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Controlling the Cost of Controlling the Climate: The Irish Government's Climate Change Strategy

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1. Introduction

'To a first approximation, raising the price of carbon is a necessary and sufficient step for tackling global warming. The rest is largely fluff'. (William Nordhaus).

Ireland is committed to substantial reductions in CO_2 and other greenhouse gas emissions. A target reduction in emissions of 3% per year to 2012 was included in the 2007 Programme for Government. This is a sharp rate of emission reduction, particularly in the short term when substitution possibilities are technology-constrained. The effort implied in the EC's proposals for 2020 is similarly demanding, with a 20% reduction on 2005 levels in Ireland,[1] and possibly 30% in the event of other developed countries making a comparable commitment (EC, 2008). Integrated climate-assessment models, which attempt to identify the economically optimal pace of emission reduction worldwide, typically do not imply sharp immediate reductions. They proceed on the basis that the best pace of emission reduction is the outcome of an inter-temporal welfare-maximising calculation, not a *deus ex machina* (Nordhaus 2007a).

For any given emission target, there are competing menus of policy actions which can deliver the desired reduction. But some of these policy measures have far higher economic costs per tonne of emission reduction than others, while the value of every tonne reduction is the same. Climate scientists have focused on identifying the sustainable level of emissions, while economists have been concerned with containing the costs, that is, with identifying the *least-cost abatement strategy*, including the most desirable time-path for emission reduction. Moreover the climate change problem is global in nature, and emission reductions are a global public good. Unilateral national targets for emission reduction which ignore this dimension run the

[1] Assuming a similar requirement of the sector in the EU Emissions Trading Scheme (ETS).

risk of shifting emissions around the globe in the absence of concerted international action, see Tol (2007).

This paper reviews recent Irish Government documents from the cost standpoint, in particular the measures proposed in National Climate Change Strategy 2007-2012 and also the Energy White Paper (DEHLG, 2007; DCMNR 2007). In addition to the overall emission reduction targets, these documents contain specific technology choices. We conclude that neither document promises cost containment.[2] We also discuss the stance that Ireland might take in the negotiations on a replacement for Kyoto.

2: The Mainstream Economics of Climate Change

The publication in late 2006 of the UK Government's Stern Review (UK Treasury, 2006) has intensified debate in the economics profession about climate change and in particular about the design of a policy regime capable of minimizing the costs of attaining emissions reduction. There is now a scientific consensus on global warming, the risk of consequent climate change, and the probable causes. While dissenting voices remain, most climate scientists accept that there has already been a climate impact and that the impact is continuing. The cause, with high probability, is greenhouse gas emissions, notably of carbon dioxide. These emissions are in large part the result of human behaviour, including fossil fuel consumption, and could be reduced by policy action. While uncertainty surrounds the extent, speed and consequences of climate change, the scientific consensus now favours an intensification of measures designed to reduce emissions from 'business-as-usual' levels. Climate scientists are also broadly sceptical that existing policy, including Kyoto and the various EU initiatives, will deliver a sufficient reduction below business-as-usual emissions.

[2] Costs are best contained by exploiting the cheapest emissions reduction options wherever they exist, and creating incentives to bring this about. This cost-effective approach aims to minimise the cost of meeting the targets by undertaking the lowest-cost emission reductions, effectively regardless of where they are located. It has been estimated that the costs of mitigation are lower if cost-effective actions are implemented (Kopp and Pizer, 2007; EC 2007; CBO, 2008). A later section in this paper discusses the role of marginal abatement costs of options and the need for their estimation if specific technologies are to be selected.

2.1: Climate Models and Optimal Policies

A second consensus has also emerged, this time amongst economists, on the form that abatement policies should take. International action to date has focussed on quantitative interventions, such as the Kyoto protocol, the EU Emissions Trading System, and the various industry-level voluntary agreements to limit emissions, while national Governments pursue a wide range of tax policies and regulatory interventions in energy markets. Public debate in many countries is dominated by specific, but sometimes quite arbitrary, proposals for energy economy, often aggressively promoted by commercial interests with investments in various technologies. There is widespread agreement in the economics profession that this is not the most promising policy architecture. Economists favour policies that focus on harnessing market forces through price signals, especially through the imposition of uniform taxes, or interventions with similar effect, on carbon and other emissions. Policies of this type have the important advantage of being *technology-neutral.*

Each unit of greenhouse gas emitted adds equally to the stock and does the same damage at the margin: hence economic efficiency requires that the same value should be attached to each unit of emission reduction, anywhere in the world, and from whatever source. Existing policies, including international agreements and the domestic policies of individual governments, often fail to meet this criterion. Indeed some emissions are actually subsidised (in the current fiscal year, the Government of India will spend $17.5 billion, 2% of GDP, on fuel subsidies), some are taxed at too low a rate,[3] and we will see that some emission reductions are being purchased at too high a cost (UNEP, 2003; OECD, 2005; IEA, 2006). A feature of policy in many countries is non-neutrality with regard to technology: Governments have favoured indigenous fuel sources for example, including high-emission fuels such as coal and peat, on the basis of assertions about energy security. They have also subvented wind, bio-fuel and other technologies on the grounds that they are low-carbon solutions. There have been arguments that emission-intensive activities experiencing rapid

[3] This refers to fossil fuels with prices not reflecting the full economic, environmental and social costs associated with their supply and use. Furthermore, financial assistance is given to indigenous coal production for example in France, Germany, Japan, Spain, Turkey and the United Kingdom. Energy subsidies are not the only and probably not the best way to alleviate poverty or achieve the other policy objectives.

growth, such as aviation, should be special targets EC, 2005). But without attention to overall cost minimization, there is no rational economic basis for these notions. A further critical feature of the economics consensus and supported by economic modelling was apparently contradicted by the Stern review. This is that a carbon tax at a low initial rate, to be increased subsequently in real terms, is optimal, in the sense that it would eventually stabilize emissions and the stock of greenhouse gases at the welfare-maximising level, taking inter-temporal welfare into account. Stern concluded that a much higher initial carbon tax (or policies with equivalent effect) was needed, and this conclusion has been disputed on the basis of integrated climate assessment models (Tol and Yohe, 2006; Nordhaus, 2007a, 2007b).

The mainstream economic analysis proceeds like this. Society produces a composite consumption good, an investment good, and ‘energy’ (fossil fuels). Energy entails a negative externality, and so should attract a Pigouvian tax. How big should this tax be, or equivalently, how quickly should the rate of carbon emission be reined back? There is a stock-flow feature to the externality. The stock of greenhouse gases, to which significant net annual additions are being made at current emission rates, will induce negative impacts on the ability to produce the consumption and investment goods over time, as well as other welfare-reducing impacts such as species loss. The rate of consumption of ‘energy’ should thus be held below the unconstrained level, in order to maximize the welfare of the current and all future generations. While no immediate economic calamity is in prospect if energy is consumed at the unconstrained level, and emissions need never be reduced to zero, they do need to be reduced to a lower trajectory. It is entirely possible (and is a common finding) that emissions, in an optimal policy scenario, would continue to rise for a time before stabilizing and possibly reducing. Returning the stock in the atmosphere to pre-industrial levels need not emerge as a target in an optimization framework based on economic/climate models.

The ‘correct’ level of energy consumption emerges as the result of an inter-temporal optimization exercise which takes into account the welfare of future generations; the damage to future production prospects for the consumer and investment goods arising from the emission externality; and the degree of risk aversion built into the calculations, since there are numerous limits to our knowledge. The economic signal that yields the ‘correct’ policy is the trajectory for the tax which should be imposed on carbon energy (fossil fuels). Numerous models which incorporate scientific knowledge about the impact of climate change as well as inter-temporal discounting and uncertainty parameters have been developed and calibrated. They tend to conclude that (i) there should be a universal carbon tax, (ii) it should be increased in real terms over time, and (iii) it should be set at initial levels ranging from under $10 per tonne CO_2 up to $100 per tonne and even more. A tax of $10 per tonne CO_2 would correspond to no more than about 13-14 US cents per gallon on auto-fuels, or 2-3 Euro-cents per litre. The high estimates of what is needed would range up to 25 or 30 Euro-cents per litre for auto-fuel, with of course corresponding taxes on all other CO_2-emitting fuels in all uses, including all oil products as well as coal and natural gas. In Europe, emission permits under the ETS (Emissions Trading Scheme) scheme have traded at (rather unstable) prices towards the bottom of the $10 to $100 range.

The Stern review produced estimates of the required carbon tax well above mainstream model-based estimates. This would indicate the optimality of a steep and early increase in the cost of energy, through a carbon tax or policies with equivalent effect, such as cap-and-trade schemes. In what follows, we will illustrate some points using carbon dioxide prices of the order of €20 per tonne, well above some of the climate model estimates of the optimal tax but below the Stern figure. The major worldwide initiative to address climate change has been the UN’s Framework Convention on Climate Change, Kyoto 1 for short, and the new programme of negotiations for a successor agreement laid out in the recent Bali Action Plan, UN (2007). The Kyoto 1 approach and its offshoots, including the EU’s emissions trading system, are time-limited and widely regarded as no longer adequate.

2.2: Kyoto’s Weaknesses

The failure of the USA and some other countries to accede to Kyoto 1 is not the principal difficulty. Many acceding countries (including Ireland) are failing to stay inside their allocated limits; the expanding Asian economies, with the potential to dominate the world’s carbon emission growth in future decades, are outside the deal, and the Kyoto 1 limits have in any case been overtaken by events. US accession would make relatively little difference at this stage. Kyoto 1 would not deliver what the climate scientists now feel is necessary, even if all countries to which it is addressed (essentially the OECD countries and the former Soviet bloc) were to comply in full. Additionally, there is evidence that the Kyoto-type architecture leads to policies that do not promote the selection of least-cost abatement strategies. Kyoto is achieving inadequate impact, and at unnecessarily high cost. When an established policy is failing to reach targets, the temptation for policymakers is often the intensification of existing measures. The economics consensus is saying that the medication is not appropriate and needs to be changed. The economists' preferred solution, a harmonised international carbon tax, is a silver bullet aimed at the principal source of the climate threat. The principal weaknesses in the Kyoto approach have been summarized thus (Nordhaus, 2006):

The Policy Design is Arbitrary: '….the policy lacks any connection to ultimate economic or environmental policy objectives'. Freezing the flow of emissions by reference to some arbitrarily chosen historical level, even if all countries participated, does not relate to identifiable goals for concentrations, temperature, potential damage or (most importantly) abatement cost minimisation.

The Policy's Coverage is Incomplete: 'Base year emissions have become increasingly obsolete as the economic and political fortunes of different countries have changed'. Large and fast-growing developing countries are exempt, and it has been calculated that just four, China, India, Brazil and Mexico, would generate the equivalent of total world emissions of the year 2000 if their economic growth ever brought them to the current emissions per capita level of the USA (Kahn and Franceschi 2006). Chinese annual emissions have now reached US levels and are growing faster, developments not contemplated when Kyoto was agreed. For those countries which are included, any base-year approach penalises fast-growing economies and those which were energy-efficient in the base-year. It benefits slow-growth economies, thus encouraging a spatial mis-allocation of economic activity, and rewarding those, such as Russia, which were energy-inefficient in the base-year. This partly explains why Russia joined and the USA did not. By contrast tax-based policies avoid the need for quantitative baselines altogether.

Quantity is the Wrong Instrument: The marginal costs of reducing the flow of emissions are uncertain, and are likely to be nonlinear, rising steeply the more reduction is sought. The marginal benefits (avoided damage), while also uncertain, are likely to be linear, related to the (slowly-evolving) stock. Over a wide range, unit benefits would be invariant to scale. Low curvature of the benefit function relative to the cost function implies that price-based policies such as carbon taxes are superior to quantitative interventions or targets. (Weitzman, 1974; CBO, 2008).[4]

Kyoto Makes Carbon Price Volatile: Under a quantitative intervention regime the supply of emission permits is fixed, and demand possibly quite inelastic in the short-run. There is a risk of price volatility and this has been the experience with the (otherwise successful) SO_2 regime in the USA, and with the EU's tradeable CO_2 permit scheme. Unstable prices give poor signals to potential investors in emission-reducing technology.

Quantitative Targets Worsen Tax Efficiency: Quantitative interventions do not raise revenue and will worsen the pre-existing efficiency losses caused by the tax system, without providing revenue which might be used to mitigate distributional effects. By contrast a Pigouvian carbon tax provides revenues that can address this issue in a framework of overall revenue neutrality. The unwieldy alternative is one hundred per cent auctioning in a trading scheme that covers all emissions.

The System Facilitates Patronage and Corruption: Systems which involve the discretionary award or grand-parenting of emission rights are more prone to patronage and corruption (patronage which has been criminalized) than tax-based systems. Countries with a poor anti-corruption record such as Russia and Nigeria are likely to have a surplus of exportable permits under Kyoto and the 'clean development

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[4] CBO (2008) states "The relative advantages of a tax and a cap could change over time, however. One area of growing concern is that the buildup of greenhouse gases in the atmosphere could cause the global temperature to reach a critical level after which further growth in emissions could trigger a rapid increase in damage. The existence of such a threshold could alter the assumption that the marginal benefit of reducing emissions would be relatively constant and could make a cap more efficient than a tax. The existence of such a threshold could alter the assumption that the marginal benefit of reducing emissions would be relatively constant and could make a cap more efficient than a tax. Although concerns about thresholds exist, analysts who have tried to define more precisely the conditions that would cause a cap to be more efficient than a tax have concluded that those conditions are quite narrow and unlikely to apply in the near term."

mechanism'. Auctioning, rather than allocating, permits is preferable, but is rarely chosen under quantity-type systems, and has been largely eschewed to date in the design of the EU's CO_2 regime. A tax-based system avoids the need for political or administrative discretion.

Accounting Problems: Choosing quotas and measuring compliance is not straightforward, and is a problem in developed as well as developing countries. Unlike straightforward tax evasion, where the incentive for the taxpayer to evade is balanced by the incentive for the tax authority to collect, fiddling a quota system is a positive-sum game for the participants. The buyer gets genuine permits, the seller gets cash, and the national Government may not care. There have been scandals in emissions markets in advanced countries with well-developed legal systems, including the United States.

There are objections to tax-based systems too. These include monitoring and compliance. What is to stop a country from collecting the tax but offsetting its impact through other subsidies or regulations? Germany could increase the already large coal subsidy, Ireland could continue with the obligation to dispatch peat-fired power stations regardless of emission cost, spreading the burden through inefficient electricity surcharges. Methods for computing and monitoring 'net carbon taxes' would be required, as would methods for dealing with pre-existing taxes and subsidies. Global efficiency requires that countries which already levy carbon (or equivalent) taxes are credited for so doing. Nordhaus argues that Europe currently has *de facto* carbon taxes substantially higher than those in the USA, though patchy and poorly targeted. But some countries have negative taxes: Indonesia spends $12 billion per annum on fuel subsidies, and many oil producers subsidise domestic retail auto-fuel prices, to yield pump prices below 10 cents per litre in many cases, well below the ex-refinery price.

A carbon tax does not explicitly limit emissions, and policymakers seem to take comfort from quantitative targets. But the measures for achieving targets produce uncertainty just as the setting of the tax is itself a kind of price discovery process. The initial price will have to be adjusted in order to target the ultimate objectives of environmental policy, temperature and climate, via the flow (or the stock) of emissions.

2.3: The EU's Emissions Trading Scheme

The balance of economic commentary on the EU's ETS, a child of Kyoto, is negative, although the system has its achievements and its defenders, see Fitz Gerald (2004) and Nordhaus (2007a) for the prosecution, Convery and Redmond (2007) for the defence. A particular difficulty arises from the grand-parenting, for free, of the emissions permits. In Europe, to the degree that electricity markets are truly competitive, generators will pass through the increased cost of permits into the wholesale price and pocket any proceeds. There may also be a substantial benefit to the (near) monopoly gas supplier, Gazprom, since controlling the quantity rather than the price of carbon reduces the elasticity of demand for gas and transfers increased rent to Russia (Newbery, 2005). Auctioning the permits would help, but it is difficult to discern a convincing defence of the trading system unless one concedes that a carbon tax is politically impossible.

Recent proposals to extend the system illustrate some of its weaknesses. There have been strident calls for a reduction in emissions from the aviation sector, not so much because it is currently lightly taxed (no VAT, virtually no excise on jet kerosene, just some arbitrary ticket taxes in a few countries), which is highly relevant, but because it has been growing quickly in recent years, which is not.[5] The EU Commission has now proposed that the ETS be extended to aviation, with free allocation of permits, possibly based on historical emissions. Commonsense predicts that airlines which have not been growing and which have elderly fleets will welcome this proposal, while fast-growing airlines with young and more fuel-efficient fleets will oppose it. Commonsense works: in the UK, British Airways and Virgin (both slow-growing airlines with elderly fleets) support inclusion in the ETS. The rise in ticket prices will help them to finance newer fleets, since the permits will be free and they should generate surplus permits for sale as they re-fleet. Ryanair amongst others is opposed:

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[5] New infrastructure built on growth forecasts which reflect incorrect pricing has promoted and continues to promote a sub-optimal pattern of consumption, which is subsequently difficult to rectify.

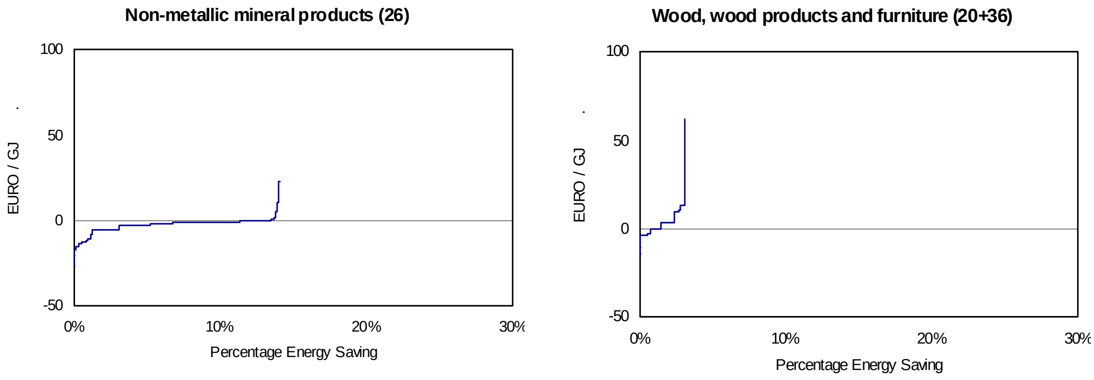
it has already acquired or contracted for its next-generation fleet and will be short of permits as it grows. In continental Europe, politically well-connected former flag-carriers are supportive of ETS inclusion, in the expectation that they will receive generous allowances for free under national allocation schemes. Finally the entire scheme will have little or no impact on emissions, according to Fitz Gerald and Tol (2007), while transferring substantial gains to incumbent airlines. This focus on aviation, based on high recent growth rates, is intriguing. Marine diesel is also untaxed. Like aviation, the marine sector pays for its infrastructure, so the untaxed externality is the only issue in both cases. Does environmental *angst* extend to aeroplanes but not to ocean freighters?

3. Minimising Abatement Costs

Abatement costs are at the core of climate policy and, given the size of the task, selecting the cheapest abatement actions per tonne of CO_2 removed is paramount. This is the cost-effective approach. Some abatement can be achieved very cheaply. A reduction of one tonne of CO_2 emitted by insulating a hot water tanks can be achieved at negative cost. But the cost per tonne rises as a reduction option is more intensively applied and next cheapest options are implemented, at which stage competing technologies, new appliances or behaviour modifications become more attractive. When a uniform emissions price is imposed, all emission reduction options costing up to that price are encouraged. Equalised abatement costs across society minimise the overall cost, because it means that cheap abatement options are not being foregone and expensive ones have been avoided.

As there is a huge range of possible costs, revealed by the abatement cost schedules that have been calculated, the scant attention paid to the issue adds to the cost of national climate policy. Abatement costs range from negative to potentially colossal amounts. Examples from the wood sector and the non-metallic minerals sector in the UK in the nineties are a case in point, shown in Figure 1.

Figure 1: Energy reduction cost curve, Euro per GJ saved

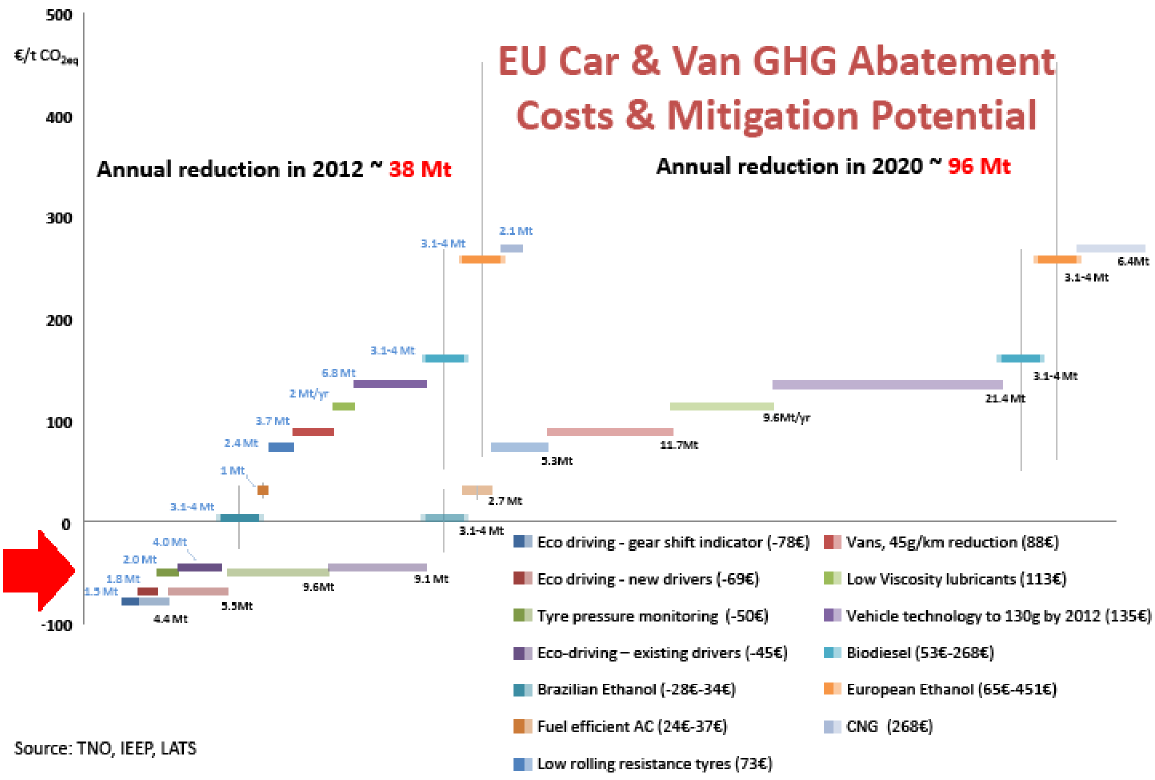


Source: DEFRA, 2003

Figure 1 shows that the options for reduction in the non-metallic minerals sector are superior to the opportunities in the wood sector. Requiring the same target percentage reductions in each would not minimise total costs. Imposing a common price for emissions would efficiently see most, possibly all, reduction effort concentrated in the non-metallic minerals sector. This principle, that an equal price saves abatement cost, is fundamental to containing cost and applies to individuals, sectors and countries.

A study of technical greenhouse gas abatement measures for cars and vans in the EU, published by TNO *et al.*, (2006), is reproduced in Figure 2. Costs of abatement in euro per tonne of CO_2 show a vast range, starting from negative cost for fuel-efficient driving on the bottom left-hand side, through use of Brazilian ethanol, to more fuel-efficient cars, up to the most expensive abatement by using European ethanol and compressed natural gas. Volumes of abatement, in million tonnes of CO_2, are shown on the horizontal axis. The first abatement cost curve shows ranked potential abatement alternatives in 2012 and the second curve shows the ranked projected potential in 2020.

Figure 2: Abatement costs in euro/t CO_2 avoided and total reduction potential in million t/year



In addition to being numerous, the actions and technologies plotted here by horizontal lines would rise in cost as they were more intensely applied. Alternatively they could fall as economies of scale were reaped and technologies improved. This gives an idea of the diversity of actions to be tapped into in just one sector. In a similar but global exercise Vattenfall (2006) offer other insights that have a bearing on policy and contest some widely held myths.

Table 1: Some Myths and Realities about Abatement Costs

Myths	Realities
• Abatement opportunities are concentrated in the industry and power sectors	• Industry and power represent <45% of the total 2030 abatement potential*. Transport, buildings, forestry and agriculture need attention. These last sectors involve billions of small emitters.
• We can only achieve the required abatement through new technology	• 70% of the total 2030 abatement potential* is not dependent on new technology
• Abatement opportunities are concentrated in industrialized countries and China	• Developing world excluding China represents >40% of the total 2030 abatement potential*
• Limited amount of low-cost opportunities in industrialized countries	• Negative-cost abatement potential represents 35-45% of the total in industrialized countries
• Addressing GHG emissions will severely strain the global economy	• Reaching 450 ppm could cost as little as 0.6% of GDP if all low-cost opportunities are addressed*

*Below 40 Euro / t CO_2e   Source: Vattenfall (2006).

Efficiency-enhancing measures, mainly in the buildings and transport sectors, carry least net cost and do not entail reduced comfort levels, but do require policy to address market imperfections by aligning incentives.

3.1: Set a unique carbon price for all

The report on Mitigation by the International Panel on Climate Change (IPCC, 2007) makes the point that no one sector can achieve the mitigation required and all sectors have a role to play. It is evident that there are billions of emitters and abatement opportunities with enormous cost variations that are specific to sectors, technologies and circumstances. How can governments know all these individual cost schedules in order to select the least cost ones? By contrast a unique emissions price triggers market participants to identify and exploit the cost-minimising possibilities below the price. Large costs can unwittingly be imposed by stipulating a quantity of abatement, rather than by stipulating a price. This is not to deny the importance of issuing generalised technical information provided by centralised bodies, but it is a uniform carbon price that can sensibly uncover worthwhile abatement options.

An example of this in the UK is described in the COMETR project (Salmons, 2007). Companies were entitled to a reduction of 80% on the Climate Change Levy (a form of carbon tax) introduced in the UK in April 2001, provided that they entered a Climate Change Agreement and achieved their negotiated targets. For example, the Chemicals sector had a target improvement in its energy/output ratio of 13 per cent in 2010, compared to projected Business As Usual (BAU). Already by 2004 the reduction had been 17 per cent below BAU 2004, beating the sector's performance target by more than 8 per cent and meeting its final target 6 years ahead of schedule. Five of the seven sectors studied beat the targets that were set for them in order to reduce their carbon levy, suggesting that individuals know more about their efficiency options than the authorities know. Evidently it is difficult for the authorities to specify correct targets but putting a price on emissions, or the threat of a tax as shown in the UK example, reveals the possibilities in the actions encouraged.

In the absence of a unique carbon price for all emissions, the job of making choices reverts to governments. They have to decide permit allocations and/or regulations and, to contain costs, they have to do this based on uncertain knowledge of the abatement costs schedules in every possible sphere of life.

4: The Irish Government's Climate Policy Proposals

In addition to the overall target of a 3% annual reduction in emissions, the Irish Government's specific proposals include a 33% target for electricity production from renewables (mainly wind) by 2020, a ban on nuclear power generation, a continuation of peat-fired electricity generation, sharp further improvements in fuel efficiency and an increased reliance on biofuels in the road fleet. Numerous measures involving subsidies, information campaigns and regulatory interventions, summarised in Table 3 below, are proposed to reduce the Kyoto over-shoot to about 5%, which would then be eliminated by purchase of carbon credits. In absolute levels, expressed in the greenhouse gas measure of CO_2 equivalent, the Strategy's targets, and minor post-Strategy recent revisions, are summarised in Table 2.

Table 2: Emissions and targets in the 2007 National Climate Change Strategy

Million tonnes CO_2 equivalent:

	Strategy	**Post Strategy* revisions**
1990 actual emissions	55.37	55.60
2005 actual emissions	69.95	70.35
Kyoto target for average 2008-2012	**63.03**	**62.84**
Projected emissions, with existing measures	**71.17**	
Projected with additional measures	66.22	
As above plus purchase of credits	62.61	
Possible 2020 target	54.70	
Possible stricter 2020 target	48.00	
Projected with existing measures	74.12	
Projected with additional measures	64.01	
Indicative EC 2020 target (post 23.01.08)		**56.28**

* *Note:* Since publication of the Climate Change Strategy, minor revisions have been made to EPA data on emissions and to the calculation of the 1990 baseline used in calculating the Kyoto target (EPA, 2008). For 2020 the EC have proposed a target of minus 20% on 2005 emissions from the non-ETS sector (EC, 2008). Using a working assumption of a similar minus 20% for ETS emissions gives the indicative 2020 target of 56.28 million tonnes at the base of the table.

Two omissions stand out in the Strategy. It makes liberal use of the term "cost-effective", meaning achieving the target at minimum total cost of abatement, as described above. In the absence of a uniform charge for emitting carbon, marginal costs of abatement have to be calculated in order to be able to *select* the cost-effective options (*viz*. Figure 5 in Conniffe *et al.*, 1997, which showed the low-cost measures that should be priorities). But there are no indications of abatement costs in the document.

Secondly, the report focuses on targets and regulatory interventions (without discussion of costs, prices or taxes though there seems to be a presumption of general taxes to finance the strategy), rather than on incentives to alter behaviour. No indication is given as to which taxes would be raised to finance the strategy, nor as to whether individuals should be faced with the costs of their own actions.

4.1: The Strategy's Measures

The Strategy's quantified emissions reductions by 2010 due to existing measures or to additional (post 2006) measures are summarised below in Table 3.

Table 3: Measures to reach Emission Reduction Targets by 2010, M tonnes CO_2 pa.

	Existing Measures	Additional Measures
Energy Supply		
Electricity from Renewables	1.3	0.17
Gas Network Improvements	0.06	-
Emissions Trading Scheme	-	2.42
Transport		
Technology Improvements	0.48	-
Motor Taxes, Fuel Economy Labelling	0.05	-
Dublin Traffic Measures	0.27	-
Biofuels – Tax Relief, Obligation	0.27	0.50
Transport 21 Investments	-	0.51
Spatial Planning	-	0.083
Driver Awareness Campaign	-	0.13
Residential		
Building Regulations 2002 & 2008	0.36	0.12
Greener Homes	-	0.037
Industry, Commerce, Services		
Building Regulations 2005	0.045	-
Large Industry Energy Network	0.145	-
Emissions Trading Scheme	-	0.6
Energy Agreements	-	0.037
F-Gases Regulations	-	0.024
Commercial Bioheat	-	-0.16
Combined Heat and Power	-	0.162
Agriculture, Forestry		
CAP Reform, Decoupling	2.4	-
Forest Sinks	2.08	-
Waste		
Diversion from Landfill	0.7	-
Landfill Gas Capture	0.5	-
Total	**8.66**	**4.95**

Source: National Climate Change Strategy 2007-2012, Table 2.1 and Table 2.2.

Of the “existing measures”, the impacts of just three, CAP reform, the forest sinks and the contribution of renewables to power generation, account for two-thirds of the total reduction. Turning to additional (post 2006) measures, most of the effects come from the operation of the ETS in industry and power generation. In addition to the measures listed, the Government proposes to spend €270 million during 2008–2012 on purchasing 18 million tonnes of CO_2 allowances abroad, at an average cost of €15 per tonne. This figure provides a convenient yardstick against which the abatement costs involved in the listed measures could have been assessed. It ought to mean that all cheaper abatements in Ireland have occurred.

With respect to 2020, quantified extra reductions due to further additional measures are given in the Strategy's Table 2.5, reproduced below.

Table 4: Further Emission Reduction Measures to 2020, million tonnes CO_2 pa.

Higher Renewables Target in Powergen	3.26
Biofuel Obligation in Transport	0.878
Renewables in Heating Sector	0.276
Transport Demand Management	0.74
Total	**5.15**

Taking account of the quantified reductions achieved by these measures, the Strategy points to a remaining gap in 2020 amounting to some 9 to 16 million tonnes of CO_2 equivalent.

To achieve some of the reductions it is clear what measures the Strategy will use: for example, CAP Reform (an economic instrument) and Building Regulations. As the type of measure used is critically important, it is useful to arrange the Strategy's reductions according to the usual classification of measures, summarised in Box 1.

Box 1: Types of measures for reducing emissions

(1) Economic instruments

a. taxes (polluters pay, polluting is discouraged, revenues are available and can be used to reduce distorting taxes elsewhere and to address distributional issues).
b. subsidies (taxpayers pay, may not influence behaviour in an enduring way, involve paperwork).
c. removal of perverse subsidies (their original objectives may be achieved in better ways than by subsidising energy use. This includes re-targeting of subsidies, e.g. CAP reform).
d. cap-and-trade emissions permits e.g. ETS (shareholders can gain at public expense unless auctioned. No revenue is generated under free allocation).

(2) Information/awareness/education/exhortation campaigns

Taxpayers pay. Information is a prerequisite for the market to function, and it economies of scale in gathering and imparting information can justify a role for central agencies.

(3) Regulation

Both the regulator and the bodies being regulated face costs, as do taxpayers for monitoring, administration etc., but they help where lack of information, trust and incomplete property rights are issues. The last gives rise to non-appropriability, where individuals making the efficiency effort do not reap commensurate benefits, e.g. employees and tenants are often inadequately rewarded for saving energy. Market power on the part of the utility may be inimical to consumers' needs for transparency so there are efficiency arguments for planning and building regulations.

(4) Industry-Level Agreements

Straddling economic instruments and regulations, these are often accompanied by penalties/enticements, such as relief from carbon tax, certificates and associated image enhancement, or free information and energy audits.

(5) Direct government infrastructure investment

Examples include transport and water infrastructure. Overall cost and amount of investment required can depend on how the asset is managed. For example congestion charging or real-time pricing can reduce the infrastructure needed.

4.2: Classifying the Strategy's Measures

The Strategy's measures are now classified into these five types. Table 5 gives the classification, according to percentage CO_2 reductions.

Table 5: Percentage breakdown of CO_2 reductions by 2020 classified by type of measure

MEASURES:	Mt CO_2 Reductions	%	Rank
Economic instruments			
Taxes	0.79	4	5
Subsidies	8.924	48	1
Removal of perverse subsidies	2.4	13	4
Emissions trading	3.02	16	2
Information/awareness etc	0.13	1	8
Regulations	2.668	14	3
Agreements	0.182	1	7
Direct government investment	0.653	3	6
TOTAL quantified	18.767	100	

Notwithstanding the uncertainty about some categorisation, subsidies and emissions trading appear to be the major measures chosen in the Strategy, with some reliance also on regulation.[6] The near 50% reliance on subsidies begs the question: how are they to be financed? Moreover, leaving aside the shortage of cost estimates, do the measures in broad terms constitute a least-cost solution?

5: Assessing the Measures

(i) The Nuclear Ban

Nuclear stations are base-load plants and are currently offered in the commercial market in minimum unit sizes roughly the scale of the Moneypoint coal plant, Ireland's largest, around 900 MW. Smaller units are possible, but there could be a unit cost diseconomy. Ireland is not prospectively short of base-load capacity given the

[6] The implications of each are discussed by Stiglitz (1988).

inherited stock and current construction plans, but the remaining technical life of Moneypoint, the largest base-load station, is no more than 15- 20 years. Nuclear as base-load becomes an option at some stage, and is the single most decisive policy choice available to cut emissions. Ireland's energy-related emissions of CO_2 would fall by almost 10% if Ireland's power system had the European average nuclear component. This is not to argue that Ireland should build a nuclear plant, but rather to argue that any decision to rule out the option needs to be based on a thorough analysis.

No study of the nuclear option, in particular no system-wide environmental, engineering and cost study, with appropriate incorporation of external and end-of-life costs, has been undertaken as part of the Irish Government's policy formulation. The range of generation possibilities considered in the recent All-Island grid study excluded a nuclear option (DCMNR, 2008). There have been several recent calls for a 'debate on nuclear power' from the ICTU, IBEC and the Minister responsible for energy policy, but there is an analytical vacuum. There is little point in such a debate in the absence of a comprehensive study.

(ii) Wind Penetration in Power Generation

The 30% target for renewables in power generation (by energy) was increased to 33% in the five months that elapsed between the Green Paper of October 2006 and the White Paper of March 2007. In a time horizon of 2020, it is improbable that renewables other than wind will contribute substantially. The 33% renewables target thus translates in practice into a wind target in the range 25 to 30%. This is a large multiple of the level of wind penetration actually achieved in any functioning power system with weak interconnection, and is also a multiple of targets enunciated in other countries. High reliance on intermittent and non-dispatchable generation creates serious challenges for system operators in maintaining system stability. These problems can only be addressed by investment in transmission infrastructure and in interconnection. The system problems appear to be highly nonlinear in the % of wind penetration: problems at 10% wind are more than double the problems at 5% wind. There are other and well-documented sources of increased system cost due to a higher level of wind penetration. Standby conventional plant must be available at substantial capital cost, which moreover will experience higher operating costs due to intermittent running (cycling). A more extensive transmission grid is also needed to connect with a more numerous and dispersed set of generation units.

A recent study for Ireland (Eirgrid, 2007) calculated that, at a relatively high (by the standards of most worldwide economic/climate models) carbon dioxide price of €30 per tonne, high levels of wind penetration make economic sense if gas prices (the realistic alternative fossil fuel) are considerably above recent levels. With moderate or low gas prices, the price of carbon needs to be higher again in order to make the economics of high wind reliance add up. As noted, one benchmark for the tolerable additional cost is provided by the Government's willingness to contemplate purchase of emission credits from other countries at €15 per tonne.

Wind power enjoys two advantages over conventional technologies, the zero fuel cost and the absence of emissions. The 'correct' level of wind penetration can only be ascertained by reference to an appropriate carbon price while requiring the technology to meet its other capital and operating costs, including the system costs of intermittent, sometimes unpredictable, generation and non-dispatchability. A market structure which internalises these costs to each generation technology, and taxes appropriately the emission externality, will yield the 'correct' level of wind penetration. Whether penetration levels for wind in Ireland would reach the high levels envisaged by the Government at plausible carbon prices is not self-evident: no economic study supporting the Government target was cited in the White Paper, and the subsequent Eirgrid study suggests that *both* carbon and gas would need to be at the upper end of plausible price ranges in order to lend support to the very high levels of wind penetration implied by the government's targets. It ought to be noted that, if carbon (and gas) prices at very high levels are required to make the economics of wind work out, those high carbon prices would likely bring numerous other, and currently marginal, technologies into the frame, in addition to nuclear.

(iii) Biofuels Target

Biofuels are an alternative transport fuel produced from biological material and consist of two main sorts: biodiesel produced from plant oils and bio-alcohol such as ethanol and methanol produced from cereals or sugar. Current policies on biofuels consist of:

- Targets on biofuel content of transport fuels, 2% by 2005 rising to 5.75% by 2010 (EC, 2003b)
- Subsidies by means of tax breaks, through reduced excise on biofuels, and
- Tariffs imposed on biofuels imported from outside the EU.

Comparing some of the different types and sources of biofuels, Ryan *et al.* (2006) show that the cheapest biofuel is made in Brazil from sugarcane. The next cheapest is from used oils and fat, while European biofuels come in at three or more times the cost of those from Brazil or developing countries. External benefits cited for supporting biofuels include the reduction in CO_2 emissions, security of energy supply and promotion of rural jobs and activity. But leaving aside the last two benefits and attributing all the extra costs to CO_2 reduction, the authors calculate that the implicit subsidy works out at €229 to €2085 per tonne of CO_2.

The present approach increases competition for land, which threatens to raise the price of food. When such impacts as soil acidification, fertiliser use, biodiversity loss and toxicity of agricultural pesticides are taken into account, the overall environmental impacts of ethanol and biodiesel can exceed those of petrol and mineral diesel. The OECD (2007) report concurs with Ryan *et al*, finding that in most cases the use of biofuels roughly doubles the costs of transportation energy for consumers and taxpayers together (the latter mainly), with the cost of corn-based ethanol in the US estimated at well over $500 per tonne of CO_2 avoided. This bet on a single technology should, say the OECD, be phased out, and preferably replaced "with technology-neutral policies such as a carbon tax".

New technologies hold out the promise of ethanol made from waste products that contain cellulose. These second-generation biofuel technologies could, in theory, avoid competition for land. By 2050 it is reckoned that these technologies, currently at demonstration phase, could have the potential to deliver 12 % of total transport fuel demand, while avoiding many of the negative effects of conventional fuels (Gummer and Goldsmith, 2007). Policy needs to be redirected from (subsidy) instruments for deployment of biofuels, to R&D, demonstration and economic assessment of advanced technologies.

(iv) Continued Reliance on Peat Generating Stations

Peat-fired power plants have CO_2 emissions per unit almost double those from gas plants. Their emissions per unit of power produced exceed even those from coal or oil plants, and the three Irish plants are the highest emitters in the system. These three plants (at Lough Ree, Edenderry and West Offaly) have combined capacity of 346 MW, and are relatively new. Their combined capacity corresponds to a single gas-fired CCGT of the size favoured recently in Ireland, but of course with almost double the emissions. The plants are base-load plants, not suitable for intermittent running.

The peat plants enjoy priority dispatch under the Irish regulatory regime, and they have been endowed with grand-parented emission permits. There are plausible combinations of gas and carbon prices (low to medium gas, medium to high carbon) in which these stations would not be dispatched regularly (or at all) in a competitive market, see McCarthy, O'Dwyer and Troy (2006). The recent Green and White papers, the Climate Change Strategy and the Grid Study are silent on these issues. Priority dispatch is an ongoing cost to the system and subsidy to the operators, which is not eliminated by failing to quantify it. Calculations undertaken in the nineties found that replacing peat-fired generation by combined-cycle gas turbines implied negative marginal cost of abating CO_2, that is, it would be a gain (Conniffe *et al.*, 1997).

(v) Fuel Efficiency

A ten per cent improvement in energy efficiency could roughly halve Ireland's overshoot on its Kyoto target.[7] To date, broad energy efficiency improvements have been patchy (SEI, 2007) yet researchers have repeatedly found that investment in

[7] Emissions from energy constitute a growing share of total emissions and stood at 66% of total emissions in 2005 (SEI, 2007). Assuming a similar share in Kyoto target years, a generalised extra 10% in energy efficiency would reduce total projected emissions by 6.6%. This can be compared with the projected overall Kyoto overshoot in Table 2 with 'existing measures' which requires a reduction of some 12% (from 71.17 down to 62.84).

energy efficiency holds out the promise of carbon reductions that are good investments in financial terms. Social cost-benefit calculations show positive net social benefits, meaning that the average cost per tonne of CO_2 abated is negative, another gain (Brophy *et al,* 1999). European Commission in its recent Action Plan stresses that realising efficiency potential is the most effective way to reduce carbon emissions, with side-benefits such as improved security of energy supply, fostering competitiveness and improving technology (EC, 2006). The European Commission put the potential for worthwhile energy saving at 20 per cent, with the residential and commercial buildings sectors identified as top priorities.

If energy savings are not being exploited in the presence of these good opportunities, how could one be sure that the situation would improve under carbon taxes? The problem is sometimes characterised as "barriers" to energy efficiency. We know in particular that barriers would be present if certain prerequisites for markets to function properly fail to be met. These include information and low transactions costs, as well as internalised external costs.

Information: By requiring transparency in meters and billing and certification of technical standards, regulations can overcome information barriers. Centralised information on technologies and costs, and assessment of emerging technologies are good ways to address information-related problems (EC, 2003a). In the case of the industrial sector, firms that adopt information measures, such as Energy Management Systems, or join networks where access to information is facilitated, subsequently tend to make efficiency investments (SEI, 2007). Improvements in energy labelling of appliances and equipment are another option.

Transactions costs: Energy is generally a small share in total outlays, so the transactions costs associated with energy efficiency investments can be high relative to the importance of the energy bill. Hassle and managerial time could negate the gains and discourage investment. Where the energy shares are higher, attention paid to energy efficiency is indeed correspondingly stronger (Scott, 1997; O'Malley *et al.,* 2003). Other transactions costs include problems of split incentives and principal-agent relationships. When the person making the investment effort cannot appropriate the benefits. The person who benefits could recompense the investor but hassle may be a deterrent.

Unpriced externalities: Only the ETS sector (one third of emissions) directly faces a price for emitting carbon. This raises the cost of other policies that have to do more to achieve the objectives.

Rebound effect: One consequence of an energy efficiency initiative is that the resulting improved energy productivity means that the heat or power ('energy services') that the energy produces now becomes cheaper. More will be consumed, thereby reducing or even possibly reversing some of the potential savings in energy and emissions. Measurements of the rebound effect in a survey of 75 US estimates for residential end-uses suggest a range of responses between 0 and 50 % for a 100% increase in energy efficiency (Greening *et al.*, 2000). For industrial and commercial firms the evidence indicates that in most cases efficiency gains result in fuel savings that are only slightly eroded by increases in demand. The authors conclude that rebound effects are low to moderate, adding that instruments such as carbon taxes will reduce the rebound (Brännlund *et al.*, 2006).

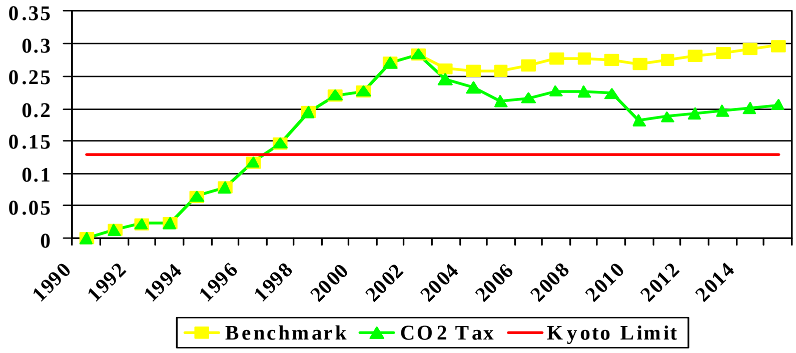
This review of salient features of the Strategy has discussed an important excluded measure where the cost of CO_2 abatement is barely known (nuclear). It has looked at included measures where the cost of abatement at proposed levels is high (wind power and biofuels, and at an expensive measure that worsens emissions, requiring intensification of other measures and extra costs (peat-generation). Finally, it has looked at the known cost-effective measure (fuel efficiency), which to a significant extent lies in the sector that is not required to face its external damage costs.

6: The Carbon Tax Alternative

The impact of a revenue-neutral carbon tax has been the subject of research here since the EC's proposal of 1991. Interest has centred mainly on the effects on the economy and prices generally, and on how to address the distributional and competitiveness impacts (EC, 1991; Fitz Gerald and McCoy, 1992; Bergin *et al.*, 2004; Scott and Eakins, 2004; COMETR, 2007).

It has been estimated that a carbon tax of €20 per tonne of CO_2 introduced in 2003 would reduce Ireland's Kyoto overshoot in 2008-2012 by approximately half. Figure 3 shows Ireland's emissions over time since 1990, and the paths of emissions after 2003 according to a business as usual benchmark and a "with CO_2 tax" situation. The horizontal line is the Kyoto limit, at 13 % above the 1990 level,

Figure 3: CO_2 emissions relative to 1990 level, with and without carbon tax



Source: Bergin *et al.*, 2004.

Effects on GNP were estimated to be minor and, depending on the manner of revenue recycling, could be positive. Among the four possible recycling options investigated, the least satisfactory in terms of GNP was to return the revenue to companies (akin to "grand-parented" emissions permits). Reductions of general taxes were found to be better recycling options, having minor and slightly positive effects on GNP. A reduction in the rate of VAT was one option where the impact on GNP would be positive though small. A reduction in social-insurance contributions was the option that would, through its positive effects on business and labour-markets, have the best GNP outcome. Prices would be reduced marginally. Hypothecating the revenues for spending on environmental projects would obviously raise the national tax-take overall, a point often overlooked.

6.1 Vulnerable groups

In order to cushion the effects on vulnerable households of the higher fuel prices induced by the carbon tax, some 23% of carbon tax revenue was assumed set aside for this purpose in this exercise. These funds would be adequate to protect the vulnerable, and the effects on the macro-economic outcome of setting aside such an amount were minor. Furthermore the administration for compensating most low-income households already exists in the present system of Fuel Allowances and in the income tax system.

6.2 Competitiveness

Competitiveness suffers if costs of production rise relatively faster than for foreign competitors. A unilateral carbon tax that causes a company to leave for a location where environmental policies are lax would be pointless, as the emissions produced elsewhere would be equally damaging to the world's climate. Six EU member states have introduced some form of carbon taxes (with revenue recycling) at different dates since the early 1990s and the effects on their competitiveness have been investigated (COMETR 2007). The countries and their years of reform are: Sweden 1990, Denmark 1992, the Netherlands 1996, Finland 1997, Germany 1998 and the UK in 1999. The UK introduced a Climate Change Levy on enterprises which was balanced by reductions in Social Insurance contributions. The findings of the *ex post* study of the effects on emissions and on GDP of the carbon tax policies in these countries are broadly in line with the *ex ante* estimates for Ireland described above, showing again small improvements in both GDP and emissions. The rates of carbon tax imposed were in fact modest, with many exemptions and accompanying agreements with sectors that were potentially vulnerable. Annex 1 shows GDP growth, emissions intensity of GDP and its reductions, for the reform countries and other Member States of the EU 15 (plus Norway which is also a reform country).

6.3 How much would a carbon tax add to prices now?

A low tax at the start, say €5 per tonne of CO_2, would ease the introduction and help to identify pressure points. At this rate, only two household fuels would rise by more than 2 per cent, briquettes and coal (see Annex 2). Table 6 shows the fuel prices in 2006 resulting from a carbon tax €20 per tonne. The price rises are hardly punitive. Where there are already high taxes, the carbon tax would evidently add but a small percentage, as is the case for gasoline and automotive diesel, with the opposite applying to natural gas sold to industry. The highest increase would apply to coal sold to electricity generation. The rise shown in the selling price of electricity *per se* takes into account the carbon in the fuel mix used for generation in 2006.[8]

It is not necessarily optimal to superimpose a carbon tax on all energy products as their existing tax and subsidy require to be taken into account.

Table 6: Carbon tax at €20 / t CO_2 if implemented in 2006

Fuels (units)	Price incl existing tax €	Price incl existing tax plus carbon tax €	Carbon tax at €20 / tCO2 * €
DOMESTIC			
Premium Unleaded Gasoline 95 RON (litre)	1.12	1.16	0.05
Automotive Diesel - Non-Commercial User (litre)	1.09	1.15	0.05
Natural gas - household (kwh)	0.0628	0.0669	0.0041
Electricity - Household (kWh)	0.1585	0.1705	0.0120
Light Fuel Oil - Household (1000 litres)	706.01	759.68	53.67
Briquettes (bale)	3.07	3.54	0.48
Premium domestic coal (tonne)	286.61	342.92	56.32
COMMERCIAL			
Automotive Diesel - Commercial User (litre)	0.90	0.96	0.05
Natural Gas - Industry (10^7 kcal GCV or TOE)	371.32	418.88	47.56
Electricity - Industry (kWh)	0.0968	0.1088	0.012
Light Fuel Oil - Industry (1000 litres)	549.05	602.72	53.67
High Sulphur Fuel Oil - Industry (tonne)	397.15	459.83	62.68
Jet fuel (litre)	0.4413	0.4909	0.0496
Marine diesel (litre)	0.5365	0.5902	0.0537

* The final column is subject to rounding.

Implications for the Consumer Price Index have been estimated from the Hermes Model as used in the *Medium Term Review* (Fitz Gerald *et al.*, 2005). Based on the assumption that a carbon tax of €20 per tonne of CO_2 were introduced in 2008, the

[8] In the ETS the price would already be included and the tax *per se* would not need to apply).

estimated overall effect on the Consumer Price Index, before compensating indirect tax reductions, is a rise in prices of approximately two thirds of a percent.[9]

6.4 Taxing Automotive Fuels

Road transport accounts for some 14 % of Irish emissions and the private car for about 8%. Though an important source of pollution, private car transport is heavily taxed in Europe, and maybe excessively so relative to untaxed or lightly taxed sectors.

Between purchase taxes, annual taxes and the fuel tax, an Irish motorist using 1,600 litres per annum in a 1500 cc saloon costing €25,000 new (middle of the range) would pay about €2,500 per annum in total. Of this, only 45% is fuel tax varying with usage. The remaining 55% is paid even at zero mileage. The total of €2,500 per annum would equal €1.56 per litre if collected entirely on fuel. Box 2 outlines the design of indirect taxes for auto-fuels.

Box 2. Designing Indirect Taxes on Auto-fuels to Include a Carbon Charge

Many auto-fuels are taxed at substantial rates, though some are taxed lightly and some are subsidised. Indirect taxes serve potentially three purposes. These are general revenue raising, recovering infrastructure costs, and penalizing externalities.

Thus the optimal tax $$T^* = G + C + E \qquad (1)$$

where G is a general sales tax or VAT, C is a cost-recovering charge for infrastructure use and E is a Pigouvian tax on externalities. G can be thought of as the average VAT rate in European countries, and is about 15% in Ireland. C will be zero for activities which pay their infrastructure costs directly (aviation, shipping, but not roads), and E would include a charge on carbon and other externalities.

Externalities from transport have been variously described and costed. A study for Ireland looked at some environmental consequences of transport growth and pointed to a number of anomalies in the fiscal treatment of the sector (Oscar-Faber, 1999). A recent study of the automobile for the USA also lists external effects and their costs,

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[9] Estimations for resource decisions should add this carbon tax on to fuel prices, in the manner shown in the UK by DEFRA's Guidance for appraising government projects. It now uses a much higher 'shadow price' of £26.50 (€34.91) per tonne of CO_2 equivalent (DEFRA, 2007).

and the figures help to clarify the orders of magnitude according to the two ways that external impacts of the automobile are felt, whether (1) per gallon of fuel used and (2) per mile travelled (Parry *et al*., 2007). A summary is given in Table 7. Components such as the geo-political costs of oil dependence have not been quantified and are omitted. The striking feature of the estimates is the low share of externalities that are fuel-related (energy security and climate change) compared to those that are mileage-related (congestion, accidents and pollution).

Table 7: Summary of external costs of the automobile in the US

Marginal external costs	Expressed in US cents per US gallon[a]
Fuel-related	
Climate change	6
Oil dependency	12
Sum of fuel-related costs	18
Mileage-related	
Local pollution	42
Congestion	105
Accidents	63
Sum of mileage related costs	210
TOTAL	228

Source: Parry *et al*., 2007.

a. Central values. Costs assume on-road fuel economy of 21 miles per US gallon. Imperial gallon = 1.201 US gallons.

The total external cost figure of $2.28 per US gallon is approaching €0.40 per litre. Total transport taxes in Ireland (and in European countries generally) comfortably exceed this figure, though road use costs should be covered as well as externalities. Parry *et al* conclude that a progressive increase in US gasoline tax seems to make sense at present, given that widespread adoption of ideal externality taxes applied to mileage is unlikely in the near term. For European countries, the tentative conclusion suggested by these figures is that taxes on private motoring are primarily poorly designed rather than too low. In the United States, and in many other countries, they are likely too low. In Ireland, a revenue-neutral switch from vehicle purchase and annual taxes to a higher fuel tax is worth considering.

7. Conclusions – Irish Climate Policy after Kyoto?

Given the global nature of the emissions challenge, it is fair to ask why individual, and especially small, countries should have a unilateral domestic climate policy at all. Irish emissions have recently been running at about 70 million tonnes per annum. In China, emissions *increased* over the 2002 to 2006 period by roughly this amount *every month*. Chinese CO_2 emissions alone rose by 2,700 million tonnes in these four years. What we do unilaterally in Ireland is in the nature of a rounding error in the global context.

The most important Irish contribution could be through the deliberations surrounding the successor to Kyoto 1. It is important that Kyoto 2 should acknowledge the limitations of the policy architecture currently in place. There is an unusual degree of consensus in the economics profession that a regime of quantitative interventions is markedly inferior to the simple price-based solution. The real inconvenient truth in climate policy is that, one way or another, the price of carbon must rise, particularly in those uses where it is currently untaxed, or subsidized. The low-hanging fruit consists firstly of the elimination of fuel subsidies, estimated at upwards of $200 billion per annum worldwide. Second, activities currently untaxed, such as marine and aviation sectors and those outside the ETS need to be brought into the tax net. Ultimately, a universal minimum tax on emissions is the first-best solution.

As to domestic policy, in place of targets the Government should focus on policy. The confusion of target enunciation with policy decisions is a contemporary political ailment particularly evident in discussion of climate and energy issues. The implication that in the face of pressures governments know (or even can know) the abatement costs is hard to sustain. It should focus on price instruments, including perverse subsidy removal, and pursue a policy of sector and technology neutrality. The Programme for Government has re-instated the Carbon Tax on the political agenda at the behest of the Green Party. Without waiting for a new Commission on Taxation, there is plentiful scope for interim taxation measures. The higher rates of fuel tax in Northern Ireland and their lower vehicle purchase taxes provide headroom for a swivel in the taxes on motoring, such as a cut in VRT (purchase tax) compensated by an increase in fuel tax at the pump, without risk of revenue leakage.

Fuel use currently lightly taxed, for example home heating fuels, public transport fuels and agricultural diesel could also be reviewed.

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Annex 1

Emissions reduction 1990-2005, Kyoto target achievement, reduced emission intensity of GDP and 2005 intensity

For the EU 15 member states, with ranking of performance. Rank: 1= best.

Those countries that introduced environmental tax reform in the form of a revenue neutral carbon tax are denoted by the colour GREEN.

	Emissions				Kyoto			GDP		GDP emissions		GDP 2005			
	1990~Base Mt	2005 Mt	2005/base growth, %	% reduction rank	target agreed %	Distance to target % points	Meet target rank	2005/base growth, %	growth rank	intensity change, %	intensity reduction, rank	at curr mkt pr Billion euro	intensity t/ M euro	intensity rank	
Germany	1232.5	1002	-18.7	1	-21	-2.3	6	20.9	15*	-32.78	5	2241	446.9	11	Germany*
UK	779.9	657.4	-15.7	2	-12.5	3.2	2	43.4	5	-41.21	3	1793	366.6	4	U K
Denmark	69.3	63.9	-7.8	3	-21	-13.2	10	38.1	9	-33.25	4	208.3	306.8	2	Denmark
Sweden	72.3	67	-7.4	4	4.0	11.4	1	36.2	11	-32.01	6	287.7	232.9	1	Sweden
Finland	71.1	69.3	-2.6	5	0.0	2.6	3	37.7	10	-29.28	8	157.2	440.8	10	Finland
Belgium	146.9	143.8	-2.1	6	-7.5	-5.4	8	33.0	12	-26.38	9	298.5	481.7	12	Belgium
France	563.9	553.4	-1.9	7	0.0	1.9	4	31.4	13	-25.35	10	1710	323.6	3	France
Netherlands	214.6	212.1	-1.1	8	-6	-4.9	7	43.2	6	-30.94	7	505.6	419.5	7	Netherlands
Luxembourg	12.7	12.7	0.4	9	-28	-28.4	13	90.0	2	-47.16	2	29.4	432.0	9	Luxembourg
Italy	519.5	582.2	12.1	10	-6.5	-18.6	12	21.2	14	-7.48	13	1423	409.1	6	Italy
Austria	79	93.3	18.1	11	-13	-31.1	14	38.3	7	-14.58	12	245.1	380.7	5	Austria
Greece	111.1	139.2	25.4	12	25.0	-0.4	5	56.3	3	-19.78	11	181.1	768.6	15	Greece
Ireland	55.8	69.9	25.4	13	13.0	-12.4	9	164.9	1	-52.67	1	161.2	433.6	8	Ireland
Portugal	60.9	85.5	40.4	14	27.0	-13.4	11	38.1	8	1.63	15	149	573.8	14	Portugal
Spain	289.4	440.6	52.3	15	15.0	-37.3	15	54.5	4	-1.43	14	905	486.9	13	Spain
Norway^	49.8	54.2	8.8	10	1.0	-7.8	9	60.5	3	-32.18	6	237.68	228.0	1	Norway

^ Norway has a carbon tax and is included for interest.

Source: EEA Technical Report No 7/2007, Annual European Community GHG inventory 1990-2005

Base year is 1990 except for fluorinated gases in the case of some countries. See note in EEA (2007).

Source: GDP growth derviced from AMECO GDP at 2000 market prices.

* German GDP growth is based on 1991 to 2005, not on 1990 to 2005 as for other countries.

Source: GDP in 2005 "Statistical Annex of European Economy". Spring 2007 from EC. Norway GDP from Statistics Norway.

/ Kyoto target-emissions-intenstyimprovt and intensity 1990-2005.xls

Annex 2

Energy prices in 2006, before and after tax, including a carbon tax, €*

Prices ex-tax, prices incl existing taxes, prices incl existing taxes plus €5 per t CO2 carbon tax

Fuel and units	Ex-tax price €	Price incl existing tax €	Price incl existing tax plus carbon tax €	Emission factors used tCO2/unit	Carbon tax @ €5 /tCO2 euro/unit
High Sulphur Fuel Oil - Industry (tonne)	383.52	397.15	412.82	3.134	15.67
Heavy Fuel Oil - Electricity Generation (tonne)	258.73	273.51	289.18	3.134	15.67
Light Fuel Oil - Industry (1000 litres)	501.69	549.05	562.47	2.683	13.42
Light Fuel Oil - Household (1000 litres)	574.70	706.01	719.43	2.683	13.42
Automotive Diesel - Commercial User (litre)	0.5365	0.9045	0.9179	0.002683	0.0134
Automotive Diesel - Non-Commercial User (litre)	0.5365	1.0945	1.1079	0.002683	0.0134
Premium Unleaded Gasoline 95 RON (litre)	0.4800	1.1170	1.1288	0.002356	0.0118
Natural Gas - Industry (10^7 kcal GCV = TOE)	371.32	371.32	383.21	2.378	11.89
Natural Gas - Household (10^7 kcal GCV =TOE)	643.93	730.86	742.75	2.378	11.89
Steam Coal - Electricity Generation (tonne)	48.82	48.82	61.99	2.634	13.17
Electricity - Industry (kWh)	0.0968	0.0968	0.0998	0.0006	0.003
Electricity - Household (kWh)	0.1396	0.1585	0.1615	0.0006	0.003
Premium domestic coal (tonne)	252.52	286.61	300.69	2.816	14.08
Briquettes (bale)	2.702	3.067	3.186	0.02385	0.1192
Jet fuel (litre)	0.4413	0.4413	0.4537	0.002479	0.0124
Marine diesel (litre)	0.5365	0.5365	0.5499	0.002683	0.0134

* The prices used are the averages of SEI's reported prices in 2006,
except the price of jet fuel, from IATA website, which refers to 10 Aug 2006.

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