cash, withdraw cash, or pay credit cards. PostBank[110] offers banking services through post offices as well as an online service. Also the Credit Unions[111] could also fulfil the intermediary role. They are individual community based financial institutions that provide financial services, including savings, loans, insurance, ATM/EFT facilities, money transfer, foreign exchange, and other services.

The IBF[112] has found that secure, reliable and easy access to cashless payments is very popular in Ireland. Their research estimates there were about 605 million payments, worth €1,200 billion in 2006. This level of popularity indicates that an online trading option to cash in allowances should be considered. This would also enlarge the role of intermediary to those that primarily offer online financial services.

Rabobank and Northern Rock have a large presence in the online savings market in Ireland, and if the allowances can be traded online and not just over the counter they could also potentially offer intermediary services online, which further expands for scope for competition. The Irish banking sector seems sufficiently competitive and is overseen by the Financial Regulator, this should avoid any abuse of market power. However a more thorough analysis looking at how the market has operated and how players compete would provide more insight, and monitoring throughout the scheme should highlight if there is any collusion or abuse of market power.

A paper based system?

As noted above technology is in place in society to use electronic funds transfers to keep track of the necessary transactions for the scheme. We would recommend that any development of the scheme be based on electronic transactions, particularly since this would help minimise concerns over transaction costs for those who have lifestyles (including those in rural communities) where visiting the bank or building societies are not a common daily routine.

110 https://www.postbank.ie/

111 www.creditunion.ie

112 http://www.ibf.ie/

However, in Ireland a high proportion of the population visit post offices and banks (compared for example with the UK) therefore it might be desirable to also maintain the option of cashing in allowances in person. This would provide individuals with an alternative route since remote banking, whilst increasingly popular, will not be a familiar concept for everyone.

There is a balance to be struck between the level of engagement and transaction costs, where the use of remote transactions would reduce both of these. Overall, however, the need to keep transaction costs down lead to us favouring remote transactions. The issue of transactions costs associated with participating in the scheme and the possible requirement to visit a bank or post office in person is discussed in detail in Section 5.6.

Non-participation

In the initial phases the government will need to focus on engaging the public and gaining acceptance and appreciation of the scheme. It was the design intent that the first phase of the EU ETS would be pilot phase (albeit emissions reductions were also anticipated at the start) and similarly the UK CRC will operate with an uncapped three-year introductory phase, where lessons will no doubt be learned.

A key area to consider in the early phase of a Cap and Share scheme would be to establish how many certificates were not cashed in, and perhaps more importantly, why not. If a significant proportion of the certificates were retired it would be important to establish whether this was because individuals were making a conscious voluntary decision to reduce carbon, using the scheme to offset their emissions or because people were not participating in the scheme because they hadn't understood it or other reasons.

Given the novelty of the concept of the scheme for many participants (albeit they would not need to understand its full workings), the possibility of non-participation arising through failure to understand how to claim allowances is a distinct possibility. Indeed, in this respect the potential for initial market

volatility may be greater than that seen previously with the EU ETS. It may also be that there are particular groups for whom the concepts behind the scheme are novel, for example the very old or partners who take no responsibility for day to day finances.

Allowing individuals to delegate responsibility for their emissions rights would help to minimise this non-participation. Indeed, with a remote (i.e. internet or postal) approach this may occur by default. A further option would be to allow individuals to voluntarily chose to have their certificates sold on a given day (say 1st January) each year and transferred to an account. Whilst this would reduce engagement it would also reduce compliance costs and non-participation.

Offsetting

The issue of offsetting may also require further attention; individuals might be tempted to treat the scheme as a way of offsetting their carbon emissions where individuals voluntary choose not to sell their certificates . It will be important to look at what level offsetting becomes an issue in terms of creating extensive scarcity in certificates and inflating the carbon price. As the price increases however individuals will be more tempted to sell, so the effect might be self limiting.

5.5 Transaction costs for the establishment and administration of the project

Any form of carbon regulation will incur set-up and administration costs. Our indicative assessment of Cap and Share suggests:

- **Set-up** costs may be similar to other schemes such as the EU ETS, but the Cap and Share scheme has the benefit that there would be fewer regulated industries.
- **Annual administration costs** would be dominated by the costs of distributing certificates to each participating individual (rather than regulating fuel suppliers).

5.5.1 Transaction costs for the establishment and administration of the project

An estimate of set-up costs can be made based on the set up and coordination costs of similar schemes such as the EU ETS (as implemented in the UK), Climate Change Agreements in the UK and the Carbon Reduction Commitment also planned for the UK. Table 5.4 summarises some of the costs associated with setting up and administering these schemes.

Table 5.4 Summaries of coordination (administration) costs for emission trading schemes

	EU ETS	CCAs	CRC
Number of sites in programme	1,100	10,000	100,000
Annual Fee Charged by coordinators (per site)	£2,200, £4,470 or £8,670 dependent on CO_2 emissions (estimated average £3,000)	Site size dependent and number of sites in CCA. The highest payments are over £2,000. Estimated average £300	Estimated to be around £80
Annual scheme "coordination" costs	£3.5 million	£3 million	£8 million

(Source: Nera & Enviros, 2006[113])

113 Nera Economic Consulting and Enviros, *Energy Efficiency and Trading Part II: Options for implementation of a New Mandatory UK Emissions Trading Scheme*, April 2006.

It is important to note that these figures apply to the implementation of the policy measure, not the development of the policy itself (which was not examined in the supporting study). The figures therefore correspond to an annual (ongoing) cost. The set-up cost for the Cap and Share Scheme would likely be greater than that for a simple carbon tax, with the establishment of a registry being a major part of the former. Indeed, the costs associated with the establishment of a registry can to some extent be influenced by policy decisions. Limiting trading to fuel importers, who must purchase and surrender allowances, and banks/post office that purchase credits from individuals would allow a simpler and cheaper scheme than one that must accommodate trading by any interested party.

The first difference to note about the Cap and Share scheme is that the number of establishments covered by the scheme is relatively small by comparison. Ten companies are listed by the Oil Supply division of the Department for Communications, Energy and Natural Resources (DCMNR)[114], whereas the Central Statistics Office for Ireland lists nine companies within the mineral oil processing sector.

Although it is unclear how many sites are possessed by each establishment, this is not a considerable problem since DCMNR reports regularly to the IEA and EU statistics such as the monthly return on oil imports and exports, crude oil and product stocks for which each company provides data on request. It appears, therefore, that site-specific information is not a requirement for the administration of the Cap and Share scheme. As a result of this simplification, it can be seen that the administration costs for mineral oil processing establishments in the Cap and Share scheme might be considerably less than those involved in the schemes summarised in Table 5.4. The administration costs associated with regulating the fuel importers in a Cap and Share scheme are considered from a bottom-up perspective in the table below. The figures are estimates and would apply on an annual basis.

Table 5.5 Estimate for the transaction costs for set-up and administration of the Cap and Share scheme – fuel importers

Set-up costs – to apply to each phase	
Number of establishments	10
Administration time per establishment (person-days)	20
Administration salary (€/day)[115]	176
Administration cost per establishment (€)	3,528
Set up cost (€)	**35,280**
Annual audit costs	
Auditing time per establishment (person-days)	10
Auditors salary (€/day)[116]	200
Total auditing cost per establishment (€/year)	2,000
Total audit costs (€/year)	**20,000**

It will also be necessary to consider who bears the cost of ensuring adequate quality/accuracy. In a system where data is verified by a third party it would be most practicable that the operating company bears the cost. In an audit-based scheme, assumed in the table above, the scheme administrator (i.e. taxpayer) in the first instance would incur the costs, although may recover these in coordination charges.

An important difference between the Cap and Share scheme and the equivalent schemes considered above is that Cap and Share requires interaction with the whole population. Although the interaction between coordinators and the public may not be particularly complex, for example there is no data gathering or auditing at the population level, the scale of the numbers involved mean that costs incurred per individual, for printing information and for postal services, could give rise to large total amounts. These are estimated below, where postal costs are associated with distribution of certificates. The costs would occur *each time* certificates are distributed.

114 Department for Communications, Energy and Natural Resources. See: http://www.dcmnr.gov.ie/Energy/Oil+Supply+Division/Links.htm

115 Average public sector administration earnings. http://www.cso.ie/statistics/public_sector_earnings.htm

116 Based on above average public sector earnings. Taken from CSO, see: http://www.cso.ie/statistics/public_sector_earnings.htm

Table 5.6 Estimate for the transaction costs for administration of the Cap and Share scheme – public

Transaction	Cost (€)
Population (> 15 y.o.a)	4,240,000
Postal and printing costs (euro/unit mailed)[117]	0.50
Total postal/printing cost (euro)	*2,120,000*
Administration time (person-days)	100
Administration salary (euro/day)[118]	176.40
Total administration costs (euro)	*17,764*
Total allocation costs (euro)	***2,137,764***

It is important to note a number of factors regarding the above estimate:

- It is a simplified analysis of the establishment and administration costs for the scheme and *does not* include the costs of policy development or the preparation of administrative procedures etc. Consequently the above table should not be used in isolation to form a view on whether the scheme would be cost effective.
- A further factor that has not been included in the above table is costs of publicity to raise awareness and guide people about what to do with their certificates (for example television and radio advertising campaigns).
- The administration effort will likely decrease after the first year of the scheme, although our estimate above is highly uncertain.
- The cost of distributing certificates is based on the assumption that this will occur once per year. If the were to be distributed multiple times during the year then the costs would increase commensurately.

The calculation carried out in Tables 5.5 and 5.6 shows that the costs associated with administrating the mineral oil processing establishments are small (2.5%) in comparison with the cost associated with dealing with the public. The overall costs for the scheme are similar to but lower than the "coordination" costs for the schemes listed in Table 5.4. For the Cap and Share scheme the main contributor to the cost is the interaction with the public.

5.6 Transaction costs for those participating in the scheme

The estimates of the transaction costs for a system where certificates are cashed in remotely lie in the range 8-11%, depending on income, assuming an allowance price of €20/tCO_2 and a bank direct transaction charge of 5%. At higher carbon prices the cost effectiveness would be better, with transaction costs around 6-7% for a price of €50/tCO_2. However, if participants were required to cash in allowances in person then the costs could be significantly higher. To minimise transaction costs for individuals to a level that will be considered acceptable consideration would need to be given to the following:

- Allowing on-line and postal facilities for converting certificates.
- Minimising the amount of material that an individual must understand, possibly making use of passive media such as television and radio broadcasts.
- Allowing individuals to delegate the authority to cash in allowances.
- Simplifying the requirements on banks and post offices to minimise their costs and the changes that they may charge for transactions.
- Giving careful consideration to the cost impacts when deciding whether to distribute certificates more frequently than yearly.

Transaction costs incurred by mineral oil processing establishments would be a relatively small cost overall, given the relatively small number of establishments involved and in comparison with the costs to other actors such as the Government and the general population.

117 Assuming that postal rates with discounts for bulk posting, €0.41 (http://www.anpost.ie/NR/rdonlyres/C42CF003-ACF9-4644-9A8D-E6EB6AEE31D7/0/2000ITEMSUPWARDS.pdf) and that with the cost of producing certificates, administration etc to total cost is in the region of is in the region of €0.50.

118 Average public sector administration earnings. http://www.cso.ie/statistics/public_sector_earnings.htm

5.6.1 Transaction costs for members of the public participating in the scheme

The analysis below gives a simplified view of the costs of the scheme to members of the public, and their acceptability. It is divided into two parts.

- Firstly, a top-down approach is taken to indicate the level of compliance costs that might be considered acceptable. This is based on analogies with other financial services.
- Secondly, a bottom-up analysis is carried out to estimate the principal costs to a participant in the scheme.

It should be noted that this analysis assumes the Cap and Share scheme is applied only to road transport emissions, and therefore would over estimate transaction costs for the public in relation to the value of certificates if further emitting sources were to be covered.

Acceptable level of transaction cost

The allocation of allowances to the members of the public can viewed as a compensatory action in advance of fuel increases that are foreseen as a result of the scheme. Therefore, the cost to a participant in the scheme must be less than a certain proportion of this amount in order to preserve this compensation, both from a practical perspective and also to ensure acceptance of the scheme in principle.

The following discussion reviews analogous bank charging arrangements which provides a view on what the public may consider acceptable for this top-down analysis and also provides an indication as to the charges banks may actually apply for Cap and Share transactions, applicable in the bottom up analysis that follows.

The charges associated with personal current accounts at banks in Ireland include those charges levied by the Government and those by the banks themselves. Fixed charges are collectively around €15 per annum and charges for the most common transactions are typically around €0.2[119]. This is difficult to translate into proportion of the value transacted, however, for a current account holder with a large number of transactions each year averaging €20 the charge would be in the region of 1%.

For business current accounts customers, the charges associated with transactions, particularly cash handling, are often expressed as a percentage of the transaction value. A value of around 1% might be expected for this service[120].

A better analogue however, might be the exchange of foreign currency. This is because it is a direct exchange of currencies and it is likely that individuals use this service on a similar frequency to that which they would be cash-in in carbon certificates. It may be that the public accepts a high transaction cost for currency exchange since it is generally linked to foreign travel which incurs many more significant costs. On the other hand, if carbon certificates were viewed as free money (without an immediate link to the subsequent fuel price rises) the public may tolerate a higher transaction cost than for money that they had earned. Overall, however, currency exchange may be viewed as a good comparable example of acceptable transaction costs.

119 Allied Irish Bank. See: http://www.aib.ie/servlet/BlobServer?blobcol=urldata&blobheader=application/pdf%0D%0AContentDisposition%3A+inline%3B+filename%3DA%20guide%20to%20fees%20and%20charges%20for%20personal%20current%20accounts.pdf%0D%0AMDT-Type%3A+abinary%3B+charset%3DUTF8&blobkey=id&blobtable=MungoBlobs&blobwhere=1141430207373&csblobid=1141322474997

120 Bank of Ireland. See: http://www.bankofireland.ie/html/gws/business/run_your_business/business_current_account/index.html#doclink5

In this situation the bank buys currency from any individual, i.e. not necessarily an account holder, at a specified rate. Of course, the bank will also sell currency at a specified rate, which is lower than that for buying, and the difference in the margin between the two rates accounts for the administration costs, central bank charges and profit. For relatively stable currencies such as the euro, US dollar or pound sterling, this margin can be around 5%.

Overall, the examples set by the financial services described above suggest that the public would bear a direct transaction cost of up to 5%. Note that this figure does not include the secondary costs associated with carrying out a transaction, discussed below. It is difficult to estimate what might be considered acceptable for these indirect costs, but perhaps is reasonable to assume that a limit comparable with direct transaction costs, giving an upper limit of 10%.

An alternative view of the acceptable value for the acceptable cost of participation as a proportion of allowance value can be obtained from the EU ETS, albeit in that scheme the participants are companies not individuals, and the emissions are much higher. Concerns were being voiced about transaction costs for small installations when the EU allowance price was in the region of €20/tonne CO_2. Now, for a small emitter, say 5,000 tCO_2/year, annual verification costs of around €7,000 would amount to 7% of the value of allowances.

Potential transaction cost

This section provides a simplified assessment of the costs that might be incurred by individuals participating in the scheme. We assume a base case scenario where transactions are carried out remotely, for example by post or using the internet. However, as a sensitivity case we also assess the cost associated with a requirement to cash in certificates in person, to reflect a scenario where this is considered necessary for the scheme as a whole or where this is the option chosen by an individual.

The value of non-working time is calculated using the world bank guideline value of 30% of the value of the household income[121]. Now, the average hourly earnings for all employees in Ireland in second quarter 2007 range between about €19 and €36, depending on the sector concerned[122]. Within each sector there is variability according to type of role, extended outside of the above range, but for illustrative purposes we consider the range specified above. Note also that here the 30% adjustment is applied to personal income not household income.

The transaction cost through an exchange rate margin in the table below assumes that costs incurred by the bank in processing the transaction and holding a carbon account with the register are passed on to the customer. We use a foreign exchange model (as discussed above) and assume that these costs are similar to those incurred through handling retail foreign currency exchange. The 5% value is based upon a typical margin of buy/sell rates for a relatively stable currency such as euro, US dollar or pound sterling.

The EPA provides figures for the total emissions in 2006 from the road transport sector of 13.33 Mt CO_2-eq. Taking the number of people in Ireland aged 16 and over[123] as 4.24 million people[124] in 2006, gives a per capita emission of 3.14 t CO_2-eq. The table below considers participation costs for a base case where transactions are carried out remotely (with average annual price of allowances of €20/tCO_2), the same case with a price of €50/tCO_2 and a case were transactions must be carried out in person (with a carbon price of €20/tCO_2).

121 http://www.worldbank.org/transport/publicat/td-ot5.htm

122 http://www.cso.ie/releasespublications/documents/earnings/current/earnlabcosts.pdf

123 For simplicity we are here assuming that it allowances would only be allocated to adult members of the community. The assumption is made that individuals aged 16 years and above are counted as adults within the scheme.

124 http://www.cso.ie/statistics/Population1901-2006.htm

Table 5.7 Bottom-up assessment of participation costs to individuals

	Costs (€)	
Transaction	**High (€36/ hour earning)**	**Low (€19/ hour earning)**
Base case – remote transactions, €20/tCO_2 carbon price		
Administration and reading (15 minutes)	2.70	1.43
Transaction time (5 minutes)	0.90	0.48
Direct transaction cost, exchange rate margin for bank (5%)	3.14	3.14
Total (€)	**6.74**	**5.05**
Allowance value (at €20/tCO_2, assuming 3.14tCO_2 per capita for transport)	*62.9*	*62.9*
Costs as proportion of allowance value (assuming a single annual allocation at €20/tCO_2)	***10.7%***	***8.0%***
Sensitivity case 1 – remote transactions, €50/tCO_2 carbon price		
Allowance value (at €50/tCO_2, assuming 3.14tCO_2 per capita for transport)	*157.2*	*157.2*
Costs as proportion of allowance value (assuming a single annual allocation at €50/tCO_2)	***7.3%***	***6.2%***
Sensitivity case 2 – in person transactions, €20/tCO_2 carbon price		
Administration and reading (15 minutes)	2.70	1.43
Travel time (20 minutes)	3.60	1.90
Transaction (queuing and processing) (5 minutes)	0.90	0.48
Direct travel cost	1.00	1.00
Direct transaction cost, exchange rate margin for bank (5%)	3.96	3.96
Total (€)	**12.16**	**8.77**
Allowance value (at €20/tCO_2, assuming 3.14tCO_2 per capita for transport)	*62.9*	*62.9*
Costs as proportion of allowance value (assuming a single annual allocation at €20/tCO_2)	***19.3%***	***13.9%***

The costs presented here are uncertain estimates, but are probably broadly representative of the scenarios concerned. On the basis of the above it would seem necessary that the scheme could be implemented so that individuals can cash in their certificates remotely. The penetration of the internet in Ireland is about 30% of households. It is reasonable then to assume that approximately this level of the population could use an on-line service. For the remainder a postal option should be made available, possibly with free postage avoiding an apparent discrimination against those without internet access. Any number of alternative scenarios could be presented, and indeed it would be expected that the cost impacts will vary between individuals. However, our approach here is to highlight the following important sensitivities.

- It is clear that the cost attributable to administration and reading time is significant. However, it can be considered that a cost at this level would only be incurred in the early years of operation. In subsequent years, individual participants would have experience with how the scheme operates and hence this cost would be expected to fall.
- The reading time should be minimised by presenting the requirements for individuals and the associated background information in a concise leaflet.
- Even in the scenario were an individual travels to cash in their certificate in person, it is a matter of debate as to whether a unique journey would be necessary. It seems quite unlikely that an individual would not combine this with another activity, since such options to combine activities would generally be expected to be available. If they were to make a unique journey then this could be viewed as a matter of choice, for which, by definition, the individual would not view this transaction cost as excessive. In any case, widespread availability of facilities for cashing in certificates increases the likelihood that it will be combined with other activities.

- If it were possible for individuals to delegate the act of cashing-in their certificates then the costs associated with all but the direct exchange costs would be commensurately reduced.
- The previous discussion is based on the assumption that a single transaction is carried out by each individual each year. It should be noted that if, as has been discussed previously, the scheme were to involve quarterly transactions for example, then the cost incurred by individual participants would rise, although the overall readings costs would not necessarily increase since learning would be more effective with more frequent transactions.

In summary, the estimates of the transaction costs for a system where certificates are cashed in remotely lie in the range 8-11%, depending on income, assuming an allowance price of €20/tCO_2 and a bank direct transaction charge of 5%. At higher carbon prices the cost effectiveness would be better, with transaction costs around 6-7% for a price of €50/tCO_2. However, if participants were required to cash in allowances in person then the costs could be significantly higher. To minimise transaction costs for individuals to a level that will be considered acceptable consideration would need to be given to the following:

- Allowing on-line and postal facilities for converting certificates.
- Minimising the amount of material that an individual must understand, possibly making use of passive media such as television and radio broadcasts.
- Allowing individuals to delegate the authority to cash in allowances.
- Simplifying the requirements on banks and post offices to minimise their costs and the changes that they may charge for transactions.
- Giving careful consideration to the cost impacts when deciding whether to distribute certificates more frequently than yearly.

5.6.2 Transaction costs incurred by mineral oil processing establishments

This section considers the costs incurred by the mineral oil processing establishments under the Cap and Share scheme. The analysis presented in Table 5.8 is based on the calculations of the costs to participants in the UK CRC scheme reported by NERA and Enviros (2006). Note that for the Cap and Share it would only be the carbon cost of the fuel that is of interest, not the emissions arising from its extraction and processing.

The time costs calculated in Table 5.8 translate into a total annual cost of around €19,000, taking an average hourly salary of €36 and an average working week of 39 hours.

This would be a relatively small cost overall, given the relatively small number of establishments involved and in comparison with the costs to other actors such as the Government and the general population.

Table 5.8 Annualised time costs incurred by establishments such as mineral oil processing companies under the EU ETS

Task	Elements	Person-Days
Understanding the rules	Read documents	
	Train colleagues (legal implications, reporting)	
	Keep abreast of updates	2.5
Initial collection of carbon content data	(Assumes system in place to record the type and amount of fuel sold from each site)	
	Calculate conversion factors for carbon content for volume of fuel	
	Query system for volume of fuel and hence calculate its carbon content	5
Development of a compliance strategy	Forecast demand and hence carbon supplied to system	
	Understand the rules for compliance	
	Develop strategy for compliance with carbon supply	3
Understanding and taking part in Trading	Read and understand rules	
	Identify brokers	
	Demonstrate credit-worthiness	
	Develop price-risk hedging strategy	
	Monitor long or short position	
	Monitor price levels to identify potential problems	
	Make trades to achieve compliance or sell surplus	2
Submit data to coordinator	Assemble total establishment values for information according to coordinators requests	1
Total		***13.5***

5.7 Cap setting and the tonnage of CO_2 emissions allocated to each person

The tonnage per person in the Cap and Share scheme would be determined by the setting of the cap. This section draws on the experience of cap setting from the other schemes and makes the following finding:

- **Setting the cap** should take into account the need for a long-term, predictable, carbon target. It would need to be consistent with emission reductions targets, taking into account other policies, and the social and economic implications. There is therefore a balance between environmental and regulatory certainty on one hand and flexibility on the other.

5.7.1 Cap Setting

The establishment of an overall emissions cap establishes the level of scarcity by setting the level of the cap less than would be required on a business as usual basis. This section provides an overview of the aspects that are important to take into consideration when setting the cap.

Factors to consider

This section looks at the approach and the factors that should be taken into consideration in relation to setting a cap. The level of the cap and how it is set will be dependent on the overall objectives of the scheme, for example whether there are economic and social goals as well as the environmental, and the relative importance of each issue. The level of the cap will be instrumental in creating the right incentives to price carbon into investment and consumption decisions How the cap is set could have implications for predictability for business and flexibility for the government with the scheme.

The Office of Climate Change (2007)[125] looked at factors that affect the setting of cap, with respect to the EU ETS, which is the instrument for which this issue has received the greatest attention. It considered that the cap must be consistent with carbon emission reductions targets, both the Kyoto and EU commitments, and those imposed if the Climate Protection Bill is passed. The cap should not be set at a level detrimental to economic growth, ensuring the correct balance between the environmental concerns and economic competitiveness will be crucial.

The ECCP working group (2007)[126] reviewing options for the EU ETS looked at the factors that will be important in ensuring predictability, which will be an important issue for businesses. They found that a stable framework of rules, having clear and transparent principles of cap-setting, the split between the trading and non-trading sector and the trajectory will be important elements for increased predictability.

Under a scheme that covers only the Republic of Ireland, which is discussed in Section 5.9, when setting the cap a factor to take into account would be the fuel price differential impacts with Northern Ireland. Particularly in the case of road fuel price increases in the Republic relative to prices in Northern Ireland, as this will mean less fuel will be purchased in the Republic by individuals from Northern Ireland, or potentially a reversal of the current fuel tourism.

In summary, the following are factors that should be taken into consideration when formulating an approach to cap setting for Cap and Share or any similar trading scheme:

- Clear transparent formulas used for cap-setting.
- Linking the cap to Kyoto, EU and domestic obligations.
- Establishing longer term indicative targets.
- A cap that encourages behavioural change and abatement.
- The distribution of effort between sectors in the scheme and those outside it, recognising sectoral growth, abatement potential and impact on competition and emissions leakage.

Cap setting institutions

Matthews (2007)[127] proposes that any carbon budgets or targets should be set by an expert independent Committee, drawing similarities with the monetary committee of the Bank of England in setting the interest rate. He argues that this should provide greater credibility to the target and avoid any political interference. Alternatively the cap could be set by the body responsible for policy provided with advice by an independent committee, and could have an obligation to state the reason for not following the committee's advice. In either case, the cap setting body would need to be sufficiently informed by the latest evidence and consideration to economic and environmental aspirations.

Coverage of cap

An overall cap will be set for the sectors covered by the scheme. The sectoral targets should be set taking into consideration the overall cap and the abatement potential in each of the sectors and the cost of abatement. The targets would be linked to the emission reduction targets set out in the Climate Protection Act. The cap would have to consider the relative effort from the traded and non-traded sectors.

125 OCC and Defra (2007). Analysis paper on EU Emissions Trading Scheme Review Options

126 ECCP (2007) working group in emissions trading. Final Report of the 3rd meeting of the ECCP working group on emissions trading on the review of the EU ETS on Further Harmonisation and Increased Predictability.

127 Laurence Matthews (2007). Memorandum to the Environmental Audit Committee Inquiry into Personal Carbon Allowances " Cap and Share"

Length of cap – flexibility vs certainty

In setting the length of the cap there needs to be a balance between avoiding locking in difficult and very expensive emissions reduction targets and ensuring adequate certainty for investment decisions, this risk depends on the stringency of the cap trajectory as well as the length of time the policy is in force. A UK Treasury Working Group[128] discussed how the initial phase of the EU ETS was too short to encourage some firms to undertake investment in abatement technology. To encourage investment, firms need certainty on the existence of a carbon market in the long run, and in the case of Cap and Share that the scheme is going to exist in the future. The length of time over which a cap is set can be just as critical as the price that results. Many of the installations within the scheme have long asset lives and decisions about investments and new build often have long time horizons. For this reason many participants have called for longer-term clarity with respect to the overall emissions cap so that they can make more certain investment decisions.

The downside of having a longer cap is that it sets an overall commitment to achieve a carbon target that could ultimately prove very expensive to meet. Whilst this may not be a concern from an environmental perspective, which is the primary objective of the scheme, it has implications for the economy and has significant negative equity implications if the carbon price reach a very high level. The decision on what period to adopt is primarily a matter of finding a balance between these issues, and in practice any negative equity effects should be taken into account.

There is also a case, however, for allowing some flexibility to respond to future carbon obligations and international agreements, the organisation setting the cap could have the freedom to adjust the rate if required, for example it might be appropriate to accelerate the rate of emissions reduction if it is found that the rate at which emissions are being cut is inadequate. Firms will base investment decisions on the emissions targets and any decisions to change these would need to be approached with caution and suitably justified.

It is vital to provide the market with long-term signals, say 5-10 years, particularly for investment decisions. The Cap and Share target would benefit from being enforced in legislation, with a carbon budget signalling to the market commitment to the scheme in order to provide credibility to the scheme and demonstrate long-term commitment to the scheme.

Regarding the possibility that relaxation is desired in response to very high carbon costs, greater market certainty would be provided through the use of a safety valve rather then the prospect of Government intervention to modify pre-established caps. Safety valves are discussed in Section 5.10 below.

5.7.2 Tonnage of CO_2 emissions allocated to each person

The tonnage allocated to each person by a per-capita method would simply divide the cap by the number of participants. Tyndall (2005)[129] in their evaluation of DTQ's, observe that there are strong fairness arguments on the equal per capita allocation of carbon credits, as this more equitable. They recognise these need to be implemented in conjunction with other policies building on the approaches existing for tackling fuel poverty. Elsewhere in the present report we consider the arguments relating to an uneven distribution of allowances to address impacts on certain groups of participants.

128 http://www.hm-treasury.gov.uk/media/6/D/minutes_tax_vs_trade_rts.pdf

129 Starkey and Anderson (2005) Domestic Tradable Quotas: A policy instrument for reducing greenhouse gas emissions from energy use. Tyndall Centre

5.8 Option to restrict Cap and Share scheme to transport sector only

There could be political and public sensitivities to the introduction of a new scheme for all the sectors outside of the EU ETS as well as practical difficulties. Whereas introduction to the transport sector first provides an opportunity to identify any design issues and solutions on a smaller scale. This section reviews whether it is worthwhile restricting the scheme to the transport sector and makes the following findings:

- **Transport emissions** increased by more than any other sector in 2006 reflecting a sustained increased in fuel consumption since 1990. Introducing the Cap and Share scheme will provide valuable experience in tackling emissions from road transport and how the sector responds to a trading scheme.
- **The benefits of restricting the scheme to the transport sector** would be a focused move towards a more sustainable transport system, a simpler scheme initially and the opportunity for learning before any further expansion. The advantages of wider initial implementation would be economies of scale and the opportunity to understand more about the interaction between the scheme and the wider economy.

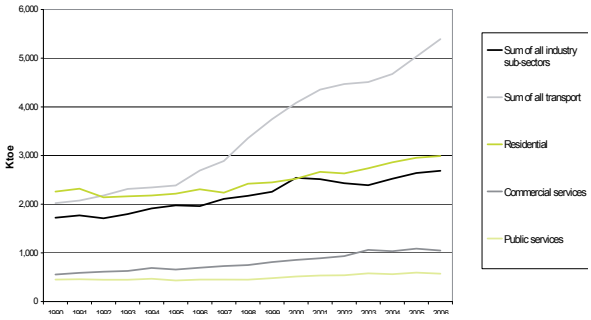
In January 2008 the Environmental Protection Agency published provisional greenhouse gas emissions figures for 2006, these indicate there is a 0.8 per cent reduction in emissions from 2005 to 2006[130]. However these levels are above Ireland's committed level under the Kyoto Protocol. Emissions from the Irish transport and domestic sector are of particular concern; the recent growth rates from the transport sector highlight the need for more innovative measures either to encourage more abatement or changes in behaviour towards more low carbon options.

130 http://www.epa.ie/news/pr/2008/name,23984,en.html

Growth in transport emissions

The Irish transport sector has grown faster than the rest of the economy and this growth has also exacerbated associated problems of congestion, local air pollution and the effects of urban sprawl as well as the increased emissions. A scheme targeted at the transport emissions will also have a have a positive impact on tackling other related social problems. The movement towards a sustainable transport system could have a greatly beneficial impact on the economy through reduced pollution and increased quality of life.

Figure 5.1: Fuel Consumption (ktoe) by Sector and Year



Source: Sustainable Energy Ireland (SEI)131

The EPA's provisional statistics for 2006 show there was an increase from transport emissions[132], these were up by 5.2 per cent. The rise of transport emissions was the largest in any sector in 2006 and reflects a 165 per cent increase on 1990 figures. Transport emissions made up almost 20 per cent of the 2006 total, and road transport accounts for 97 percent of the sectors emissions. The increase in the GHG emissions from the transport sector reflects sustained increases in fuel consumption with petrol usage up 3.4 percent and diesel consumption up 7.9 percent from 2005. The EPA attribute the increase in emissions from the transport sector to an increase in vehicle numbers, a trend towards purchasing larger vehicles, an increased reliance on private cars and increasing road freight transport.

131 SEI – Energy balance statistics: http://www.cso.ie/px/sei/database/SEI/Energy%20Balance%20Statistics/Energy%20Balance%20Statistics.asp

132 EPA's press release http://www.epa.ie/news/pr/2008/name,23984,en.html, and report http://www.epa.ie/downloads/pubs/air/airemissions/ghg_provisional_20061.pdf

A Study in Personal Carbon Allocation: Cap and Share

Transport is one of the key challenges to sustainable development facing Ireland as the movement of people and goods is essential to the Irish economy, but the increasing growth in the sector will pose a complex challenge for the government. The implementation of the Cap and Share scheme to a less significant sector could provide opportunities for learning with reduced consequences of failure, although clearly the environmental benefits that could arise would be similarly reduced.

Current policy developments

Road transport requires more targeted attention, as the efforts to curb transport emissions have been largely reliant on weak fiscal incentives or voluntary action, which have not curbed the growth in emissions. Ireland has recently introduced some additional policies to encourage individuals to make more informed decisions in their consumption of road transport.

In the December budget it was announced that from the 1 July 2008, motor tax is to be changed from the current system of bands based on engine size to one based on CO_2 emissions. There will be seven bands in total, ranging from €100 a year for the greenest cars, to €2000 for cars with the highest emissions ratings. It will result in savings of more than €300 for motorists who chose the lowest emission vehicles. The objective of this new motor tax system is to influence the purchasing decisions of consumers by rewarding the buyers of low-emission cars and charging more on less efficient vehicles.

A new mandatory labelling system based on CO_2 emission levels for cars will also be introduced from 1st July, this will show clearly the environmental impact of cars. This will be accompanied by a public information campaign which will promote the purchase of fuel efficient cars.

Road transport emissions are an issue across Europe, the transport sector is the second biggest polluter by source and emissions are projected to continue increasing. This sector requires additional abatement measures and is not currently sufficiently incentivised to reduce carbon emissions.

In the Commission's proposed amendment to the EU Emissions Trading Directive the greenhouse emissions from road transport and shipping are not included[133]. They recognised that the emissions from road transport and shipping are still increasing, however, decided that in order to decide whether emissions trading is the most appropriate instrument a more detailed analysis that incorporates a comprehensive cost-benefit analysis is necessary.

Regarding aviation, the European Commission in December 2006 published a proposal to include aviation into the EU ETS for the first time[134]. The key elements of the scheme, as proposed by the European Commission, are as follows:

- Aircraft operators would be the trading entity and thus be responsible for complying with the obligations of the EU ETS. Each will be administered by one Member State only.
- The scheme would apply to flights between EU airports from 2011 and all flights arriving at, or leaving, an EU airport from 2012.
- Focus of the proposal is on CO_2; other gases to be considered later.
- Allowance methodology would be harmonised across the Community and the emissions cap would be set at the Community level with reference to aviation's emissions averaged over 2004 to 2006.
- Domestic aviation will be treated in the same way as international aviation.

Implications of restriction to the transport sector

Cap and Share could be one of the possible measures employed to tackle the issue of the growth in transport emissions, and encourage the

133 Amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community proposal http://ec.europa.eu/environment/climat/emission/pdf/com_2008_16_en.pdf

134 COM(2006)818.

movement towards a more sustainable transport system. It would be complementary to the existing policy developments announced in December 2007.

Introducing the Cap and Share scheme only to the transport sector initially would be an opportunity for Ireland to create a blue print for a policy that deals with carbon emissions from road transport, and may provide valuable experience concerning how the sector responds to a targeted carbon policy. The advantages of a staged approach would be:

- A focused scheme developed to tackle emissions from a single sector.
- The opportunity to learn prior to expansion to other sectors.
- A simpler scheme initially, avoiding complexities associated with rolling out to multiple sectors at once.
- The introduction to only a subset of the economy where the economic consequences of any design shortfalls would be lower.

An alternative option would for the scheme to be introduced to a number of sectors. The benefits of such an approach would be:

- The opportunity to identify whether any design shortfalls were specific to a given sector or characteristic of the scheme in principle.
- The economies of scale from developing the scheme for multiple sectors at once.

Whether as a transport only scheme or with wider coverage, Matthews (2007)[135] notes that swift adoption of a cap would provide operational experience and strengthen international negotiators' efforts to develop a global emissions reduction global framework.

5.9 Could the scheme be extended to cover the whole island of Ireland, what would be the cross-border effects if Northern Ireland were not covered by the scheme?

The Cap and Share scheme could potentially cover Northern Ireland as well as the Republic, creating a whole of Ireland working model, this would provide the scheme with more flexibility. An option could be to introduce the scheme first in just the Republic then if successful extend the scheme to Northern Ireland. This section reviews the issues associated with the scheme covering the whole of Ireland and the potential cross boarder effects if Northern Ireland were not included, and makes the following findings:

- **In a Republic only scheme cross-border effects** using the transport sector as an example could be significant, changes in the price differential between Northern Ireland and the Republic of Ireland initially would reduce fuel tourism and possibly reverse it (at carbon prices around carbon price of €120/tCO_2). Issues of competitiveness and carbon leakage will have to be evaluated for each specific sector that might be included under a Cap and Share scheme.
- **A Whole Island of Ireland scheme** seems feasible taking the example of the establishment of the Single Electricity Market under the devolved powers of the Northern Ireland Executive. The implementation in Northern Ireland will have to fully evaluate the interaction of the scheme with UK policy measures, in order to avoid any double counting. Consideration will have to be given regarding the setting of the cap given different emission reduction targets as well as the presence of parallel institutions and processes, for example using the National Insurance number for Northern Ireland in place of the PPS.

135 Laurence Matthews (2007). Memorandum to the Environmental Audit Committee Inquiry into Personal Carbon Allowances " Cap and Share".

Overall, it appears preferable therefore to introduce a Republic only scheme in the first instance, with subsequent consideration to expansion.

5.9.1 Cross-border effects if Northern Ireland were not included

Taking the example of the transport sector, under the current situation fuel prices are lower in the Republic and this results in some cross-border consumption with fuel being purchased in the Republic for use in Northern Ireland, as the public take advantage of the lower prices. This effect is significant with approximately 25% of diesel and 10% of petrol sold in Ireland is consumed outside, with the main consumer being Northern Ireland.[136]

The barriers to getting fuel from the south, for example the time taken to travel, and the cost of travelling south support the price differential between the Republic of Ireland and Northern Ireland. If the price differential decreased then the level of incentive would also decrease and less people would be prepared to overcome the barriers and cross the boarder to purchase their fuel. Therefore even a small change in prices would have an effect, and if prices where to rise significantly above those in Northern Ireland this may provide an incentive for those living close to the boarder to purchase their fuel from across the border.

Currently, the price differential is typically 27 €cents /litre for diesel and petrol. Now, the average car uses about 1250 litres of fuel per year and emits 3000 kg CO_2, so about 2.3 kg CO_2 are emitted per litre. Assuming the car characteristics to be representative of the average, a carbon price of around €120/tonne CO_2 would halt the fuel tourism described above and one might expect that a higher price would start to reverse it.

136 Environmental Protection Agency (2007) Ireland's National Allocation Plan 2008-2012.

Carbon leakage

Carbon leakage is the tendency for industries and sectors to migrate from nations with a carbon tax to those nations without a carbon tax where some of the receiving nations might be less energy-efficient. Neuhoff, Grub, Hourcade, and Matthes (2007)[137] looked at the issue of leakage and competitiveness in relation to the EU ETS. If significant carbon leakage results from the scheme it may effect on the level of emissions, dampen the price signal, and the incentives and liquidity to finance innovation may be lost. However their analysis recognises that leakage is only a concern of certain sectors within the EU ETS. These issues have generally been reviewed for industrial sectors covered in the EU ETS, although it is not clear whether the implications of Cap and Share could be as significant.

For a Cap and Share scheme based on assigning emissions to fuel imports the effects of leakage would arise where high energy consuming activities could be carried out abroad. At the domestic level there seems minimal short term likelihood of leakage (emigration) resulting from the inclusion of home energy use, and the consequences of vehicle fuels are discussed above. To assess the implications for commercial and industrial sectors would require economic analysis beyond the scope of this report.

However, in line with the principle that the Cap and Share be considered against alternatives rather than a do nothing baseline, discussed in Chapter 2, we must note that the possible leakage effects would be expected for any scheme which places a carbon price on energy consuming activities in Ireland alone.

Nevertheless, possible counter-measures for leakage are:

- to levy carbon-equivalent fees on imports from non-taxing nations;
- sectoral agreements with other countries to pursue similarly stringent carbon reduction policies;

137 Karsten Neuhoff, Michael Grubb, Jean-Charles Hourcade, and Felix Matthews (2007) EU ETS Post 2012 Submission to the EU Review. Climate Strategies.

- border adjustments to compensate for higher production costs, or through reimbursing allowance costs for products if they use the best available techniques.

5.9.2 Whole Ireland Scheme

Administratively the scheme could potentially cover Northern Ireland as well, creating a working model for expanding the concept more widely, a whole of Ireland scheme would eliminate any new price differentials created by the Cap and Share scheme. The Northern Ireland Executive[138] has devolved powers to enforce environmental legislation, unlike a carbon tax where the powers are retained in Westminster. The energy sector is an area where the Republic of Ireland and Northern Ireland have co-operated. In both areas there exists political commitment to the development of competition in the energy sectors in the interests of delivering improved services and economic benefits to customers.

This was reflected in the establishment of the Single Electricity Market (SEM), which commenced on 1st November 2007. SEM is the operation of a single competitive wholesale electricity market on the island of Ireland. It was recognised that competition on an island-wide basis was likely to increase the choices available to customers and to support continued economic growth in both the Republic and in Northern Ireland.

Interaction with other policies

An all Ireland model may overlap with UK policies, it will be important to conduct a full impact assessment into the feasibility and take into account the interaction with current UK policies. If Cap and Share were to be extended to all non-EU ETS sectors there could potentially be some cross over with the UK's Carbon Reduction Commitment (CRC), as this targets large non-intensive energy users not covered by the EU ETS. However in order to ensure a smooth transition and avoid overlapping of policies a stepwise approach could be employed to the introduction of the scheme in Northern Ireland. An agreement would have to be sought to adjust the relevant policies in Northern Ireland where there was potentially any double counting of the emissions between the schemes.

Roberts and Thumim (2006)[139] in their report for Defra looked at the compatibility of personal carbon allowances with the existing UK measures. The issues they highlight will be relevant if a Cap and Share scheme were to include Northern Ireland. In the UK there are a number of supply side and upstream policy instruments in place but fewer downstream or measure that target the demand side. The following are the policies they looked at for possible overlaps.

- *Regulation*
  - EEC, building regulations, standards
  - Climate change agreements
- *Taxation*
  - Climate Change Levy
- *Trading*
  - EU Emissions trading
  - Renewables Obligation

They concluded in terms of regulatory instruments there aren't any which are directly targeted at individuals, and a scheme targeted at the individual may in fact create an end-user demand for the supply-side approaches required in legislation therefore filling a gap and providing an essential role. The relationship between Climate Change Agreements and EU ETS would mean some adjustment might be required.

The PPS mechanism is not in operation in Northern Ireland, therefore compiling the register will also need to be taken into consideration. Roberts and Thumim (2006) identify the national registers of national insurance numbers and child benefit as sources of information for compiling a list of those

138 The assembly has primary and secondary legislative powers and there is also cross-border co-operation on environmental issues.

139 Simon Roberts and Joshua Thumim (2006) A Rough Guide to Individual Carbon Trading. Centre of Sustainable Energy and Defra.

individuals who will be eligible. The National Insurance number has a similar coverage to the PPS.

The cap would also have to be an overall cap covering both regions, however the Republic of Ireland and Northern Ireland will have different emission reduction targets. This issue will require further consideration and agreement.

For the scheme to have full flexibility it would be beneficial for it to cover both Ireland and Northern Ireland. A further potential benefit of a whole Ireland scheme would be that it might aid the introduction of a Cap and Share in the UK covering the sectors not covered by existing UK schemes, as many of the interactions and impacts on existing UK policies would already been taken into consideration.

Overall, it appears preferable therefore to introduce a Republic only scheme in the first instance, with subsequent consideration to expansion.

5.10 Safety Valves

The purpose of introducing a safety valve into a trading scheme would be to provide a means of limiting the economic impacts that might otherwise arise from very high carbon prices. If environmental outcome were the sole objective then it would be argued that such high prices, if they were to occur, would be necessary. However, concerns over fuel poverty, impacts on other social groups and competitiveness of the commercial and industrial sectors suggest that the ability to limit carbon prices may be desirable, particularly if other countries were pursuing less ambitious carbon reduction objectives. A general feature of safety valves is that the public might no longer be fully compensated for the increase in carbon costs because the certificates they receive correspond to the value of only a subset of the emissions arising. To maintain full compensation would require the costs to fuel suppliers from using the safety valve to be returned to individuals, either through additional allowances or through reductions in taxation. The options for introducing a safety valve would include:

- **Option 1**: The ability for the Government to issue additional allowances if required. For example, the issue of allowances could be triggered by the price reaching a ceiling level. This ceiling level could be gradually increased as the scheme becomes more established and tougher emissions cuts are sought. The design of the Cap and Share scheme would require these to be issued to individuals to maintain full compensation, which would in turn introduce transaction costs. A cheaper option would be to auction them to the fuel suppliers. In either case, the environmental integrity of the scheme would not be preserved.
- **Option 2**: Offer a buyout price. Again this would not preserve the environmental integrity of the scheme but would cap the overall scheme costs. It would probably administratively simpler than issuing further allowances.
- **Option 3**: Allow the use of credits from other capped schemes. A link to another scheme, for example the EU ETS, would allow additional credits to be used to alleviate the price in the Cap and Share scheme. It would preserve environmental integrity since the EU ETS is itself a capped scheme, however reductions would no longer be guaranteed to occur in Ireland. It would in practice be a form of offsetting.

  However, the cost of abatement in the transport sector (the main candidate for the Cap and Share scheme) is generally considered greater than for the sectors currently in the EU ETS. For example, a UK Treasury Working group[140] discussed whether it was worth including road transport in the EU ETS, and considered it would be a net purchaser of permits due to the lack of low carbon alternatives and relatively high costs of abatement. In this case a safety valve might see *all* reductions occurring within the EU ETS.

140 http://www.hm-treasury.gov.uk/media/6/D/minutes_tax_vs_trade_rts.pdf

- **Option 4**: A possible modified approach would therefore be to apply a buyout price in the Cap and Share scheme at a level high enough to deliver some domestic action (and by implication higher than the EU ETS price) in the transport sector but without being excessively high. The revenues from this buyout could be used in part to purchase and surrender EUAs, thereby retaining the environmental integrity of the scheme. However under such a scheme the public would not be fully compensated for fuel price rises.
- **Option 5**. Allow the use of other carbon reduction credits. These credits could be from mechanisms that are intended to deliver additional emissions reductions, such as the Clean Development Mechanism. However, the reductions would arise outside Ireland and there have been questions raised over the extent to which projects funded by the mechanism are truly additional.

6 Conclusions

The challenge of achieving greenhouse gas emissions reductions at the individual level is significant. It raises questions regarding engagement with individuals, public acceptability, transaction costs and the complexities of scheme design for mechanisms aimed at accounting for and pricing the emissions of individuals.

The Cap and Share proposal aims to achieve reductions at the individual level by introducing a cap and trade scheme. Overall, we have examined in some detail the key design issues relating to the Cap and Share scheme, and suggested possible ways forward. We have also reviewed the proposal against other possible measures. Without repeating the detail of the issues considered (the executive summary provides a stand-alone review), this report concludes the following on the main points:

- A cautious approach would suggest implementation for the transport sector only in the Republic, with subsequent consideration to sectoral and geographical expansion.
- The scheme is not inherently inequitable, but measures would be needed to shield the vulnerable from increased costs. We suggest this be separate from the scheme itself.
- The scheme should be based on the PPS system and electoral role, with consideration given to the treatment of children. Evidence suggests not allocating to children, although again consideration will be needed for increasing support to families.
- The roles of various institutions have been defined, with a key element being the scheme administrator that would have an overview of the whole scheme. We suggest this be the EPA.
- Transaction costs to individuals can be acceptably low, provided they can cash in their certificates remotely (on-line or by post). We make other suggestions for reducing transactions costs.
- Of the various personal carbon allocation approaches proposed, Cap and Share and the Sky Trust currently appear the most favourable.
- Furthermore, the lack of public engagement, uncertainty over environmental outcome and no direct compensation for individuals mean non-traded options such as a carbon tax and direct regulation score less well in our analysis than Cap and Share and Sky Trust.

Part 2:
Cap and Share: Possible Macroeconomic Effects in Ireland

Cambridge Econometrics
Authors:
Hector Pollitt
Unnada Chewpreecha
Jamal Tarafdar

1 OVERVIEW

1.1 Introduction

This report presents the final set of modelling results produced by Cambridge Econometrics in the assessment of the impacts of the introduction of a personal Cap and Share carbon trading scheme in the Republic of Ireland. This quantitative analysis builds on the findings from AEA Energy & Environment (2008), whose report introduces the trading system and outlines many of the more practical aspects of the scheme. These are not described again in detail in this document.

The modelling was carried out using E3ME, a large-scale econometric model of Europe with a detailed sectoral disaggregation and a full treatment of the two-way links between the economy, energy system and environment. The E3ME model is described in this section of the document.

The following chapters describe the basic methodology and assumptions and how the model was applied to analysing a personal Cap and Share trading scheme. The results are presented in aggregate and at more detailed levels in Chapter 4 and a list of key conclusions is presented in Chapter 5.

For further information about the E3ME model the reader is referred to the model website, http://www.e3me.com, and online manual, www.camecon-e3memanual.com/cgi-bin/EPW_CGIU.

Users are requested to report any errors or omissions to the authors.

1.2 Acknowledgements

The team would like to acknowledge the efforts of David Harrop (AEA), who originally requested Cambridge Econometrics' participation, but tragically died before the study was commissioned.

The team are also grateful for important inputs from Tom Cleary (Byrne O Cleirigh) for providing emission factors, Lisa Ryan as project manager at Comhar SDC Sustainable Development Council and for the insights of the project steering group and contributors to the stakeholder workshop held in Dublin. These contributions are greatly appreciated.

2 THE E3ME MODEL

2.1 Introduction

Short and long-term effects of E3 policies

E3ME is intended to meet an expressed need of researchers and policy makers for a framework for analysing the long-term implications of Energy-Environment-Economy (E3) policies, especially those concerning R&D and environmental taxation and regulation. The model is also capable of addressing the short-term and medium-term economic effects as well as, more broadly, the long-term effects of such policies, such as those from the supply side of the labour market.

The European contribution

The E3ME model has been built by an international European team under a succession of contracts in the JOULE/THERMIE and EC research programmes. The projects 'Completion and Extension of E3ME'[1] and 'Applications of E3ME'[2], were completed in 1999. The 2001 contract, 'Sectoral Economic Analysis and Forecasts'[3] generated an update of the E3ME industry output, products and investment classifications to bring the model into compliance with the European System of Accounts, ESA 95 (Eurostat, 1995). This led to a significant disaggregation of the service sector. The 2003 contract, Tipmac[4], led to a full development of the E3ME transport module to include detailed country models for several modes of passenger and freight transport and Seamate (2003/2004)[5] resulted in the improvement of the E3ME technology indices. The COMETR[6] (2005-07), Matisse[7] (2005-08) and DROPS[8] (2005-08) projects allowed the expansion of E3ME to cover 29 countries (the EU27 plus Norway and Switzerland) and material inputs. More recently E3ME has been applied in a number of forecasting and Impact Assessment (IA) exercises at the European level. A full list of project references is available on the model website.

E3ME is the latest in a succession of models developed for energy-economy and, later, E3 interactions in Europe, starting with EXPLOR, built in the 1970s, then HERMES in the 1980s. Each model has required substantial resources from international teams and each model has learned from earlier problems and developed new techniques.

The E3ME approach

E3ME combines the features of an annual short- and medium-term sectoral model, estimated by formal econometric methods, with the detail and some of the methods of the Computable General Equilibrium (CGE) models that provide analysis of the movement of the long-term outcomes for key E3 indicators in response to policy changes. It can be used for dynamic policy simulation and for forecasting and projecting over the medium and long terms. As such, it is a valuable tool for E3 policy analysis in Europe and its member countries.

In particular E3ME has the following strengths:

Model disaggregation

The detailed nature of the model allows the representation of fairly complex scenarios, especially those that are differentiated according to sector and to country. Similarly, the impact of any policy measure can be represented in a detailed way.

Econometric pedigree

The econometric grounding of the model makes it better able to represent and forecast performance in the short to medium run. It therefore provides information that is closer to the time horizon of many policy makers than pure CGE models.

1 European Commission contract no: JOS3-CT95-0011.

2 European Commission contract no: JOS3-CT97-0019.

3 European Commission contract no: B2000/A7050/001.

4 European Commission contract no: GRD1/2000/25347-SI2.316061.

5 European Commission contract no: IST-2000-31104.

6 European Commission contract no: 501993 (SCS8).

7 European Commission contract no: 004059 (GOCE).

8 European Commission contract no: 022788 (SSPI).

E3 linkages

An interaction (two-way feedback) between the economy, energy demand/supply and environmental emissions is an undoubted advantage over other models, which may either ignore the interaction completely or only assume a one-way causation.

2.2 The theoretical background to E3ME

Introduction

Economic activity undertaken by persons, households, firms and other groups has effects on other groups after a time lag, and the effects persist into future generations, although many of the effects soon become so small as to be negligible. But there are many actors, and the effects, both beneficial and damaging, accumulate in economic and physical stocks. The effects are transmitted through the environment (with externalities such as greenhouse gas emissions contributing to global warming), through the economy and the price and money system (via the markets for labour and commodities), and through the global transport and information networks. The markets transmit effects in three main ways: through the level of activity creating demand for inputs of materials, fuels and labour; through wages and prices affecting incomes; and through incomes leading in turn to further demands for goods and services. These interdependencies suggest that an E3 model should be comprehensive, and include many linkages between different parts of the economic and energy systems.

Key characteristics

These economic and energy systems have the following characteristics: economies and diseconomies of scale in both production and consumption; markets with different degrees of competition; the prevalence of institutional behaviour whose aim may be maximisation, but may also be the satisfaction of more restricted objectives; and rapid and uneven changes in technology and consumer preferences, certainly within the time scale of greenhouse gas mitigation policy. Labour markets in particular may be characterised by long-term unemployment. An E3 model capable of representing these features must therefore be flexible, capable of embodying a variety of behaviours and of simulating a dynamic system. This approach can be contrasted with that adopted by general equilibrium models: they typically assume constant returns to scale; perfect competition in all markets; maximisation of social welfare measured by total discounted private consumption; no involuntary unemployment; and exogenous technical progress following a constant time trend (see Barker, 1998, for a more detailed discussion).

2.3 E3ME as an E3 model

The E3ME model comprises:

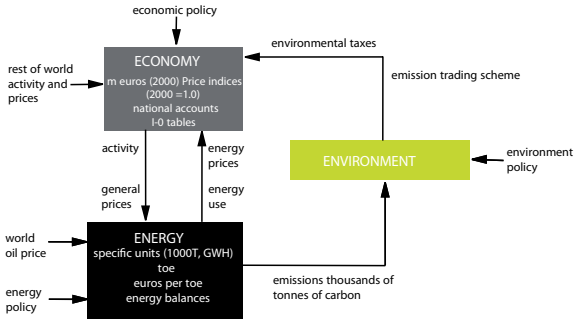
- the accounting balances for commodities from input-output tables, for energy carriers from energy balances and for institutional incomes and expenditures from the national accounts
- environmental emission flows
- 29 sets of time-series econometric equations (aggregate energy demands, fuel substitution equations for coal, heavy oil, gas and electricity; intra-EU and extra-EU commodity exports and imports; total consumers' expenditure; disaggregated consumers' expenditure; industrial fixed investment; industrial employment; industrial hours worked; labour participation; industrial prices; export and import prices; industrial wage rates; residual incomes; investment in dwellings, normal output equations and demand for seven material inputs)

Energy supplies and population stocks and flows are treated as exogenous.

The E3 interactions

Chart 2.1 below shows how the three components (modules) of the model- energy, environment and economy- fit together. Each component is shown in its own box with its own units of account and sources of data. Each data set has been constructed by statistical offices to conform with accounting conventions. Exogenous factors coming from outside the modelling framework are shown on the outside edge of the chart as inputs into each component. For the EU economy, these factors are economic activity and prices in non-EU world areas and economic policy (including tax rates, growth in government expenditures, interest rates and exchange rates). For the energy system, the outside factors are the world oil prices and energy policy (including regulation of energy industries). For the environment component, exogenous factors include policies such as reduction in SO_2 emissions by means of end-of-pipe filters from large combustion plants. The linkages between the components of the model are shown explicitly by the arrows that indicate which values are transmitted between components.

Chart 2.1 E3ME As An E3 Model



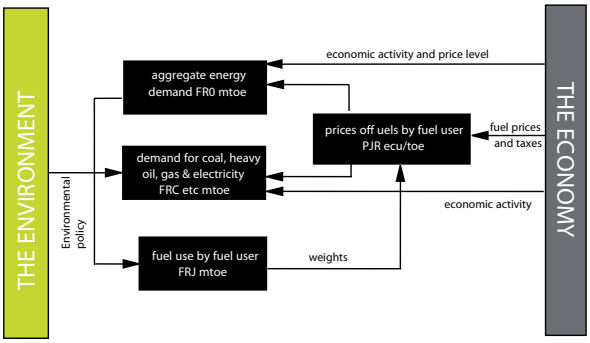
The economy module provides measures of economic activity and general price levels to the energy module; the energy module provides measures of emissions of the main air pollutants to the environment module. The energy module provides detailed price levels for energy carriers distinguished in the economy module and the overall price of energy as well as energy use in the economy.

2.4 Energy-environment links

Top-down and bottom-up methodologies

E3ME is intended to be an integrated top-down, bottom-up model of E3 interaction. In particular, the model includes a detailed engineering-based treatment of the electricity supply industry (ESI). This is based on available technologies and is described in Barker et al (2007). Demand for energy by the other fuel-user groups is top-down (see below), but it is important to be aware of the comparative strengths and weaknesses of the two approaches. Top-down economic analyses and bottom-up engineering analyses of changes in the pattern of energy consumption possess distinct intellectual origins and distinct strengths and weaknesses (see Barker, Ekins and Johnstone, 1995).

Chart 2.2: Inputs To The Energy Sub-model



A top-down submodel of energy use

The energy submodel in E3ME is constructed, estimated and solved for 19 fuel users (as mentioned above power generation is treated differently), 12 energy carriers, termed fuels for convenience below, and 29 regions. Chart 2.2 shows the inputs from the economy and the environment into the components of the submodel.

Determination of fuel demand

Aggregate energy demand, shown at the top of Chart 2.2, is determined by a set of co-integrating equations[9], whose the main explanatory variables are:

- economic activity in each of the 19 fuel users
- average energy prices by the fuel users relative to the overall price levels
- technological variables, represented by R&D expenditure in key industries producing energy-using equipment and vehicles

Fuel substitution

Fuel use equations are estimated for four fuels – coal, heavy oils, gas and electricity – and the four sets of equations are estimated for the fuel users in each region. These equations are intended to allow substitution between these energy carriers by users on the basis of relative prices, although overall fuel use and the technological variables are allowed to affect the choice. Since the substitution equations cover only four of the twelve fuels, the remaining fuels are determined as fixed ratios to similar fuels or to aggregate energy use. The final set of fuels used must then be scaled to ensure that it adds up to the aggregate energy demand (for each fuel user and each region).

Emissions submodel

The emissions submodel calculates air pollution generated from end-use of different fuels and from primary use of fuels in the energy industries themselves, particularly electricity generation. Provision is made for emissions to the atmosphere of carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), methane (CH_4), black smoke (PM_{10}), volatile organic compounds (VOC), nuclear emissions to air, lead emissions to air, chlorofluorocarbons (CFCs) and the other four greenhouse gases: nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6). These four gases together with CO_2 and CH_4 constitute the six greenhouse gases (GHGs) monitored under the Kyoto protocol. Using estimated (ExternE) damage coefficients, E3ME may also estimate ancillary benefits relating to reduction in associated emissions eg PM_{10}, SO_2, NO_X (see Barker and Rosendahl, 2000).

CO_2 emissions

Emissions data for CO_2 are available split by fuel user and fuel (and country). The energy submodel estimates emission coefficients (tonnes of carbon in CO_2 emitted per toe) for each case. The coefficients are calculated for each year when data are available, then used at their last historical values to project future emissions. Other emissions data are available at various levels of disaggregation from a number of sources and have been constructed carefully to ensure consistency.

Feedback to the rest of the economy

Changes in consumers' expenditures on fuels and petrol are formed from changes in fuel use estimated in the energy submodel, although the levels are calibrated on historical time-series data. The model software provides an option for choosing either the consumers' expenditure equation solution, or the energy equation solution. Whichever option is chosen, total consumer demand in constant values matches the results of the aggregate consumption function, with any residual held in the unallocated category of consumers' expenditure. The other feedbacks all affect industrial, including electricity, demand via changes in the input-output coefficients.

9 Cointegration is an econometric technique that defines a long-run relationship between two variables resulting in a form of 'equilibrium'. For instance, if income and consumption are cointegrated, then any shock (expected or unexpected) affecting temporarily these two variables is gradually absorbed since in the long-run they return to their 'equilibrium' levels. Note that a cointegration relationship is much stronger relationship than a simple correlation: two variables can show similar patterns simply because they are driven by some common factors but without necessarily being involved in a long-run relationship.

2.5 Model data sources

European industry-energy analysis

E3ME is a detailed model of 42 product/industrial sectors, mainly defined at the NACE 2-digit level. These are compatible with ESA95 accounting classifications, and include a disaggregation of energy and environment industries for which the energy-environment-economy interactions are central. The model also includes a linked set of 19 fuel-using sectors, covering the energy-intensive sectors in detail (see Appendix A).

Like its predecessors, E3ME is an estimated model (see below). Version 4.6 (E3ME46) is based on international data sources such as Eurostat's[10] national accounts and the OECD Stan[11] database, which provide detailed sectoral disaggregation, and DG Ecfin's AMECO[12] database, which is used for macro-level variables.

The data for the model's energy module come from the IEA's[13] databases, namely the energy balances and price levels.

2.6 Parameter estimation

Econometric specification

The econometric model has a complete specification of the long-term solution in the form of an estimated equation that has long-term restrictions imposed on its parameters. Economic theory, for example the recent theories of endogenous growth, informs the specification of the long-term equations and hence properties of the model; dynamic equations that embody these long-term properties are estimated by econometric methods to allow the model to provide forecasts. The method utilises developments in time-series econometrics, in which dynamic relationships are specified in terms of error correction models (ECM) that allow dynamic convergence to a long-term outcome. The specific functional form of the equations is based on the econometric techniques of cointegration and error-correction, particularly as promoted by Engle and Granger (1987) and Hendry et al (1984).

10 http://epp.eurostat.ec.europa.eu/pls/portal/ddis.go_home?p_language=en

11 http://www.oecd.org/document/15/0,3343,en_2649_201185_1895503_1_1_1_1,00.html

12 http://ec.europa.eu/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm

13 http://data.iea.org/ieastore/statslisting.asp

3 DETAILED METHODOLOGY

3.1 Introduction

The study was carried out using version 4.6 of the E3ME model. The results therefore reflect the structure of the model and the system of National Accounts (see Eurostat, 1995), the cross-section and time-series data collected, and the equation parameters estimated from these data. This chapter describes the assumptions that are most relevant to the model results; for an in-depth technical description the reader is referred to the model manual (Cambridge Econometrics, 2007).

Geographical coverage

In the scenarios E3ME was run for Ireland and the UK. As the policies are domestic to Ireland, with the rest of Europe being affected only in terms of international trade, the other countries in the model were fixed as exogenous. In addition, as Ireland is a small country in Europe, it was assumed that there were no impacts on the allowance price in the European Emission Trading Scheme (ETS).

The policy options were defined in terms of model variables in a series of scenarios, which are described in Section 3.3. These were compared to a baseline solution, which is described in Section 3.2. The analysis covers the period up to 2020, with the policy options in place from 2010 onwards.

3.2 Baseline forecast

The role of the baseline forecast is to provide a context in which forward-looking (ex-ante) quantitative analysis may be carried out. All the scenarios outlined in Section 3.2 represent carefully-defined differences from this baseline case.

Impacts on results

The baseline does not normally have a direct impact on the scenario results, which are typically reported as percentage differences from base; however, the indirect effects should not be dismissed. In the field of energy policy, the two most common cases where the baseline has a significant impact on results are:

- when an emissions target is set relative to historical values (eg a reduction in CO_2 emissions compared to 2005 levels)
- when assessing the impacts of tax rates defined in euros per unit of energy, where the baseline energy prices determine the resulting relative increase in fuel prices

Both of these are highly relevant to the results presented in this report. Alternative energy prices were tested through sensitivity analysis in the high oil-price scenarios.

Overall objective

The baseline should therefore provide a set of projections that is regarded as a neutral viewpoint of future developments (ie not something that is seen as being obviously too high or too low, which would bias the results). It need not represent the views of the modelling team and should not necessarily be regarded as a most likely outcome.

To aid interpretation of results, the baseline includes only policies that already exist or are certain to come into existence (ie the legislation is in place). This allows a direct comparison of the policies defined in the scenarios with the current situation. The most important policy change in place over the forecast period in the baseline is the inclusion of aviation in the ETS. This means air transport is not included in the Cap and Share schemes or carbon taxes that are modelled in the scenarios. However, other sectors which have been proposed for inclusion in the ETS (mainly in non-ferrous metals and chemicals) are not included in the ETS and are therefore subject to the Cap and Share and carbon tax schemes.

The PRIMES baseline

The current preferred method is that a baseline is usually formed on the basis of expert specialist views, to form an overall context, and large-scale computer models to fill out the details. It is important to note that the modelling results are used to inform rather than replace the human aspect of the development process.

Available software

In Europe the E3M-Lab at the National Technical University of Athens produces a combined energy-environment-economy (E3) forecast, using its PRIMES model (E3M-LAB, 2005). PRIMES is a large-scale Computable-General-Equilibrium (CGE) model with a very detailed specialist treatment of Europe's energy systems.

The economic part of the forecast is derived from a solution of the GEM-E3 model (KU Leuven, 2005), a commonly used Computable-General-Equilibrium (CGE) model that may be used for long-term economic forecasting. Other inputs to the energy modelling include global energy prices from the POLES model (Criqui, 2001) and transport activity from the SCENES model. The RAINS model (Amann et al, 2004) may also be attached to provide more detailed emissions projections.

The key point is that the projections provide a consistent picture of economic development and energy demands. It is thus a suitable forecast to calibrate an integrated E3 model such as E3ME.

Forecast version

The version of the forecast that is used in the current version of the E3ME model was published in spring 2008 (see European Commission, 2008b). It includes indicators of demographic developments, economic activity disaggregated across energy-intensive sectors, detailed energy demands, and CO_2 emissions disaggregated by broad sector. The forecast is based on five-year snapshots covering the period up to 2030, of which the period up to 2020 has been used in the scenarios.

Further processing

The figures presented in the published forecast were converted into classifications consistent with those used in E3ME and expanded to form annual time series. This mainly involved a system of linear interpolation and disaggregation of economic projections for the service sectors. This work was carried out using custom software developed with the Ox programming language (see Doornik, 2007).

To account for slight discrepancies in historical data (for example in cases where there were missing data points) and to prevent discontinuities in time series, growth rates were applied to E3ME's historical data sets.

Other economic variables, such as fixed investment and international trade, were estimated using simple assumptions based on the structure of the National Accounts. The baseline forecast for employment was taken from recent projections using E3ME carried out for CEDEFOP (see Wilson et al, 2007).

Summary of the baseline

Table 3.1 presents a quantitative summary of the baseline forecast for Ireland and other key indicators. The oil price does not take into account recent increases, but is expected to rise by 1% pa plus inflation over 2010-20. Results from an alternative set of scenarios, based on higher oil prices, are presented in Section 4.3. The main ETS carbon price, which is fixed in all of the scenarios, is also set to rise by 1% pa plus inflation over 2010-20.

Alternative baselines for Ireland

It should be noted that there are alternative views of future developments in Ireland, for example produced by ESRI (Fitz Gerald et al, 2008, see below for a brief comparison). The choice of forecast was the subject of some discussion at the start of the project. We do not suggest that one forecast is any better or worse than the alternatives available. The PRIMES forecast was chosen as the baseline because E3ME is set up to use this for its European analysis; recalibrating the model solution to an alternative

baseline forecast would have required some considerable use of resources.

Comparison with ESRI forecast

At an aggregate level the PRIMES and ESRI projections are fairly similar. CO_2 emissions are slightly higher throughout the ESRI forecast due to the inclusion of non-energy emissions and a different treatment of aviation emissions (which is not included in the Cap and Share schemes). In the economic indicators, while the ESRI forecast takes into account more recent developments, GDP growth in the two forecasts is almost identical over 2010-20.

Table 3.1: Primes Baseline Summary

	2005	2010	2020	Average growth 2010-20 (% pa)
GDP (€2000bn)	134.7	171.9	241.3	3.4
Employment ('000)	1962	2222.6	2528.9	1.3
Energy demand (k toe)	18078.2	19940.3	21823.9	0.9
CO_2 emissions (k tCO_2) - ETS	21905.4	23826.7	24976.2	0.5
CO_2 emissions (k tCO_2) non-ETS	25169.8	26313.5	27744.2	0.5
Oil price ($05/boe)	54.5	54.5	61.1	1.1
ETS price (€05/tCO_2)	18	20	22	1.0

Source(s): European Commission, E3ME.

However, at a sectoral level there are some important differences. The emissions levels are important because they determine the targets in the scenarios (which are in relation to 2005 levels) and the scale of action required (in terms of percentage difference from base) to meet these targets. In particular, transport emissions are expected to grow by 38% in the ESRI baseline over 2005-20, compared to 22% in the PRIMES figures. In other non-ETS sectors included in the Cap and Share scheme, the PRIMES baseline forecasts for energy demand appear to be up to 10% lower in 2020 than in the ESRI forecast, suggesting that the targets are easier to achieve.

3.3 Formal definition of scenarios

Other than the baseline, the scenarios fall into three groups:

- Cap and Share schemes
- carbon tax scenarios
- a combination of these (or "hybrid schemes")

Each of these schemes was run for a set of emission-reduction targets (e.g. 30%, 20% and 10% for the Cap and Share schemes) in 2020 with baseline oil prices and higher oil prices. The targets were defined as reduction in energy-related CO_2 emissions from the non-ETS sectors compared to 2005. These represent political objectives: the 30% reduction follows the Programme for Government's commitment of reductions of 3% pa up to 2012 and extends this to 2020; the 20% reduction is the current target for non-ETS sectors in Ireland under the EU's climate and energy package proposals (European Commission, 2008a); and 10% is a possible target if there was fungibility between the ETS and non-ETS sectors.

It should be noted that, in the baseline, CO_2 emissions from the non-ETS sectors were 10% higher in 2020 than in 2005 so a larger reduction in CO_2 emissions in 2020 compared to base is required to meet the 30% target.

Cap and Share scenarios

The Cap and Share scheme places a fixed ceiling on the level of emissions from a group of sectors, in this case the non-ETS sectors. At the start of each year, allowances under the ceiling are distributed to households who then sell them through financial intermediaries to the companies producing or importing fossil fuels in Ireland. Each fuel company must acquire enough allowances to cover the emissions to be released by the fuel it sells. Every time a company or individual purchases a fossil fuel, they must pay the importer or producer the cost of the CO_2 allowances required for it in addition to the price of the fuel. Thus there is a transfer of money from companies and households using a lot of fossil energy to households using less fossil energy.

The Cap and Share scheme is modelled using E3ME's emission trading scheme routines (with the main European ETS price treated as exogenous). The assumptions in the modelling therefore reflect the ones used in these routines, mainly:

- a single carbon price is calculated each year
- the carbon price is added on to the cost of energy and is treated the same way as an increase in energy costs for any other reason
- all installations (including households) that are included in E3ME's non-ETS sectors are included in the scheme; all installations that are included in E3ME's ETS sectors are excluded from the scheme
- there are no signalling or awareness effects
- there is no equivalent action in other countries
- all allowances are used, and the market for allowances is assumed to clear
- there are no transaction costs other than those mentioned below

E3ME calculates the allowance price based on the supply of allowances (fixed to meet a specified target) and demand (determined by emissions of CO_2, which in turn is determined by the level of energy use and economic activity). The allowance price automatically adjusts (causing demand to adjust in response to higher energy prices) until demand and supply are equal. The supply of allowances declines evenly each year until the target is met in 2020. This approximately equates to a 3% reduction each year.

Only direct emissions are counted in the calculation, so there is no increase in the price of electricity.

Use of revenues

Although it is envisaged that a government agency would calculate each year's emissions ceiling and distribute the allowances to each individual or household, at no stage does the revenue from the sale of the allowances pass through government hands. Households receive an equal allocation of allowances per person from the agency, regardless of income or socio-economic status. The lump sum that the household receives when it sells its allowances is not a transfer of resources (treated as wealth in the modelling) from government to households but rather, a transfer from those whose lifestyle consumes a lot of fossil energy to those whose lifestyle consumes less.

Transaction costs

Usually in E3ME's emission trading routines transaction costs are assumed to be zero. However, in this case data on transaction costs for households were provided from the first part of the study by AEA Energy and Environment (2008) and this was incorporated into the modelling. The assumption was that households had to pay a small fee to banks to sell their allowances. This is factored into the results but it should be noted that even when the fees from all Irish households are added together the impact is very small (around €4m pa).

Other transaction costs identified by the AEA study were not included in the modelling, for example it is assumed that there are no transaction costs for government in setting up or running a Cap and Share scheme. Following similar assumptions, there are no transaction costs in the carbon tax scenarios.

Carbon tax scenarios

The carbon taxes are imposed at a rate that meets the CO_2 emissions reductions specified in the scenarios. The exact rate is determined by a software algorithm recently developed at Cambridge Econometrics which effectively runs the model repeatedly until the desired result is obtained. As is the case with the Cap and Share scheme, the tax is gradually increased over time so that the emission reductions occur evenly over the forecast period. In practical terms the carbon tax is levied on fuels according to their carbon content. The emission factors used for this calculation were provided by the steering group and allocated to the fuel types as defined in E3ME. These are presented

in Table 3.2. Electricity was not taxed in the carbon-tax scenarios and was not included in the Cap and Share schemes as it is regulated by the ETS.

Table 3.2: Emission Factors Used In Carbon Tax

Fuel	tCO_2/toe
Hard coal	3.96
Other coal	4.14
Crude Oil	2.67
Heavy fuel oil	3.18
Middle Distillates	3.01
Other gas	2.38
Natural gas	2.38
Electricity	0

Source(s): Project Steering Group.

Revenue recycling

Revenues from the carbon tax were returned to households in the form of reduced income taxes and higher social benefits (after a correction to ensure revenue neutrality, see below). The main effect of this was to increase real household incomes. This is subtly different from the transfer received from the Cap and Share scheme, which is an increase in wealth. Typically a much larger share of wealth is saved with OECD (2004) showing saving rates of 90-100% of increases in wealth in large European countries. A good comparison is with the recent one-off rebates in the United States which also transferred wealth to households in the face of a slowing economy and higher energy prices; it was reported that 90% of this was saved. The US Federal Reserve assumes saving rates of 96.25% for increases in both housing and financial wealth in its model.

E3ME's parameters suggest that 8% of the revenues from Cap and Share schemes is spent immediately, compared to 20% (rising to 100% in the long run) from a reduction in taxes. Other than the effects of higher energy prices, the patterns of spending are assumed to remain unchanged. One of the aims of the Cap and Share scheme is to increase awareness and promote investment in energy-saving equipment; this is not included in the modelling.

There are additional incentive effects from the revenue recycling through income taxes and benefits but these largely cancel out (lower income taxes encourage people to work but higher social benefits encourage people not to work).

Hybrid scenarios

As an additional step, two hybrid scenarios including a combination of Cap and Share schemes and carbon taxes were set up. The targets were 30% and 20% reductions in CO_2 emissions in the non-ETS sectors in 2020 compared to 2005. As requested by the project steering group, the Cap and Share was applied to domestic use, and the carbon taxes to industrial use. In the hybrid scenarios, households received the revenues from the Cap and Share allowances (minus the fees paid to banks); however, the revenues from the carbon taxes were used to reduce employers' social security contributions, keeping a balance between payments and receipts by households and businesses (so that the method of recycling the revenues back to business was different from both the Cap and Share and carbon tax scenarios). Road transport was assumed to be 50% domestic and 50% for business purposes in these scenarios. Since the revenue-recycling methods in the hybrid scenarios are different to those in the Cap and Share and carbon tax scenarios, modelling results from the hybrid schemes will not necessarily fall between those for the Cap and Share and carbon tax schemes.

Revenue neutrality

It is assumed that all the scenarios are revenue neutral. Differences in modelling results therefore represent the impacts of a shift in taxation rather than a change in the overall level of taxation. It should be noted that this is not the same as saying that the Cap and Share or carbon tax schemes are revenue neutral as policies because one of the main impacts of these policies was to substantially reduce demand for motor fuels which are subject to excise duties. Other tax receipts (for example VAT) are also changed but to a lesser degree. The

distinction is important in terms of not introducing bias to the results, the underlying principle is that the government deficit as a share of GDP remains constant in all the scenarios.

Table 3.3: E3ME Fuel User Classification

Sector	Included in Cap and Share?	Included in ETS?
Power own use & transformation	No	Yes
Other energy own use & transformation	No	Yes
Iron & steel	No	Yes
Non-ferrous metals	Yes	No
Chemicals	Yes	No
Non-metallic mineral products	No	Yes
Ore-extraction (non-energy)	Yes	No
Food, drink & tobacco	Yes	No
Textiles, clothing and footwear	Yes	No
Paper & pulp	No	Yes
Engineering etc	Yes	No
Other industry	No	Yes
Rail transport	Yes	No
Road transport	Yes	No
Air transport	Yes	No
Other transport services	Yes	No
Households	Yes	No
Other final use	Yes	No
Non-energy use	No	No

3.4 Additional assumptions

Sectoral allocation

The Cap and Share schemes and carbon taxes are applied to CO_2 emissions from fossil fuels that are not included in the European ETS. In E3ME these are defined by sector. The sectoral allocation is shown in Table 3.3. Aviation is assumed to be covered by the ETS and so is not included in the Cap and Share schemes. However, emissions from the non-ferrous metals and chemicals sectors, which may also be covered by the ETS in the forecast period, are not included in the modelling. As the Cap and Share schemes and carbon taxes focus on energy emissions, non-energy emissions are not included in the schemes.

Fuel switching options for road transport

E3ME includes twelve energy carriers (termed "fuels" for convenience) of which four are explicitly modelled: hard coal, heavy fuel oil, natural gas and electricity. The other eight fuels are modelled as fixed ratios to aggregate energy demand or similar fuels. Road transport is modelled on the basis that a single fuel, middle distillates, is consumed, with the relative shares of petrol and diesel fixed in the scenarios.

Historically only liquid fuels have been available for consumption by motor vehicles. However, more recently, and to a greater extent over the forecast period, alternative fuels will become available for motorists. In the case of biofuels, the share is held constant at 10% of total consumption in 2020 in line with the proposed EU directive. The assumption is that any further expansion of biofuels would be prevented by capacity constraints on supply.

The case of electric vehicles is more difficult to address. It is likely that electric vehicles will become available over the forecast period but there are no historical data available with which to estimate their take-up rates. Furthermore, the Cap and Share and carbon tax schemes are likely to increase the rate of take-up. After discussion with the project steering group it was decided that any fuel-switching in the road transport sector would be by assumption (and the results are easiest to interpret). Therefore no fuel switching is allowed in this sector in the period up to 2020. In the base case this is consistent with EIA (2008) assumptions in the US.

This assumption does not have an effect on the type of impacts seen in the economic results but it does affect the magnitude of these results. This is because the allowance price in the Cap and Share schemes is pushed higher, and possibly quite a lot higher, because the reductions in fuel demand must come from greater (liquid) fuel efficiency in petrol and diesel-driven cars (including hybrids) and fewer

journeys being made by car or truck, rather than by fuel switching. This in turn means that there are more revenues available for the positive impacts, ie households can sell their allowances for a larger sum.

Given that, in terms of CO_2 emissions, road transport is the largest of the sectors included in the scheme, this is a key assumption.

Fixed input-output coefficients

The sectors in the E3ME model interact through the input-output relationships defined in the most recent OECD publication (Yamano and Nadim, 2006). Where equations exist (for energy sectors, water supply and producers of minerals or biomass), these input-output relationships are allowed to vary according to equation results, for example, if demand for coal by the iron and steel sector doubles in the energy equations, the economic purchases of that sector from the coal industry also double. However, for other sectors, there are no time-series data to estimate equations, so input-output coefficients remain fixed in the scenarios.

This is important in the economic results for the land transport industry, which is largely made up of road haulage companies (use of private cars falls under final demand so is not affected by input-output relationships). Most of the demand for this sector comes from other companies and is therefore calculated using fixed input-output coefficients. This means that if prices in this industry increase, as happens in the scenarios, its demand does not decrease (all other things being equal). In fact as retail output increases in the scenarios, this sector is forced to spend more on transportation and distribution to fill the shelves. One way of looking at it is that there is no alternative (rail transport is also included in land transport) so users of haulage firms have to accept the higher costs and possibly pass them on to customers.

The result is that, despite a fairly large increase in prices, economic activity in the land transport sector does not decrease. To properly assess these impacts a fully-integrated transport model would be required.

Table 3.4: Long-run Price Elasticities For Aggregate Energy Demand

Sector	Long-run Elasticity
Power own use & transformation	N/A
Other energy own use	-0.25
Iron & steel	-0.25
Non-ferrous metals	-0.25
Chemicals	-0.20
Non-metallics nes	-0.20
Ore-extraction (non-energy)	-0.20
Food, drink & tobacco	-0.20
Textiles, clothing	-0.20
Paper & pulp	-0.20
Engineering etc	-0.20
Other industry	-0.20
Rail transport	-0.20
Road transport	-0.70
Air transport	-0.40
Other transport services	-0.20
Households	-0.20
Other final use	-0.20
Non-energy use	N/A

Note(s): Figures show long-run price elasticities imposed on equations for aggregated energy demand in E3ME.

Source(s): Cambridge Econometrics.

Price elasticities

Long-run price elasticities for total demand for energy products are the only parameters in E3ME that are taken from the economic literature rather being estimated empirically on Irish national-level data. The reason for this is that when these elasticities are estimated from time-series data they tend to be biased downwards because, in the past, changes in energy demand have been viewed as temporary and therefore not induced behavioural change. E3ME's elasticities are taken from cross-sectional studies using data across members of the OECD by Franzen and Sterner (1995) and Johansson and Schipper (1997) and in the US by Roy et al (2006). These are shown in Table 3.4. Power generation uses a separate technology-driven submodel (see Barker et al, 2007) and so is not estimated.

The key price elasticity for the scenarios is the one for road transport, which is -0.7. This was found in Franzen and Sterner (1995) for the OECD countries. Although the size of the elasticity is often regarded as high, in internal studies at Cambridge Econometrics the same value has been estimated using a similar technique for the EU member states with more recent data. It is suggested that Ireland may have a lower elasticity than other OECD countries due to a lack of public transport in many rural areas; this may be the case, but is not reflected in the modelling.

Price elasticities for fuel shares (for example switching between gas and electricity) are estimated using Irish time-series data.

Use in the scenarios

The main impact of the price elasticities is in determining the allowance price, or carbon tax rate, required to meet the specified emission reduction targets. A lower elasticity would mean that a higher price is required.

These elasticities, and indeed most of E3ME's other model parameters, do not change in the scenarios. For example this means that an increase in petrol prices from €1/litre to €1.10/litre will cause the same percentage reduction in demand (10% price increase x 0.7 = 7% in the long run) as an increase in prices from €2/litre to €2.20/litre. This ignores the possible existence of "tipping points" that are often described in more qualitative analysis.

It is not always clear whether this is an appropriate assumption to make, as the basis for the elasticities was a period of low fuel prices while the ambitious scenarios form a period of very high energy prices. However, if the analysis is to be based on equations that are estimated empirically, using standard estimation techniques it is necessary to impose such an assumption. This assumption does not directly affect the economic results but does impact on the allowance price and carbon tax rates (although the direction is not clear), and therefore indirectly impacts the scale of the economic effects.

Non-energy emissions

The scenarios did not target non-energy emissions (which in any case are not modelled in E3ME) and so these were not included in the target reductions. In particular the agricultural sector was forced to pay for allowances for its use of carbon-based fuels, but not for emissions resulting from livestock.

Manufactured fuels

The analysis makes the incorrect assumption that the economic output of the manufactured fuels sector is zero. This is not by design but because the team were unable to find data for this sector:

- Eurostat does not go down to this level of detail
- OECD data implicitly set this sector to zero

The most likely reason for this is that there are a small number of companies in this sector (ie refineries) so data have been withheld under disclosure rules. Limited data are available from the Irish CSO but were not immediately comparable. This suggested that values for the manufactured fuels industry may have been included elsewhere in the E3ME databases and adding them again risked double counting. Therefore, the numbers were not used. Overall, however, the figures suggest that although this treatment leads to a small upward bias in the economic results, this is a very small sector (for example, counting for less than 0.5% of total value added in 2002) and so the impact on the aggregate results would have been small.

Household distributional impacts

The household distributional impacts in the model results are the result of a calculation that takes into account relative nominal incomes and relative prices for 13 socio-economic groups, split by income, employment status and urban/rural location. Changes in nominal income for each group are estimated according to changes in aggregate incomes in the modelling results, depending on the share of income in each group met by wages, by social benefits (including pensions) and from

other sources, such as dividends. Changes in prices for each group are estimated by taking a weighted average of the prices of the goods that each group spends income on, taken from survey data. The changes in real income that are presented are the changes in nominal incomes divided by the changes in relative prices. Data are taken from the most recent Eurostat publication.

In the scenarios, the distributional results therefore show the direct effects of higher energy prices, the indirect effects of higher energy costs passed on through higher prices for manufactured goods, and the positive effects of the allowances and revenue recycling measures.

This gives a reasonably accurate description of the likely distributional effects of the policy options; however, due to a lack of time-series data, it is necessary to make the assumption that price elasticities are the same for each group, implying that all groups have the same options for reducing energy consumption. There are cases where this is not true, for example options for public transport are much more limited in rural areas.

There is no feedback from the estimated distributional impacts to the rest of the model (eg through the consumption equations) as this would require parameters estimated on time-series data.

4 MODEL RESULTS

4.1 Aggregate results

The carbon price required to meet the target is high

One of the main outcomes of the scenarios is that there is a substantial fall in energy demand and emissions from the non-ETS sectors. This is part of the design of the scenarios but in most cases a high carbon price is required to achieve the reductions (see Table 4.1). When there is a 30% target, the required carbon price in 2020 is over 300€/tCO_2 (in 2008 prices), compared to an average EU ETS price around 24€/tCO_2 in the first half of 2008. It should also be noted that there are substantial differences in the required allowance prices for the different targets, with the price in 2020 roughly halving for a 20% target and again for a 10% target.

The patterns with the carbon taxes are similar. In the scenarios with carbon taxes the rates of the tax are set to achieve the same emissions reductions. Although the carbon taxes are converted to energy units according to the carbon content of each fuel type, the 30% target requires a tax double that required to meet the 20% target.

The differences between results for different targets are not due to an assumed cost curve but are determined by the estimated model parameters. An implicit cost curve, which takes an average for all the non-ETS sectors, may be estimated from the modelling results; this is shown in Chart 4.1 (based on the Cap and Share schemes) and clearly demonstrates that the lower targets may be met with a smaller increase in energy prices, but it becomes much harder to reach the higher targets. Chart 4.2 shows the development of the carbon price over time to meet the targets.

The differences between the carbon tax and Cap and Share scenarios are mainly in the economic results.

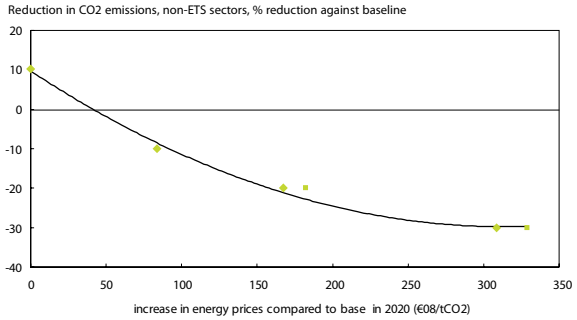
Table 4.1: Energy/Environment Results, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
Energy demand	-14.9	-11.2	-7.5	-14.4	-10.9	-15.2	-11.5
Total Irish CO_2 emissions	-18.8	-14.2	-9.6	-18.0	-13.6	-18.8	-14.1
Allowance price (€08/tCO_2)	308.8	167.2	83.9	0.0	0.0	325.9	221.9
Carbon tax (€08/tCO_2)	0.0	0.0	0.0	329.0	182.0	328.8	163.9
Allowances issued per hh (tCO_2)	11.9	13.7	15.4	0.0	0.0	6.5	7.0
Allowances issued per hh (€08)	3677.7	2287.5	1290.8	0.0	0.0	2122.2	1556.6

Note(s): Figures show percentage change for energy demand and CO_2 emissions in Ireland, relative to the baseline, and the carbon prices (in €08/tCO_2) required to achieve the target under Cap and Share and carbon tax scenarios. The number of households (hh) is assumed to be constant throughout the forecast period.

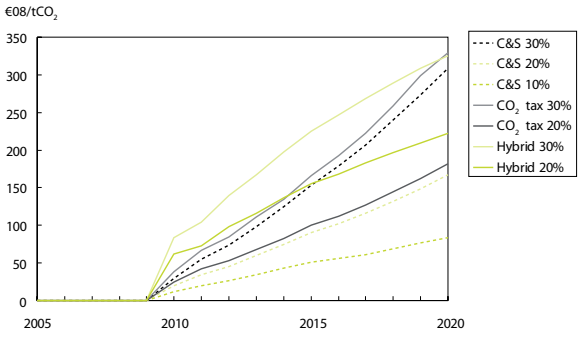
Source(s): E3ME.

Chart 4.1: Energy Prices and CO_2 Reductions



Source(s): E3ME.

Chart 4.2: Carbon Price



Note(s): Chart shows Cap and Share allowance price or CO2 tax rates in each scenario.

Source(s) : E3ME.

Explaining the high carbon prices

The high carbon prices may be surprising but there are several underlying reasons:

- the 30% emissions reduction target (compared to 2005) for the non-ETS sectors is highly ambitious, with the baseline predicting a 10% rise in emissions
- the eleven-year period in which to achieve this goal is relatively short
- one of the largest-affected sectors, road transport, does not have options in the modelling for switching to alternative fuels or vehicles

Road transport is a key sector in the results, as it is the largest sector included in the schemes. In the long run it is also a sector that has options for reducing fuel demands through efficiency gains. However, replacing the national fleet of vehicles requires time and does not fit well into the eleven-year period (remembering that the allowance price increases over time, so motor-fuel prices do not increase by much in the early years of the scheme). In addition, the modelling does not allow for the adoption of electric vehicles, as there are no historical data on which to base their take-up rates; in reality, however, much higher fuel prices may speed up the introduction of these vehicles. The share of biofuels in petrol is assumed to remain unchanged due to capacity constraints. This share is consistent with the proposed EU directive.

Emissions from power generation increase slightly

Overall energy demand falls by a lower percentage than the fall in CO_2 emissions. This is because the Cap and Share schemes and the carbon taxes affect the most carbon-intensive fuels (ie coal rather than oil and oil rather than gas). In particular, electricity is not covered by either of the schemes so demand for electricity does not fall and, in sectors where there is the possibility of switching between gas and electricity, there may be an increase in demand. This results in a small increase in required generation capacity, and emissions from the power generation sector increase by 2-3%. In the refining sector, which is also part of the ETS, the opposite is true as reduced demand for transport fuels means that less refining capacity is required.

In the other sectors included in the European ETS there is no direct impact on energy demand or emissions, although changes in relative prices or economic activity may mean that there are small changes in fuel demands.

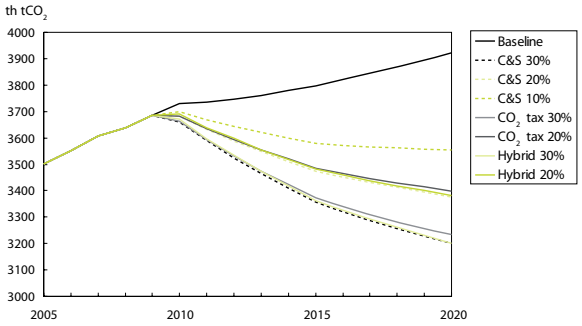
Overall CO_2 emissions in Ireland fall by around 19% in the 30% target Cap and Share scenario, compared to the baseline (see Chart 4.3).

The Cap and Share scheme has little impact on GDP and employment

The macroeconomic results present a balance of positive and negative impacts. The main negative impact is the increase in energy prices, which increases the overall price level (i.e. has an

inflationary impact) and reduces real incomes and household consumption. In the 30% Cap and Share scenario, the price level is around 3% higher in 2020 than in the baseline, mainly due to the higher prices of motor fuels and gas for heating, but also partly due to higher costs being passed on in the prices of manufactured goods. The effects of this are partly compensated by the lump-sum payments that households receive from selling allowances but total household consumption still falls by ¾% in 2020 compared to the baseline. However, excluding reductions in spending on energy products, consumption increases by ¼%.

Chart 4.3: Total CO_2 Emissions in Ireland



Source(s): E3ME

In the final GDP figures this is compensated by an improvement in the trade balance and, in particular, a reduction in imports. This may seem surprising but simply represents the fact that much less oil is being imported, meaning that the cap and trade scheme effectively becomes a tax on imports. Somewhat surprisingly there was little impact on export volumes, mainly because Irish firms were found not found to increase prices in response to higher unit costs and instead absorbed the increases (possibly as Ireland is a small country firms are price takers). This did have some negative impact on profitability in exporting sectors[14] (see Section 4.2).

Overall in the Cap and Share scheme, lower household spending was balanced by lower imports so there was no impact on GDP.

14 As national accounts data do not tend to include profits this is something that is difficult to measure.

E3ME does not assume full employment (or equilibrium in the labour market) so, although the schemes have no direct effect on employment, any changes in sectoral output could be expected to impact on employment levels. However, while there were changes in employment levels in some sectors, overall employment was roughly unchanged.

The carbon taxes have net positive benefits

The increase in energy prices in the carbon tax scenarios is roughly the same as in the Cap and Share scenarios. However, the revenues raised from the tax are used to reduce income taxes and increase benefit rates rather than being spread evenly between households. This has some impacts on incentives, but the two effects (lower taxes increasing incentives to work but higher benefits reducing incentives to work) largely cancel each other out.

The main difference between the Cap and Share and carbon tax schemes is subtle but important: lump sums in the Cap and Share scheme are treated as a transfer of wealth while altering the taxation system changes disposable income. The difference is wealth is allowed to accumulate over time, but in the long run all income is spent (see Section 3.2). This is why there is a positive impact on GDP in the carbon tax scenarios. The results from this reflect the view that a Cap and Share scheme (or tax with lump-sum recycling) is an inefficient instrument in macro-economic terms although it may be progressive in terms of income distribution.

In the modelling results household consumption increases by 1¾% in 2020 in the highest carbon tax scenario (see Table 4.2). This in turn leads to higher investment in response to higher expected future output. Some of this is extra demand is met by imports, but aggregate GDP increases by almost 1%. The proceeds of this growth are split between higher wages (wage demands can be stronger as Ireland has low unemployment rates) and slightly higher employment (and lower unemployment) levels, around 2,000 extra jobs in 2020. Employment falls in some manufacturing sectors that are affected by the carbon tax but increases in other sectors.

Table 4.2: Economic Results, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
GDP	0.0	-0.0	-0.0	0.9	0.5	-0.1	-0.1
Household spending	-0.8	-0.6	-0.3	1.7	1.0	-1.0	-0.7
Investment	0.0	-0.1	-0.1	0.5	0.3	-0.1	-0.1
Imports	-0.5	-0.4	-0.2	-0.1	-0.1	-0.5	-0.3
Exports	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0
Employment	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0
Price level	3.1	1.9	1.1	2.4	1.5	3.5	2.5

Note(s): Table shows percentage change in main economic indicators, compared to baseline.

Source(s): E3ME

4.2 Sectoral results

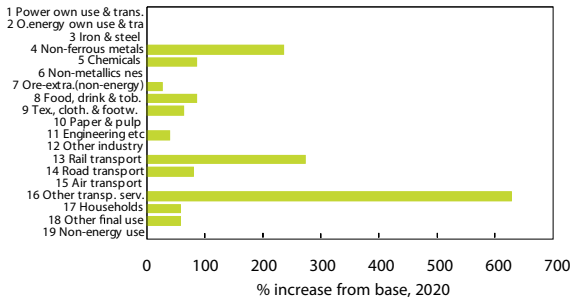
Changes in energy price and demand

Chart 4.4 presents the relative increase in energy prices for each of E3ME's fuel user groups under the Cap and Share scheme in the 30% reduction scenario. In the carbon tax scenario with the same reduction target, the increases in fuel prices were the same. This illustrates one of the main issues with the Cap and Share scheme adding a nominal amount on to the price of fuels; to meet the target there must be a large increase in the price of motor fuels, however these are already highly taxed so the relative impacts on other sectors are much higher. Most obviously if the same charge could be added to the price of fuels used for shipping, it would increase the price more than seven times. In comparison, a carbon tax could provide more flexibility for varying rates across sectors.

It should also be noted that electricity prices do not increase in the scheme so sectors that use more electricity (for example households) are affected less.

These differences are reflected in reductions in sectoral energy demand (see Table 4.3). Road transport has a high price elasticity of demand for fuel but smaller relative price increases. Households and some other sectors are able to switch to electricity, meaning that their emissions fall but

Chart 4.4: Increase In Energy Prices, By Sector



Note(s): Chart shows increase in average energy prices in the 30% target Cap and Share scenario

Source(s): E3ME.

energy demand less so and emissions in another sector, power generation, may increase as a result (see Table 4.4). The main trends in these results also hold for the carbon tax scenarios.

Output increases in most sectors under the Cap and Share scheme

Three sectors stand out for having gains in output under the Cap and Share schemes, each for their own reason:

- Retailing: Despite a reduction in total household spending the retail sector benefits from the way that spending is redirected away from energy goods, which are either supplied directly

(e.g. gas) or at low margins (petrol), to other consumer products, including cars (see below).

- Motor vehicles: In response to the higher fuel prices, motorists are more likely to upgrade to newer, more efficient vehicles. Other transport also benefits, although to a lesser extent.
- Electricity: The Cap and Share scheme encourages households and other user groups to switch from gas to electricity as gas prices increase, while electricity prices do not.

The sector that loses out the most by far is gas distribution, where output falls by up to 20%. It should be noted that if data were available for manufactured fuels we would also expect to see a large fall in output from this sector. The other sector where there is a fall in output (of nearly 1% in 2020) is construction; this is mainly a result of new capacity in gas supply not being required, hence lower demand for building work.

In the other sectors the effects of the Cap and Share scheme on output are limited. Some sectors gain, others lose out slightly, but overall there is little net change.

Table 4.3: Fuel Demand By Fuel User, % Difference From Base, 2020

Scheme	Cap & Share		
Target Reduction	**30%**	**20%**	**10%**
1 Power own use & trans.	2.1	1.4	0.9
2 Other energy own use and trans.	-0.6	-0.3	-0.1
3 Iron & steel	0.9	0.6	0.4
4 Non-ferrous metals	-58.2	-49.1	-36.0
5 Chemicals	-6.9	-4.5	-2.6
6 Non-metallics nes	0.2	0.1	0.1
7 Ore-extra.(non-energy)	-3.8	-2.3	-1.3
8 Food, drink & tob.	-17.7	-12.3	-7.7
9 Tex., cloth. & footw.	-8.5	-5.6	-3.3
10 Paper & pulp	0.8	0.6	0.4
11 Engineering etc	-5.4	-3.3	-1.8
12 Other industry	0.3	0.2	0.1
13 Rail transport	-67.6	-56.1	-41.6
14 Road transport	-28.0	-18.1	-10.4
15 Air transport	2.0	0.8	0.2
16 Other transp. serv.	-78.6	-67.8	-53.2
17 Households	-5.1	-3.2	-1.8
18 Other final use	-47.5	-40.5	-30.2
19 Non-energy use	0.0	0.0	0.0

Source(s): E3ME.

Sectoral exports are largely unaffected by the scheme

One of the arguments frequently put against environmental taxation is the effects of competitiveness in affected industries. There are many ways of measuring competitiveness (see Andersen, 2005 for a discussion in the context of environmental tax reform); here we focus on the impact on exports. Ireland's exports are dominated by a small number of sectors (see Table 4.5). Of these, only food and drink is negatively affected by the Cap and Share scheme. In the other sectors, either energy makes up a very small share of unit costs, export prices are not increased (most sectors), or export volumes are not affected by higher prices (less common). The result that export prices do not increase in response to higher unit costs is consistent with Ireland being a price taker in the global market. This means that it is company profits rather than export volumes that are adversely affected by the higher costs.

Table 4.4: CO_2 Emissions, % Difference From Base, 2020

Scheme	Cap & Share		
Target Reduction	**30%**	**20%**	**10%**
1 Power own use & trans.	2.1	1.4	0.9
2 Other energy own use and trans.	-0.9	-0.4	-0.2
3 Iron & steel	0.0	0.0	0.0
4 Non-ferrous metals	-77.3	-63.3	-44.7
5 Chemicals	-16.8	-10.8	-6.4
6 Non-metallics nes	0.1	0.1	0.1
7 Ore-extra.(non-energy)	-17.3	-10.7	-6.0
8 Food, drink & tob.	-37.4	-26.3	-16.6
9 Tex., cloth. & footw.	-23.5	-15.3	-8.8
10 Paper & pulp	1.0	0.7	0.4
11 Engineering etc	-14.2	-9.1	-5.1
12 Other industry	0.4	0.3	0.2
13 Rail transport	-75.3	-63.8	-48.2
14 Road transport	-28.1	-18.1	-10.5
15 Air transport	2.0	0.8	0.2
16 Other transp. serv.	-78.0	-67.1	-52.5
17 Households	-7.0	-4.2	-2.3
18 Other final use	-86.7	-73.5	-54.4
19 Non-energy use	0.0	0.0	0.0

Source(s): E3ME.

Table 4.5: Detailed Exports Results

	Export share in Ireland's total, 2006 (%)	Energy consumed as share of output, 2000 (%)	Export price increase, 2020 (%)	Change in exports, 2020 (%)
Electronics	31.8	0.1	0.0	-0.0
Chemicals nes	24.3	3.7	0.1	-0.0
Food	8.6	2.3	0.4	-0.2
Pharmaceuticals	8.4	0.3	0.0	0.0
Elec. Eng. & Instrum.	7.2	1.7	0.0	-0.0
Printing & Publishing	4.8	0.3	0.0	0.0
Mech. Engineering	1.7	1.2	0.0	-0.0

Note(s): Table shows relative importance of export industries and of energy to these industries, plus change in export prices and volumes in the 30% Cap and Share scenario

Source(s): E3ME

Impacts on profitability

It is not possible to quantify the effects of the scenarios on company profits as data for profits tend not to be published in national accounts data sets and profits are usually of interest at a firm, rather than sectoral, level. However, it is possible to make a qualitative analysis, defining profits as the difference between output and input costs, including wages. Not all sectors will lose out as a result of the policies but the following sectors could be expected to be adversely affected:

- land transport, which does not increase prices in line with costs
- sectors that are major exporters and do not increase prices (eg electronics, chemicals, food and drink)
- sectors that use land transport services but do not increase prices (eg distribution)

This could have further impacts on business investment, but again the data required to model this are not available.

Output increases in most sectors under the carbon tax

The impacts on the energy sectors are broadly the same under the carbon tax and Cap and Share scheme. The main sectoral differences, which lead to an overall increase in output, are due to the extra income being spent by households. Sectors where demand comes from household expenditure benefit the most; notably retail and other service sectors, but also in motor vehicles.

Aggregate employment is unchanged, but there are variations between sectors

Overall employment does not change in the Cap and Share scenario but there is a marked difference in the results between sectors. The main sectors where employment increases are the higher-skilled engineering sectors, including machinery and transport equipment. There are two reasons for this: demand for these industries' products may increase due to investment patterns, and these sectors face higher energy costs and so may substitute labour for energy inputs. In contrast, employment falls in the more basic manufacturing sectors (and pharmaceuticals) that are covered by the Cap and Share scheme. In the service sectors there is not much change in employment levels.

With the CO_2 taxes the same patterns are evident but the magnitude of the impacts is larger. Overall there is no change in employment levels.

4.3 Impacts on the fuel mix

The Cap and Share and carbon tax scenarios both target the most carbon-intensive fuels. However, the most carbon-intensive fuel of all, coal, is not widely used in the sectors where the schemes are applied. Consequently, use of coal does not decrease and across the economy as a whole actually increases due to demand from the power generation sector (see below).

Heavy fuel oil is the next most polluting of the main fuel groups. Its use falls by almost 40% in the most ambitious scenarios, mainly due to a reduction in demand by non-ferrous metals. Fuel oil accounts for almost 15% of energy CO_2 emissions in the baseline in 2020 so this is a sizable contribution to meeting the target.

Demand for middle distillates falls by around a quarter in the 30% target scenarios, almost completely from the road transport sector, which is by far the largest user of this fuel. Demand for gas falls by 17-18% due to reductions in demand from households and from commerce.

As electricity prices are not affected at all by either the Cap and Share scheme or the carbon taxes there is no downward pressure on levels of electricity consumption. There is, however, upward pressure on demand due to fuel-switching from gas. This is mainly for heating in houses and in offices, but to a lesser extent other sectors can also switch. Overall demand for electricity therefore increases by up to 7-8%. This means that in turn the power generation sector must increase capacity and its emissions rise by 2-3%.

The impacts on the fuel mix are shown in Table 4.6.

4.4 Household distributional results

Introduction

E3ME includes a basic model of distributional impacts based on the most recent household spending survey data published by Eurostat in spring 2008. This splits households into 13 groups, including five income groups, six socio-economic groups and a split between urban and rural households. Nominal incomes are estimated for each group according to increases in wages, benefits and other income (eg dividends) and the importance of these in the incomes of each group. Real incomes are calculated by dividing this by an aggregate price deflator, which is calculated by taking a weighted average of the prices of each consumer good, with the weights being the share of expenditure by each group. The results are then scaled to match the main model aggregates, which take into account changes in the shares.

The main distributional impacts come from:

- different sources of income
- differences in spending patterns

The spending patterns are summarised in Table 4.7. The main patterns are that the lower-income groups are much more reliant on social benefits for their incomes and, as incomes in the lowest group are half the mean, the lump-sum payments have a much larger relative effect. In the spending patterns there is not much difference between the groups in spending on heating fuels but there are large differences in consumption of motor spirit, with the higher income groups spending a larger share of earnings on motor fuel. Rural population groups also spend a larger share of income on transport.

Table 4.6: Fuel Demand By Fuel Type, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	30%	20%	10%	30%	20%	30%	20%
Coal	0.5	0.2	0.0	1.6	0.9	0.4	0.3
Heavy fuel oil	-39.5	-31.9	-22.4	-37.6	-29.7	-37.0	-28.1
Middle distillates	-24.8	-17.2	-10.7	-24.7	-17.4	-25.7	-18.5
Gas	-16.7	-14.3	-10.7	-16.1	-14.1	-17.2	-14.3
Electricity	7.7	5.5	3.3	8.2	5.8	7.3	5.1

Source(s): E3ME

Table 4.7: Share Of Spending On Energy, 2005

	Heating fuels	Transport fuels	Total fuel (Average households = 1)
All households	3.4	4.7	1.0
First quintile	7.4	3.8	0.5
Second quintile	5.1	4.8	0.7
Third quintile	3.8	4.9	1
Fourth quintile	2.9	5.3	1.3
Fifth quintile	2.2	4.3	1.5
Manual workers	2.8	4.2	1.1
Non-manual workers	2.8	4.2	1.3
Self-employed	3.4	5.3	1.1
Unemployed	4.1	5	0.7
Retired	4.9	4.7	0.7
Inactive	4.8	4.5	0.7
Densely populated	3	3.6	
Sparsely populated	4.2	6.7	

Note(s): Eurostat data scaled to official national statistics values. The column for total shows spending on fuels compared to the average household

Source(s): Eurostat and the Central National Statistics Office Ireland

The Cap and Share scheme benefits low income households

The scenarios could therefore all be considered equitable, in that the burden of higher energy prices falls more on high-earning households. The carbon tax scenarios also help out low-income groups through increasing social benefit rates. However, the largest impact is the receipt of the lump-sum payment on low-income households. The size of the increase is determined by the value of the allowances compared to average incomes in each group. In the lowest income group, incomes are around half the mean for Ireland as a whole and in the scenarios the lump-sum payment of allowances can increase incomes in the lowest income groups by more than 5%.

The other key trend is that households in urban (defined as densely-populated) areas are likely to gain more from the schemes. The reason for this is that spending on transport fuels makes up a larger share of total spending by rural households and therefore they are more affected by the price increases for petrol and diesel.

The impacts of the Cap and Share and carbon tax scenarios on the different household groups are presented in Table 4.8.

Table 4.8: Income Distribution, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
All households	1.8	1.1	0.6	2.1	1.3	1.6	1.0
First quintile	5.6	3.5	2.0	4.2	2.7	5.2	3.4
Second quintile	3.2	2.0	1.1	2.0	1.2	2.9	1.9
Third quintile	1.5	0.9	0.5	1.9	1.1	1.3	0.8
Fourth quintile	0.8	0.5	0.3	2.0	1.2	0.7	0.4
Fifth quintile	0.6	0.3	0.2	2.6	1.5	0.5	0.3
Manual workers	1.2	0.7	0.4	1.7	1.0	1.0	0.6
Non-manual workers	1.1	0.6	0.3	2.4	1.4	0.9	0.6
Self-employed	1.1	0.7	0.4	1.7	1.1	1.0	0.6
Unemployed	3.4	2.1	1.2	2.3	1.4	3.2	2.1
Retired	3.3	2.0	1.2	4.6	2.8	3.0	1.9
Inactive	3.4	2.1	1.2	2.0	1.3	3.1	2.0
Densely populated	2.4	1.4	0.8	2.9	1.7	2.3	1.5
Sparsely populated	1.1	0.7	0.4	0.8	0.5	0.8	0.5
Allowances issued per hh (€08)	3677.7	2287.5	1290.8				

Note(s): Figures include revenues from selling Cap and Share allowances and the impact of an increase in fossil price. The value of the Cap and Share allowances to each household is shown in the final row. The number of households is assumed to be constant throughout the forecast period.

Source(s): E3ME

4.5 Results in the context of higher oil prices

Most of the scenarios (and the baseline) were also run in the context of higher global oil prices. This serves two purposes: to test the robustness of the model results to a key input assumption, and to run the scenarios under an oil price that is closer to actual prices in mid 2008. The two sets of oil prices are shown in Table 4.9. Under these high oil price scenarios the oil price is roughly 50% higher in 2020. The ETS prices were not assumed to change.

The higher oil prices have two main impacts on the scenarios. First, the emissions targets are easier to achieve because baseline emissions are lower due to higher energy prices. Emissions from the non-EU ETS sectors in the baseline with the high oil prices in 2020 are 6% below the 2005 level. Second, the relative impact of the policies on fuel prices is less (eg to raise prices by 10% a much higher allowance price is required).

The study is not intended to examine the effects of higher global oil prices (which would have impacts on Ireland's trading partners in the rest of Europe as well, but other than the UK, these were not modelled) but for reference, GDP is up to 1% lower in 2020 under the higher oil prices, mainly due to falls in real income and household spending. Exports and import volumes are also lower by up to 1%.

Table 4.9: Oil Prices

		2010	2015	2020
Baseline	$2005/boe	54.50	57.90	61.10
	nom $ /boe	60.01	70.78	83.41
High oil scenario	$2005/boe	56.50	69.45	84.86
	nom $ /boe	67.13	91.60	125.00

Note(s): Figure shows price of oil in barrels of oil equivalent in real and nominal terms

Source(s): European Commission, Cambridge Econometrics

The impacts of the scenarios are similar (see Table 4.10) but generally smaller in magnitude, because the targets become less ambitious. For example, the allowance price in the 30% target Cap and Share scenario is €221 rather than €309, a fall of nearly 30%. This means that there is 30% less revenues to redistribute to households, so the economic impacts are smaller. This does not make much difference at the aggregate level, where impacts were small anyway but does have some effect at the more detailed level, including for low-income households, where incomes including the value of the allowance increase by 3.6% rather than 5.6% when the oil price is lower.

Table 4.10: Energy Results, % Difference From Respective Base, 2020

Scheme	**Cap & Share**			
Target Reduction	**30%**	**30% high oil**	**20%**	**20% high oil**
Energy	-14.9	-8.7	-11.2	-4.9
CO_2	-18.8	-11.6	-14.2	-6.5
Allowance price (€08/tCO2)	308.8	221.3	167.2	85.1
Carbon tax (€08/tCO2)	0.0	0.0	0.0	0.0
Scheme	**CO_2 tax**			
Target Reduction	**30%**	**30% high oil**	**20%**	**20% high oil**
Energy	-14.4	-8.4	-10.9	-4.8
	-18.0	-11.0	-13.6	-6.2
Allowance price (€08/tCO2)	0.0	0.0	0.0	0.0
Carbon tax (€08/tCO2)	329.0	239.6	182.0	92.4

Note(s): Figures show change in energy demand and CO2 emissions in Ireland, relative to baseline, and the carbon/energy prices required to achieve this.

Source(s): E3ME.

Table 4.11: Economic Results, % Difference From Respective Base, 2020

Scheme	Cap & Share			
Target Reduction	**30%**	**30% high oil**	**20%**	**20% high oil**
Scenario oil price (nom $/boe)	83.4	125.0	83.4	125.0
GDP	0.0	0.1	-0.0	0.0
Household spending	-0.8	-0.5	-0.6	-0.3
Investment	0.0	-0.0	-0.1	-0.1
Imports	-0.5	-0.4	-0.4	-0.2
Exports	-0.0	-0.0	-0.0	-0.0
Employment	-0.0	-0.0	-0.0	-0.0
Price level	3.1	1.7	1.9	0.8
Scheme	**CO_2 tax**			
Target Reduction	**30%**	**30% high oil**	**20%**	**20% high oil**
Scenario oil price (nom $/boe)	83.4	125.0	83.4	125.0
GDP	0.9	0.6	0.5	0.2
Household spending	1.7	1.1	1.0	0.3
Investment	0.5	0.3	0.3	0.0
Imports	-0.1	-0.1	-0.1	-0.1
Exports	0.0	0.1	0.0	0.0
Employment	0.0	0.0	0.0	0.0
Price level	2.4	1.1	1.5	0.6

Note(s): Table shows percentage change in main economic indicators, compared to baseline

Source(s): E3ME

Matching the ETS price

For comparison, a scenario was set up that set a carbon tax for the non-ETS sectors that was equal to the main European ETS price in €/tCO_2, meaning that all sectors pay the same for releasing one tonne of CO_2. This scenario was run in the context of high oil prices (although baseline ETS prices were assumed unchanged). Overall, this tax did not have a very big impact on CO_2 emissions, reducing overall CO_2 emissions from the non-ETS sectors by around 1% in 2020 compared with the baseline. Total Irish CO_2 emissions (those from the EU ETS and non-EU ETS sectors) are ½% lower than the base case in 2020.

5 CONCLUSIONS

5.1 Introduction

The E3ME model was set up to assess the energy, environmental and economic impacts of the introduction of a personal Cap and Share emission trading scheme in Ireland. The scheme was applied to all economic sectors that are not included in the EU's Emission Trading Scheme and covered all energy-related CO_2 emissions. E3ME determined the carbon prices in the scheme such that the targets, described below, were met. The economic impacts resulting from this increase in energy costs were evaluated according to the structure of the national accounts, as embodied in the E3ME model, and the model's two-way linkages between the environment, energy systems and economy.

As a comparison, scenarios with an equivalent carbon tax and revenue recycling were also modelled, and two hybrid options that split the burden between business and households.

The Cap and Share schemes included a set of ambitious emission-reduction targets in the sectors that were covered by the scheme. The largest reduction was 30% in 2020 compared to 2005 levels, compared to a projected 10% increase under business as usual conditions. This roughly represents a 3% reduction in CO_2 emissions in each year up to 2020.

Each scenario was compared to an agreed baseline solution. An alternative base case, with higher oil prices, was used to test the sensitivity of the modelling results to this key input assumption.

5.2 Economic impacts

The overall impact of the Cap and Share scheme on aggregate GDP and employment levels is small. However, looking at the more detailed results, the following trends are clear from the modelling:

- higher energy prices have an inflationary impact (whether due to Cap and Share or carbon taxes)
- this reduces real incomes and household spending (although excluding energy, household expenditure increases)
- sales of allocated allowances boost household wealth, but the modelling assumes that most of this is saved
- a reduction in energy imports boosts Ireland's Balance of Payments, as exports are largely unchanged

Sectoral impacts

At the sectoral level there are some sectors that are able to increase output, while others lose out. The sectors that lose out are concentrated in the energy branch, in particular gas distribution and manufactured fuels (although this could not be modelled due to missing data). The construction industry was also found to lose out due to lower investment in gas infrastructure. The gains were more widely spread, including recipients of consumer spending (eg retail) but also sectors that manufacture energy-efficient products, in particular motor vehicles and mechanical engineering. These highly-skilled sectors were found to increase employment, while employment decreased in more basic manufacturing sectors. Output from the electricity industry also increased in response to higher demand.

In terms of profitability, and also possibly investment, firms in some sectors are likely to be particularly affected, mainly those that are unable to pass on cost increases to domestic markets and, in particular, exporting firms that are unable to increase prices in international markets.

The impacts on haulage firms are difficult to measure; undoubtedly the sector faces higher costs but it is not clear how much of this can be passed on to customers and how this would affect output and profitability in the sector. To fully assess these impacts, a transport model with an equation to describe demand for road freight is required.

Distributional impacts

The Cap and Share scheme was found to be highly equitable, partly because the product that had the largest price increase (motor fuels) makes up a larger share of spending in higher-earning households, but mainly because the relative value of the allowance was much higher for low-income households.

The other notable distributional impact is that households in urban areas gain more from the scheme as they spend a smaller share of income on transport fuels.

5.3 Energy and environment impacts

A high carbon price is required

The reduction in CO_2 emissions is part of the definition of the scenarios. The modelling results suggest a very high carbon price would be required to achieve these targets by 2020. This partly reflects the ambitious nature of the targets and the sectors that are included in the scheme, and partly reflects modelling assumptions. In particular, the modelling does not allow the provision of electric vehicles, meaning that emission reductions had to be met through efficiency improvements in liquid fuels or a reduction in the number of journeys made.

Furthermore, while the highest carbon price is large enough to increase the price of motor fuels by 80%, adding this on to the fuels used by some other sectors increases their average energy prices by much more. The reason for this is that motor fuels are already taxed heavily through excise duties, so a larger allowance price is required to change behavioural patterns.

Other sectors

As electricity, which does not directly produce CO_2 emissions, does not increase in price, households and some other sectors covered by the Cap and Share scheme are able to switch from use of gas to use of electricity. Overall consumption of electricity increases. This has a secondary impact that additional capacity is required in the power generation sector. Consequently, emissions from this sector increase slightly and overall use of coal in Ireland is also slightly higher.

5.4 Comparing Cap and Share with carbon taxes

The effects of the Cap and Share schemes and the carbon taxes on energy prices, fuel demand and emissions are almost identical; the extra cost is added on to the price of the fuels and this reduces demand according to the price elasticities. The main difference comes from the revenue recycling methods and their economic and distributional impacts.

The main difference between the two policies is that under the personal Cap and Share scheme, households receive an increase in financial wealth through the allowances that they receive. It is assumed that much of this is saved (in Ireland 8% is spent, in line with the European historical average and similar to figures quoted in other studies). Under the carbon taxes, the revenue recycling feeds directly into income, through lower income taxes and higher social benefits. While some of this is also saved, a larger share is used for immediate consumption and in the long-run (which could be after 2020) all the extra income is spent. The multiplier effects of higher immediate spending boost output in the period up to 2020, meaning that under the carbon tax with revenue recycling, there is a net increase in economic activity.

At a distributional level the carbon taxes with revenue recycling are less beneficial for low income households, although due to the increases in social benefits their incomes do increase. However, the reduction in income taxes is of more benefit to the higher-earning groups.

6 REFERENCES

AEA Energy and Environment (2008) 'Cap and Share: Phase 1; policy options for reducing greenhouse gas emissions', report produced for Comhar Sustainable Development Council.

Amann, M., J. Cofala, C. Heyes, Z. Klimont, R. Mechler, M. Posch and W. Schöpp (2004) 'RAINS Review 2004'. International Institute for Applied Systems Analysis, http://www.iiasa.ac.at/Admin/PUB/Documents/IR-06-029.

Andersen, M. S. (2005) 'ETR and Competitiveness - Conceptual Issues', COMETR, European Commission project No 501993 (SCS8).

Barker, T., O. Løfsnaes and H. Pollitt (2007) 'The ETM in E3ME43', Cambridge Econometrics, http://www.camecon.com/suite_economic_models/e3me/pdf%20files/ETM.pdf.

Barker, T S (1998) 'Use of energy-environment-economy models to Inform greenhouse gas mitigation policy', Impact Assessment and Project Appraisal, vol. 16, no. 2, pp. 123-131.

Barker, T S, Ekins, P and N Johnstone (1995) Global Warming and Energy Demand, Routledge, London.

Cambridge Econometrics (2007), 'E3ME Manual', http://www.camecon-e3memanual.com/cgi-bin/EPW_CGIU.

Criqui, P (2001) 'POLES Prospective Outlook on Long-term Energy Systems', Institut d'Economie et de Politique de l'Energie, http://web.upmf-grenoble.fr/iepe/textes/POLES8p_01.pdf.

Doornik, J. A. (2007) 'Ox: An Object-Oriented Matrix Language', Version 5, London: Timberlake Consultants Press.

E3M-LAB (2005) 'The PRIMES Energy System Model: Reference Manual', Institute of Communication and Computer Systems, National Technical University of Athens, http://www.e3mlab.ntua.gr/manuals/PRIMsd.pdf.

EIA (2008) 'International Energy Outlook 2008', Table F6, Energy Information Administration, US Government, see http://www.eia.doe.gov/oiaf/ieo/ieoenduse.html.

Engle, R F and C W J Granger (1987) 'Cointegration and error correction: representation, estimation and testing', Econometrica, 55, 251-76.

European Commission (2008a) 'Impact Assessment: Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020', page 9, SEC(2008) 85/3, Commission Staff Working Document, European Commission, see http://ec.europa.eu/energy/climate_actions/doc/2008_res_ia_en.pdf.

European Commission (2008b) 'Energy and Transport: Trends to 2030 (Update 2007)', Directorate General for Transport and Energy, European Commission, http://ec.europa.eu/dgs/energy_transport/figures/trends_2030_update_2007/index_en.htm.

Eurostat (1995) 'European System of Accounts (ESA95)', Eurostat, European Commission.

Fitz Gerald, J., A. Bergin, T. Conefrey, S. Diffney, D. Duffy, I. Kearney, S. Lyons, L. Malaguzzi Valeri, K. Mayor, R. Tol (2008) 'Medium-Term Review 2008-15', May 2008, Number 11, Economic and Social Research Institute, Dublin.

Franzen, M and T Sterner (1995) 'Long-run Demand Elasticities for Gasoline' in Barker, T, N Johnstone and P Ekins (eds), *Global Warming and Energy Elasticities, Routledge*.

Hendry, D F, Pagan, A and J D Sargan (1984) Dynamic specification, in Handbook of Econometrics EM, Vol II, Griliches, Z and M D Intriligator (eds), Amsterdam, North Holland.

Johansson, O. and L. Schipper (1997) 'Measuring the long-run fuel demand of cars', *Journal of Transport Economics and Policy, Volume XXXI, No 3, pp 277-292*.

KU Leuven (2005) 'GEM-E3 Computable General Equilibrium Model for studying Economy-Energy-Environment Interactions for Europe and the world', see http://www.gem-e3.net/download/GEMmodel.pdf.

OECD (2004) 'Housing Markets, Wealth and the Business Cycle', OECD Economic Outlook (2004), Chapter IV, see http://www.oecd.org/dataoecd/4/60/31920338.pdf.

Roy, J., A. Sanstad, J. Sathaye and R. Khaddaria (2006) 'Substitution and price elasticities using inter-country pooled data in a translog cost model', Formal Report, LBNL-5306, 2006.

Wilson, R., F. Cörvers, B. Gardiner, B. Kriechel, H. Pollitt, I. Livanos and U. Chewpreecha (2007) 'Medium-term forecasts of occupational skill needs in Europe', Report for CEDEFOP, European Commission project No 2006/S 125-132790.

Yamano, N. and N. Ahmad (2006) 'THE OECD INPUT-OUTPUT DATABASE: 2006 EDITION', STI working paper 2006/8, Statistical Analysis of Science, Technology and Industry, OECD.

APPENDIX A

SCENARIO OUTCOMES

Table A1: Macroeconomic Summary, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
GDP	0.00	-0.03	-0.03	0.88	0.52	-0.07	-0.11
Household spending	-0.85	-0.57	-0.34	1.73	1.04	-0.95	-0.73
Investment	0.00	-0.07	-0.06	0.54	0.26	-0.07	-0.08
Government spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	-0.52	-0.35	-0.20	-0.08	-0.08	-0.51	-0.32
Exports	-0.04	-0.04	-0.03	0.05	0.02	-0.05	-0.04
Employment	-0.02	-0.02	-0.01	0.05	0.02	-0.02	-0.02
Real incomes	-1.27	-0.81	-0.45	2.11	1.28	-1.40	-1.04
Price level	3.05	1.90	1.07	2.44	1.54	3.55	2.55

Source(s): E3ME

Table A2: Macroeconomic Summary, High Oil Price Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
GDP	0.10	0.02	0.01	0.65	0.22
Household spending	-0.49	-0.25	0.03	1.10	0.29
Investment	-0.02	-0.09	-0.01	0.33	0.03
Government spending	0.00	0.00	0.00	0.00	0.00
Imports	-0.41	-0.22	-0.01	-0.14	-0.13
Exports	-0.01	-0.01	0.00	0.07	0.02
Employment	-0.00	-0.01	0.00	0.03	0.01
Real incomes	-0.74	-0.36	0.02	1.53	0.43
Price level	1.73	0.82	0.03	1.15	0.58

Source(s): E3ME

Table A3: Sectoral Output, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
Agriculture etc	0.03	-0.01	-0.02	0.31	0.17	-0.00	-0.03
Mining	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Drink & Tobacco	-0.09	-0.09	-0.07	0.22	0.11	-0.16	-0.14
Textiles, Clothing & Leather	0.94	0.54	0.31	0.97	0.58	1.01	0.66
Paper & Publishing	0.05	0.00	-0.01	0.32	0.18	0.05	0.02
Chemicals	-0.03	-0.03	-0.02	0.06	0.03	-0.03	-0.03
Non-metallic Mineral Products	0.09	0.05	0.03	0.08	0.05	0.09	0.06
Metals	-0.14	-0.11	-0.07	0.08	0.02	-0.21	-0.17
Engineering	-0.03	-0.03	-0.02	0.09	0.05	-0.05	-0.04
Motor Vehicles	1.63	-0.00	-0.36	8.82	4.59	1.25	0.08
Other Transport Equipment	0.46	-0.42	-0.44	6.78	3.60	-0.58	-0.98
Electricity	2.13	1.45	0.89	3.48	2.34	1.95	1.49
Gas Supply	-18.93	-11.24	-5.74	-18.27	-10.82	-20.01	-12.59
Construction	-0.85	-0.68	-0.41	0.67	0.27	-0.97	-0.73
Distribution and Retail	0.38	0.05	-0.03	1.93	1.04	0.30	0.05
Hotels & Catering	-0.05	-0.20	-0.15	2.02	1.09	-0.06	-0.18
Land Transport etc	0.35	0.02	-0.03	2.35	1.25	0.37	0.12
Air Transport	-0.17	-0.89	-0.71	6.23	3.25	-2.86	-2.62
Communications	-0.10	-0.24	-0.18	1.94	1.04	-0.21	-0.28
Business Services	-0.07	-0.15	-0.11	1.05	0.56	-0.13	-0.18
Government Services	0.03	-0.03	-0.02	0.52	0.27	0.03	-0.01
Miscellaneous Services	-0.19	-0.47	-0.36	2.34	1.12	-0.20	-0.46

Source(s): E3ME

Table A4: Sectoral Output, High Oil Price Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
Agriculture etc	0.07	0.00	0.00	0.28	0.08
Mining	0.00	0.00	0.00	0.00	0.00
Food, Drink & Tobacco	0.02	-0.03	0.00	0.29	0.08
Textiles, Clothing & Leather	0.67	0.25	0.01	0.72	0.23
Paper & Publishing	0.06	0.00	0.00	0.23	0.06
Chemicals	-0.00	-0.01	0.00	0.07	0.02
Non-metallic Mineral Products	0.03	0.01	0.00	0.02	0.00
Metals	-0.05	-0.06	-0.01	0.17	0.01
Engineering	-0.01	-0.02	-0.00	0.08	0.01
Motor Vehicles	1.39	-0.20	0.00	5.85	1.36
Other Transport Equipment	1.37	-0.08	-0.02	6.45	1.94
Electricity	1.80	0.83	0.06	2.76	1.15
Gas Supply	-16.25	-7.45	-0.57	-15.97	-7.48
Construction	-0.66	-0.46	-0.03	0.32	-0.13
Distribution and Retail	0.47	0.08	0.02	1.46	0.40
Hotels & Catering	0.00	-0.12	0.03	1.21	0.26
Land Transport etc	0.33	-0.00	0.02	1.54	0.41
Air Transport	2.03	-0.05	-0.16	8.87	3.11
Communications	0.03	-0.13	0.02	1.34	0.31
Business Services	0.08	-0.04	0.01	0.85	0.22
Government Services	0.02	-0.02	0.00	0.32	0.07
Miscellaneous Services	0.13	-0.21	0.02	1.78	0.34

Source(s): E3ME

Table A5: Employment, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
Agriculture etc	-0.23	-0.14	-0.08	0.15	0.09	-0.26	-0.18
Mining	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Drink & Tobacco	-0.10	-0.06	-0.03	0.37	0.23	-0.11	-0.08
Textiles, Clothing & Leather	-0.97	-0.61	-0.36	-0.32	-0.19	-1.10	-0.80
Paper & Publishing	-1.08	-0.69	-0.40	-3.73	-2.39	-1.24	-0.91
Chemicals	-0.18	-0.13	-0.08	-1.13	-0.72	-0.23	-0.17
Non-metallic Mineral Products	-0.13	-0.07	-0.05	0.16	0.11	-0.18	-0.12
Metals	-0.27	-0.16	-0.09	1.21	0.79	-0.27	-0.20
Engineering	0.42	0.25	0.14	0.10	0.07	0.52	0.37
Motor Vehicles	0.70	-0.40	-0.57	5.30	2.76	0.57	-0.33
Other Transport Equipment	0.15	-0.17	-0.19	2.89	1.59	-0.13	-0.30
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	-0.01	-0.00	0.00	0.00
Distribution and Retail	-0.04	-0.04	-0.03	0.16	0.09	-0.03	-0.04
Hotels & Catering	-0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00
Land Transport etc	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00
Air Transport	1.05	0.49	0.14	3.21	2.00	1.95	1.21
Communications	-0.32	-0.24	-0.15	0.20	0.08	-0.44	-0.34
Business Services	0.03	0.01	-0.00	0.19	0.11	0.05	0.03
Government Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous Services	-0.01	-0.01	-0.00	-0.00	-0.00	-0.01	-0.01

Source(s): E3ME

Table A6: Employment, High Oil Price Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
Agriculture etc	-0.14	-0.07	0.00	0.09	0.01
Mining	0.00	0.00	0.00	0.00	0.00
Food, Drink & Tobacco	-0.07	-0.04	0.00	0.25	0.07
Textiles, Clothing & Leather	-0.60	-0.28	0.00	-0.19	-0.14
Paper & Publishing	-0.64	-0.31	-0.05	-2.35	-0.95
Chemicals	-0.10	-0.06	-0.02	-0.68	-0.27
Non-metallic Mineral Products	-0.07	-0.02	0.01	0.05	0.02
Metals	-0.11	-0.03	0.03	0.93	0.58
Engineering	0.22	0.11	0.01	-0.08	-0.00
Motor Vehicles	0.56	-0.35	0.12	2.75	0.49
Other Transport Equipment	0.51	-0.00	0.01	2.63	0.81
Electricity	0.00	0.00	0.00	0.00	0.00
Gas Supply	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	-0.01	-0.00
Distribution and Retail	0.01	-0.00	0.00	0.15	0.03
Hotels & Catering	0.00	-0.00	0.00	0.00	0.00
Land Transport etc	-0.00	0.00	0.00	-0.00	-0.00
Air Transport	0.85	0.31	0.10	2.91	0.89
Communications	-0.16	-0.11	-0.00	0.18	0.01
Business Services	0.02	0.00	0.00	0.11	0.03
Government Services	0.00	0.00	0.00	0.00	0.00
Miscellaneous Services	-0.01	-0.01	-0.00	-0.01	-0.00

Source(s): E3ME

Table A7: Household Real Incomes, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
All households	1.80	1.07	0.61	2.11	1.28	1.60	1.02
First quintile	5.55	3.48	2.00	4.22	2.66	5.16	3.44
Second quintile	3.19	1.98	1.14	1.99	1.25	2.89	1.91
Third quintile	1.49	0.90	0.51	1.87	1.14	1.30	0.81
Fourth quintile	0.85	0.47	0.27	2.02	1.22	0.69	0.40
Fifth quintile	0.64	0.33	0.18	2.55	1.54	0.50	0.26
Manual workers	1.20	0.70	0.40	1.71	1.03	1.01	0.62
Non-manual workers	1.07	0.61	0.34	2.40	1.45	0.93	0.55
Self-employed	1.13	0.67	0.38	1.75	1.06	0.96	0.58
Unemployed	3.45	2.13	1.22	2.26	1.41	3.18	2.10
Retired	3.26	2.02	1.16	4.58	2.85	2.96	1.94
Inactive	3.39	2.10	1.21	2.00	1.25	3.10	2.04
Densely populated	2.41	1.43	0.79	2.88	1.75	2.25	1.45
Sparsely populated	1.08	0.68	0.42	0.83	0.52	0.83	0.52

Note(s): Figures for Cap and Share schemes include the value of allocated allowances
Source(s): E3ME

Table A8: Household Real Incomes, High Oil Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
All households	1.50	0.60	0.02	1.53	0.43
First quintile	4.34	1.87	0.06	2.91	0.87
Second quintile	2.55	1.08	0.03	1.43	0.37
Third quintile	1.27	0.51	0.02	1.35	0.36
Fourth quintile	0.79	0.29	0.02	1.46	0.41
Fifth quintile	0.64	0.22	0.03	1.85	0.56
Manual workers	1.06	0.41	0.02	1.24	0.32
Non-manual workers	0.95	0.36	0.03	1.74	0.52
Self-employed	1.00	0.39	0.02	1.26	0.33
Unemployed	2.72	1.15	0.03	1.61	0.44
Retired	2.63	1.11	0.06	3.15	0.95
Inactive	2.69	1.14	0.03	1.46	0.39
Densely populated	1.92	0.77	0.03	2.08	0.65
Sparsely populated	1.00	0.42	0.01	0.57	0.04

Note(s): Figures for Cap and Share schemes include the value of allocated allowances
Source(s): E3ME

Table A9: Competitiveness, €08m, Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
Agriculture etc	-2.74	-0.65	-0.08	-12.53	-6.90	-1.41	-0.04
Mining	-1.42	-1.34	-1.47	-15.31	-10.22	-1.03	-1.83
Food, Drink & Tobacco	-73.27	-48.47	-28.26	-68.42	-42.90	-95.16	-67.30
Textiles, Clothing & Leather	-14.17	-5.78	-2.00	-39.84	-22.18	-12.58	-6.00
Paper & Publishing	1.60	1.34	0.88	-1.96	-0.78	3.15	2.54
Chemicals	-22.47	-18.21	-12.55	-0.48	-2.57	-23.41	-20.05
Non-metallic Mineral Products	2.51	1.67	0.93	0.61	0.48	2.59	1.91
Metals	-7.86	-3.42	-1.44	-24.02	-13.79	-8.26	-4.84
Engineering	-20.80	-13.17	-8.09	-14.43	-8.83	-23.16	-17.77
Motor Vehicles	-30.11	-0.36	6.23	-159.97	-83.41	-23.26	-1.86
Other Transport Equipment	-5.03	4.07	4.29	-69.20	-36.73	5.60	9.70
Electricity	-1.15	-0.78	-0.48	-1.88	-1.27	-1.05	-0.80
Gas Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution and Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hotels & Catering	1.58	11.24	8.45	-127.10	-68.75	2.62	10.27
Land Transport etc	11.55	10.29	6.16	-17.34	-6.72	20.97	15.94
Air Transport	-0.65	-0.60	-0.43	0.75	0.33	-0.71	-0.66
Communications	-0.24	-0.18	-0.09	-0.06	-0.07	-0.35	-0.26
Business Services	-13.19	-2.36	-0.38	-78.43	-42.79	-11.54	-3.64
Government Services	0.84	0.29	0.10	3.59	2.00	0.99	0.52
Miscellaneous Services	-5.75	-1.97	-1.26	-15.81	-7.95	-5.98	-3.18

Note(s): Competitiveness impacts here defined as change in trade balance

Source(s): E3ME

Table A10: Competitiveness, €08m, Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
Agriculture etc	-3.54	-0.74	-0.15	-10.52	-3.25
Mining	-1.22	-0.14	-0.18	-10.18	-3.03
Food, Drink & Tobacco	-36.40	-22.26	-1.39	-10.87	-8.71
Textiles, Clothing & Leather	-12.54	-3.58	-0.57	-27.67	-8.37
Paper & Publishing	0.40	0.51	-0.04	-2.25	-0.41
Chemicals	-5.58	-6.54	0.06	19.21	3.66
Non-metallic Mineral Products	0.94	0.45	0.02	-0.61	-0.23
Metals	-5.43	-1.29	-0.18	-13.88	-4.56
Engineering	-10.29	-4.90	0.16	-3.13	-1.41
Motor Vehicles	-28.38	3.81	-0.00	-118.11	-27.40
Other Transport Equipment	-13.35	0.66	0.18	-62.29	-18.77
Electricity	-0.96	-0.44	-0.03	-1.47	-0.61
Gas Supply	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00
Distribution and Retail	0.00	0.00	0.00	0.00	0.00
Hotels & Catering	-0.32	7.21	-1.79	-73.14	-16.04
Land Transport etc	5.43	5.25	0.19	-10.86	-0.82
Air Transport	-0.11	-0.23	0.00	1.11	0.24
Communications	-0.07	-0.08	-0.01	0.14	0.03
Business Services	-12.35	-1.95	-0.76	-50.39	-13.88
Government Services	0.52	0.08	0.04	2.03	0.55
Miscellaneous Services	-2.84	-0.14	-0.24	-7.04	-1.17

Note(s): Competitiveness impacts here defined as change in trade balance

Source(s): E3ME

Table A11: Fuel Use, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
1 Power own use & trans.	2.13	1.45	0.89	3.48	2.34	1.95	1.49
2 Other energy own use and trans.	-0.63	-0.28	-0.14	-0.59	-0.26	-0.61	-0.32
3 Iron & steel	0.92	0.62	0.37	0.31	0.23	1.00	0.72
4 Non-ferrous metals	-58.23	-49.05	-36.02	-55.48	-45.65	-54.84	-43.22
5 Chemicals	-6.89	-4.45	-2.63	-6.01	-3.86	-5.49	-3.34
6 Non-metallics nes	0.18	0.12	0.07	0.17	0.11	0.20	0.14
7 Ore-extra.(non-energy)	-3.75	-2.33	-1.33	-6.89	-4.67	-6.43	-4.14
8 Food, drink & tob.	-17.74	-12.34	-7.74	-19.13	-13.62	-18.04	-12.21
9 Tex., cloth. & footw.	-8.49	-5.59	-3.25	-11.56	-8.21	-11.50	-7.66
10 Paper & pulp	0.84	0.57	0.36	0.78	0.54	0.85	0.58
11 Engineering etc	-5.38	-3.28	-1.80	-3.49	-2.08	-3.39	-1.93
12 Other industry	0.32	0.21	0.12	0.32	0.22	0.31	0.21
13 Rail transport	-67.59	-56.14	-41.57	-44.32	-31.81	-45.65	-30.55
14 Road transport	-28.04	-18.11	-10.44	-29.29	-19.25	-30.03	-21.06
15 Air transport	2.01	0.75	0.24	6.70	3.86	2.02	0.99
16 Other transp. serv.	-78.57	-67.76	-53.21	-60.11	-46.42	-57.36	-42.42
17 Households	-5.09	-3.17	-1.82	-5.24	-3.32	-6.38	-4.74
18 Other final use	-47.46	-40.50	-30.16	-47.22	-40.67	-46.41	-38.28
19 Non-energy use	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source(s): E3ME

Table A12: Fuel Use, High Oil Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	**30%**	**20%**	**ETS price**	**30%**	**20%**
1 Power own use & trans.	1.80	0.83	0.06	2.76	1.15
2 Other energy own use and trans.	-0.54	-0.15	-0.03	-0.64	-0.23
3 Iron & steel	0.50	0.21	0.01	0.01	0.01
4 Non-ferrous metals	-42.22	-26.68	-1.23	-39.30	-24.00
5 Chemicals	-4.86	-2.32	-0.14	-4.24	-2.02
6 Non-metallics nes	0.12	0.06	0.00	0.11	0.06
7 Ore-extra.(non-energy)	-2.65	-1.24	-0.18	-5.22	-2.74
8 Food, drink & tob.	-12.84	-6.64	-0.59	-14.15	-7.60
9 Tex., cloth. & footw.	-5.49	-2.55	-0.15	-8.14	-4.13
10 Paper & pulp	0.63	0.32	0.02	0.63	0.33
11 Engineering etc	-3.64	-1.63	-0.03	-2.19	-0.92
12 Other industry	0.26	0.11	0.00	0.26	0.11
13 Rail transport	-54.99	-34.39	-0.47	-30.54	-14.52
14 Road transport	-19.04	-8.84	-0.42	-20.25	-9.66
15 Air transport	2.12	0.46	0.05	6.56	2.15
16 Other transp. serv.	-66.07	-45.27	-1.44	-44.74	-25.72
17 Households	-3.49	-1.59	-0.10	-3.69	-1.74
18 Other final use	-28.07	-18.84	-1.84	-28.05	-19.25
19 Non-energy use	0.00	0.00	0.00	0.00	0.00

Source(s): E3ME

Table A13: Emissions Of Carbon Dioxide, % Difference From Base, 2020

Scheme	Cap & Share			CO_2 tax		Hybrid	
Target Reduction	**30%**	**20%**	**10%**	**30%**	**20%**	**30%**	**20%**
1 Power own use & trans.	2.11	1.44	0.88	3.45	2.32	1.93	1.47
2 Other energy own use and trans.	-0.90	-0.39	-0.20	-0.85	-0.36	-0.88	-0.46
3 Iron & steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Non-ferrous metals	-77.33	-63.29	-44.72	-73.25	-58.37	-72.15	-54.87
5 Chemicals	-16.75	-10.84	-6.38	-14.66	-9.40	-13.55	-8.23
6 Non-metallics nes	0.14	0.09	0.06	0.16	0.09	0.17	0.12
7 Ore-extra.(non-energy)	-17.25	-10.70	-6.01	-30.10	-20.55	-28.91	-18.68
8 Food, drink & tob.	-37.45	-26.34	-16.55	-39.97	-28.94	-38.06	-26.06
9 Tex., cloth. & footw.	-23.48	-15.34	-8.80	-31.77	-22.54	-31.97	-21.16
10 Paper & pulp	1.01	0.69	0.43	0.95	0.64	1.04	0.72
11 Engineering etc	-14.20	-9.09	-5.06	-9.98	-6.36	-10.82	-6.33
12 Other industry	0.41	0.30	0.19	0.16	0.14	0.56	0.40
13 Rail transport	-75.34	-63.77	-48.21	-50.89	-36.97	-51.82	-35.29
14 Road transport	-28.08	-18.14	-10.46	-29.34	-19.28	-30.08	-21.10
15 Air transport	2.01	0.75	0.24	6.70	3.86	2.02	0.99
16 Other transp. serv.	-78.00	-67.07	-52.47	-59.37	-45.70	-56.61	-41.71
17 Households	-6.98	-4.24	-2.33	-7.00	-4.35	-8.03	-5.94
18 Other final use	-86.74	-73.48	-54.45	-87.32	-74.41	-84.69	-69.35
19 Non-energy use	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source(s): E3ME

Table A14: Emissions Of Carbon Dioxide, High Oil Scenarios, % Difference From High Oil Price Base, 2020

Scheme	Cap & Share			CO_2 tax	
Target Reduction	30%	20%	ETS price	30%	20%
1 Power own use & trans.	1.79	0.82	0.06	2.73	1.14
2 Other energy own use and trans.	-0.72	-0.15	-0.05	-0.83	-0.26
3 Iron & steel	0.00	0.00	0.00	0.00	0.00
4 Non-ferrous metals	-61.76	-37.27	-1.61	-57.20	-33.32
5 Chemicals	-12.11	-5.77	-0.33	-10.56	-5.02
6 Non-metallics nes	0.09	0.04	0.00	0.09	0.04
7 Ore-extra.(non-energy)	-13.02	-5.92	-0.81	-23.95	-12.34
8 Food, drink & tob.	-28.60	-15.04	-1.28	-31.50	-17.24
9 Tex., cloth. & footw.	-16.32	-7.51	-0.41	-24.09	-12.11
10 Paper & pulp	0.75	0.38	0.03	0.73	0.39
11 Engineering etc	-9.79	-4.34	-0.07	-6.99	-2.85
12 Other industry	0.30	0.17	0.02	0.12	0.10
13 Rail transport	-63.02	-40.68	-0.63	-35.94	-17.56
14 Road transport	-19.07	-8.85	-0.43	-20.29	-9.68
15 Air transport	2.12	0.46	0.05	6.56	2.15
16 Other transp. serv.	-65.47	-44.66	-1.41	-44.14	-25.28
17 Households	-5.25	-2.34	-0.18	-5.45	-2.49
18 Other final use	-77.30	-51.40	-4.93	-78.62	-52.94
19 Non-energy use	0.00	0.00	0.00	0.00	0.00

Source(s): E3ME

Cambridge Econometrics Limited
Covent Garden
Cambridge
CB1 2HS
United Kingdom

Tel: 01223 460760
Fax: 01223 464378
Email: info@camecon.com
Web: www.camecon.com

Cambridge Econometrics Limited is owned by a charitable body, the Cambridge Econometrics Trust for the Promotion of New Thinking in Economics.

AEA Energy & Environment
Harwell International Business Centre
Didcot
Oxfordshire
OX11 0QR

Tel: 0870 190 6748
Fax: 0870 190 6318
E-mail: info@aeat.co.uk
www.aea-energy-and-environment.co.uk

Printed on recycled paper