Plugging the gap in energy efficiency policies: the emergence of the UK 'carbon reduction commitment'

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Abstract

This paper investigates energy efficiency policies in the UK with particular reference to the business and public sectors. There are a number of instruments already in place that aim to improve energy efficiency in these sectors as part of wider UK climate change policy. These instruments have, however, failed to address key barriers to uptake that are specific to large, less-energy-intensive companies and public sector organisations – light manufacturing and the "service sector". In this paper, we tell the story of how policy has evolved to plug this gap between barriers to and policy instruments for energy efficiency.

We firstly set the context for energy efficiency in the business and public sectors in terms of existing policy and the potential for carbon abatement. We then examine the barriers to energy efficiency and map these against the main policy instruments. Our analysis clearly illustrates the need for a different approach if the potential for improving energy efficiency is to be realised. We discuss the features of the main proposal for providing this new approach: a consumption-based cap-and-trade scheme. We then trace its path from concept through to policy design to what is now known as the Carbon Reduction Commitment (CRC). We conclude by evaluating the importance of the CRC, due to commence in 2010, in contributing to cost-effective emissions reduction and security of supply in the UK.

1. Introduction

Almost all technology assessments suggest that improving energy efficiency offers both the cheapest and the quickest route to energy systems that are both more secure and lower in their environmental impacts. Many studies have noted a wide array of options that appear to offer this potential, spanning energy efficiency in buildings, vehicles, industry and various 'system' technologies.

Based on straightforward engineering cost estimates, many indeed appear to offer the potential of 'negative costs' – technologies for which the value of energy savings, discounted at a market rate of return, exceed the up-front additional investment cost – sometimes to a huge degree. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change estimated that 'negative cost' options could save around 5-7GtCO_2 emissions by 2030, compared to reference projections – saving 7-14% of global emissions (depending on the reference projection) at considerable net economic benefit; the vast majority of these are from improving energy efficiency (IPCC, 2007, Table SPM-1 [1]). The International Energy Agency similarly assesses a huge cost-effective contribution from improving energy efficiency (IEA, 2007[2]; IEA, 2008 [3]). The European Commission 2006 Energy Efficiency Action Plan [4] projected that the combination of structural change and improving energy could keep the growth of energy demand in the EU out to 2020 to 0.5%/yr, in the context of more than 2%/yr economic growth rates – and that stronger energy efficiency policies could deliver additional savings.

This has posed an obvious puzzle for the energy-economics profession, mirrored to some degree by policy debates within governments. If energy markets are functioning properly, then why don't energy consumers implement optimum levels of energy efficiency? Consequently, there has been considerable questioning of the idea of 'negative cost' options, and scepticism about the ability of specific policy interventions to deliver savings more efficiently than would be achieved through price alone. However, this view has gradually given way in the face of mountains of evidence to the contrary (e.g. the surveys in references 1-5).

This paper does not duplicate such analysis, but rather focuses upon a different dimension: how the potential for energy efficiency matches against the span of existing policy instruments, and the resulting policy implications, with particular reference to the business and public sectors in the UK. Specifically, the paper tells the story of the development of an entirely new proposal – eventually termed simply the 'Carbon Reduction Commitment' - which formed the main new policy instrument in the UK's 2007 Energy White Paper (DTI, 2007 [6]).

2. Climate change policy in the UK: the business and public sector[1]

Climate change policy in the UK is not new. Indeed by November 2000 the government had introduced the major package of measures that formed the Labour government's Climate Change Programme (CCP). The main instruments bearing upon the business and public sector are:

- The Climate Change Levy (CCL), a "downstream" tax on energy use in the business and public sectors;
- Emissions trading, with the pilot UK Emissions Trading Scheme (UK ETS) being superseded in 2005 by the much more far-reaching EU Emissions Trading Scheme (EU ETS);
- The Climate Change Agreements (CCA), emission targets negotiated by 44 sectors and applied to their member companies in return for an 80% rebate of the CCL;
- Building regulations, now complemented by the EU Energy Performance in the Buildings Directive;
- A range of support measures managed by the Carbon Trust, the institution established under the CCP to provide support services to help UK business and public sector move towards a low carbon economy.

[1] Note that the earlier parts of this paper, notably sections 2 and 3, draw heavily upon material published originally as a report by Carbon Trust (2005) [7] and subsequently in a book chapter, Grubb, Wilde and Sorrell (2008) [8].

The CCP was always intended to be subject to a 5-year review. To feed into this, the Carbon Trust decided to conduct its own review of the policy landscape, which became a principal external component of the 'Climate Change Programme Review'. This paper draws upon that assessment, and analyses what flowed from it.

The focus is upon business and public sector use of energy. Of the UK's overall carbon emissions of c. 150MtC/yr (c. 550MtCO_2/yr, excluding air transport and GHGs other than CO_2), just over one third (54MtC) comes from these sectors, including the attributed portion of power generation emissions. In terms of *electricity* consumption, use in the UK is divided roughly equally between residential, industrial, and service (commercial and public) sectors; the others (transport, agriculture, and energy sector) comprise little over 5% together. This paper pays particular attention to the service sector use of electricity, for reasons that become apparent from a close look at the data[2].

From a policy perspective, it is most relevant to divide sectors based on the entity types that need to be engaged, and their principal types of energy use. Figure 1 indicates how business and public sector emissions from both direct fuels (solid areas) and electricity (hatched areas) divide between four entity types (horizontal).

[2] Issues about the domestic sector are discussed in Bilton et al. (2008) [9].

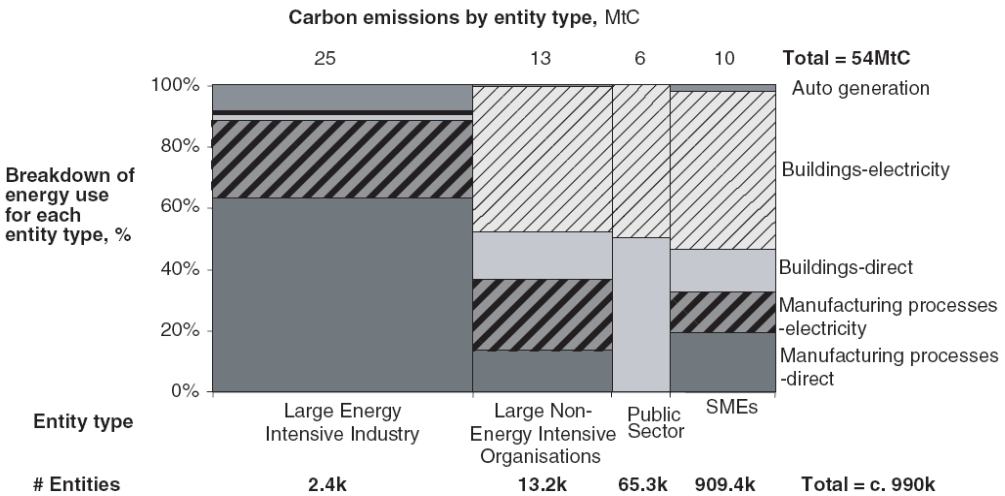

Figure 1: UK business and public sector carbon emission by energy and entity type (2002)
Source: Carbon Trust (2005) [7]

Note: For definition of entity type see text. Direct emissions are CO_2 emissions from gas, oil and coal consumption including those used for direct process conversion (e.g. in cement and steel). Electricity attributed at 143tC/GWh. Building emissions include appliances, computers etc.

- Large energy intensive users, defined as sectors for which more than a third of their emissions are covered by either the EU Emissions Trading Scheme or the UK's Climate Change Agreements, both of which have been targeted at energy intensive sectors (size cut off >50 employees in manufacturing sectors);

- Large non-energy intensive users, which covers both low energy intensive manufacturing and the larger service sector organisations (size cut off >50 employees in manufacturing sectors and >250 employees in service sectors);

- Public sector, covering all government estate including e.g. education, hospitals, local government etc;

- Small and medium-sized enterprises (SMEs), defined here as companies with less than 50 employees in manufacturing sectors or 250 employees in service sectors – almost a million legal entities in total.

As illustrated in Figure 1, in 2002 the energy intensive category accounted for about 45% of the *total* business and public sector CO_2 emissions in 2002 – but barely a quarter of the *electricity*-related emissions. The energy-intensive sectors are dominated by activities like steel and cement manufacturing that consume huge quantities of direct fuels. With a prime exception of aluminium smelting, electricity consumption is largely accounted for by far less energy-intensive operations.

3. The technical and economic potential for carbon abatement

The abatement potential can be expected to vary by sector, and over time as capital stock replacement facilitates new opportunities. Detailed sector- and technology-specific modelling was used to estimate the mitigation potential available by 2010 and 2020 (for details see Carbon Trust, 2005 [7]). Figure 2 summarises the findings. This suggested that the potential emission reductions from the take-up of currently available more efficient technologies by 2020 (allowing for stock turnover, etc.) would total around 25%, with more than half (15%) assessed as being "cost effective" – i.e. financial rate of return greater than 15%. Moreover, the cost-effective potential is largest in both the sector of highest electricity use (large non-energy-intensives, at 18%); and the activity that dominates this consumption (buildings-related consumption, with 22% cost-effective potential).

Thus, really tackling the inefficiencies in how the business and public sectors use energy might be expected to save up to 20% of their consumption – potentially at net economic benefit. Tackling energy and climate change cost-effectively, in others words, means tackling the reasons why companies and other organisations apparently waste so much energy, particularly in the buildings they occupy.

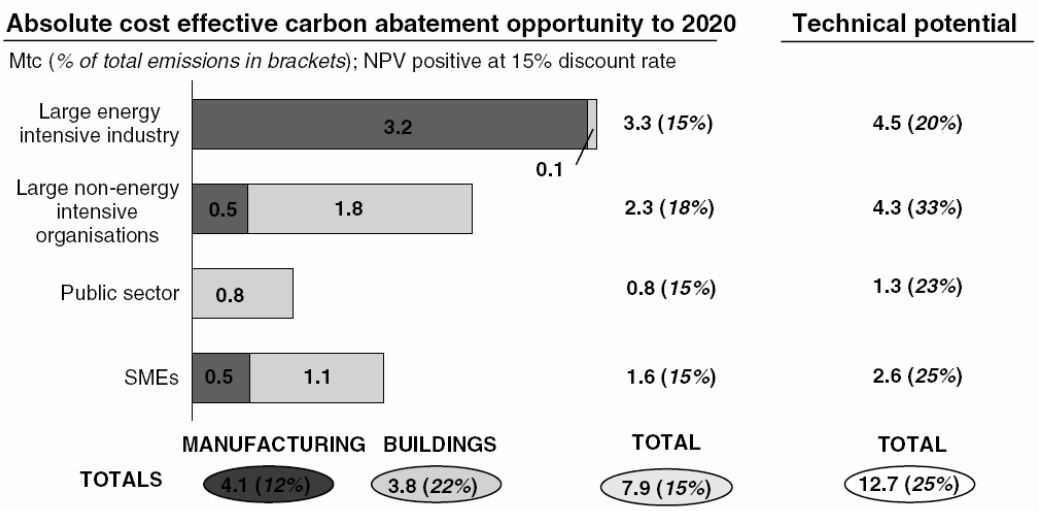

Figure 2. Carbon abatement opportunity by 2020: cost-effective (@15% discount rate) and identified technical potentials by energy use and entity type
Source: Carbon Trust (2005) [7]

Note: Carbon saving opportunity is based on detailed sector-level source data (ENUSIM and BRE abatement curves), providing a measure-by-measure breakdown of abatement opportunities using existing technologies and their cost implications (buildings figures based on opportunity in existing stock only). Cost effective opportunity has positive Net-Present-Value (NPV) at 15% discount rate; full technical potential includes all measures in abatement curves. Opportunity as stated does not allow for innovation and introduction of new technologies between now and 2020 (which would be expected to significantly increase figures shown).

3.1. The challenge of the less energy intensive sectors

Figure 1 above also illustrates the split between emissions attributable to manufacturing process operations, and those associated with building occupancy including heating, lighting, refrigeration, and 'plug-in' loads such as computers. In the less energy-intensive sectors, electricity consumption accounted for about 70% of the total emissions; and electricity use in buildings-related uses, rather than manufacturing processes, accounted for at least two-thirds of this. Particular attention is paid to these components, notably in commercial and public sector services, for three reasons:

(1) whilst industrial use of electricity increased only slowly (by 36% over roughly the same number of years, i.e. 1970-2006), electricity use in commercial and public services increased by 150% over the same period;

(2) the identified potential for cost-effective improvements is substantially greater in these sectors, as in Figure 2;

(3) in much of heavy industry, electricity costs are significant and the sector is consequently responsive to price signals, such as those that would be induced by carbon pricing, which is only weakly the case in the less energy intensive sectors for reasons outlined in this article.

However, a measure of the challenge for any policy other than those based purely on price is that in the UK, these non-energy-intensive sectors comprise almost a million organisations. And yet, about half of the total use was accounted for by just 13,000 large companies – for example supermarket and retail chains, financial service companies, etc. This is key to the proposal analysed in this paper.

3.2. An overview of the barriers

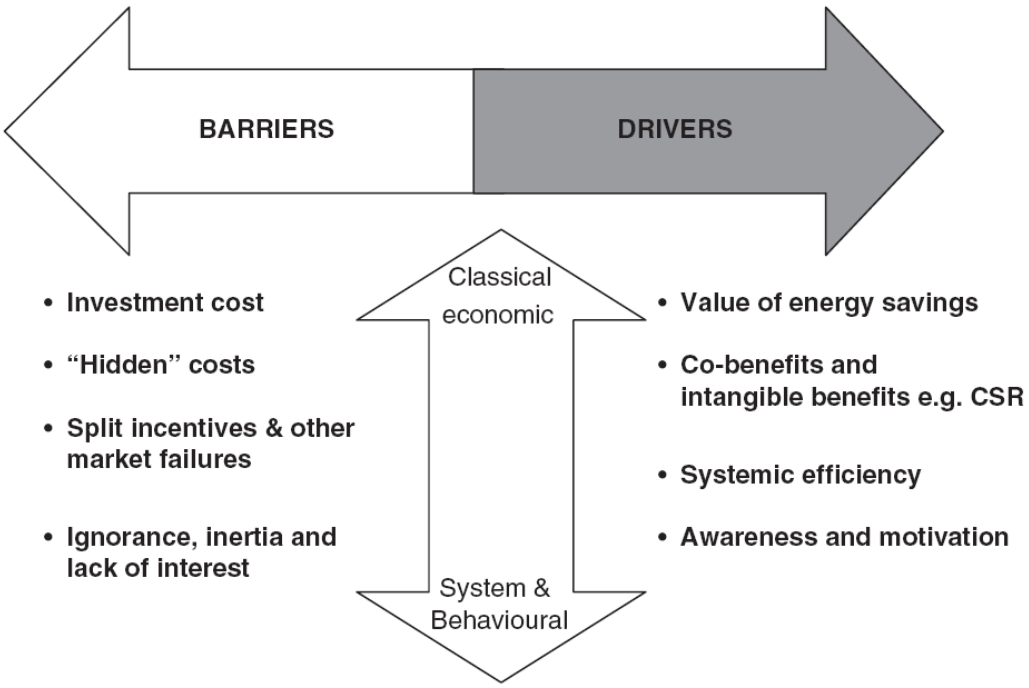

Figure 3: Barriers to, and drivers for, energy efficiency uptake
Source: Carbon Trust (2005) [7]

Figure 3 summarises the four main classes of 'barriers' and corresponding 'drivers' to improved energy efficiency developed for the study, as described in more depth in Carbon Trust (2005) [7] and in a companion paper (Grubb, 2008 [5]). Broadly, they move from the most obvious trade-off of financial costs (investment) and benefits (energy savings), to issues much more around the behavioural and organisational realities of imperfect organisations. The focus in the analysis is how these *map* on to the energy use structures identified in Figure 1, and how these relate to existing policies.

The essential finding is that whilst issues of 'behavioural and organisational realities' are significant across all large organisations, the combination of this

with market misalignments (such as the tenant-landlord split) dominates building energy use; (a parallel study for the UK government estimated 'hidden costs' to be potentially significant but *not* a dominant part of the explanation).

3.3. Mapping barriers against policy instruments and options

As indicated in the introduction, the UK already has a significant suite of policy instruments intended to improve its energy efficiency. In Figure 4 the main ones are set out against the mapping introduced above. The energy intensive industries are to a large extent covered by the EU ETS, which focuses on power generation and a few core energy-intensive sectors,[3] and the UK Climate Change Agreements (CCAs) that set negotiated emission targets for 44 manufacturing sectors in return for a discount from the UK Climate Change Levy (CCL).

For the other sectors, however, the main instruments (other than the advisory services and low-interest SME loans provided by the Carbon Trust) are the Climate Change Levy, and building standards. However UK building regulations apply principally to new build, which is a very small part of the stock, and the European Energy Performance in Buildings Directive is aimed primarily at providing information about building performance. Neither necessarily tackles the behavioural dimensions of how organisations choose, and operate within, the buildings they use.

[3] The EU ETS in Phases 1 (2005-7) and 2 (2008-12) sets emission caps on individual facilities in electricity generation, refineries, and manufacturing of iron and steel, cement, glass and ceramics, and pulp and paper. In Phase III (2013-20), its coverage will be extended mainly to include various activities in chemicals, and aviation (for an overview of Phase III proposals see Carbon Trust (2008) [10]). Overlap with the CRC will remain extremely modest and the nature of the instrument, targeted at individual monitored facilities, is entirely different.

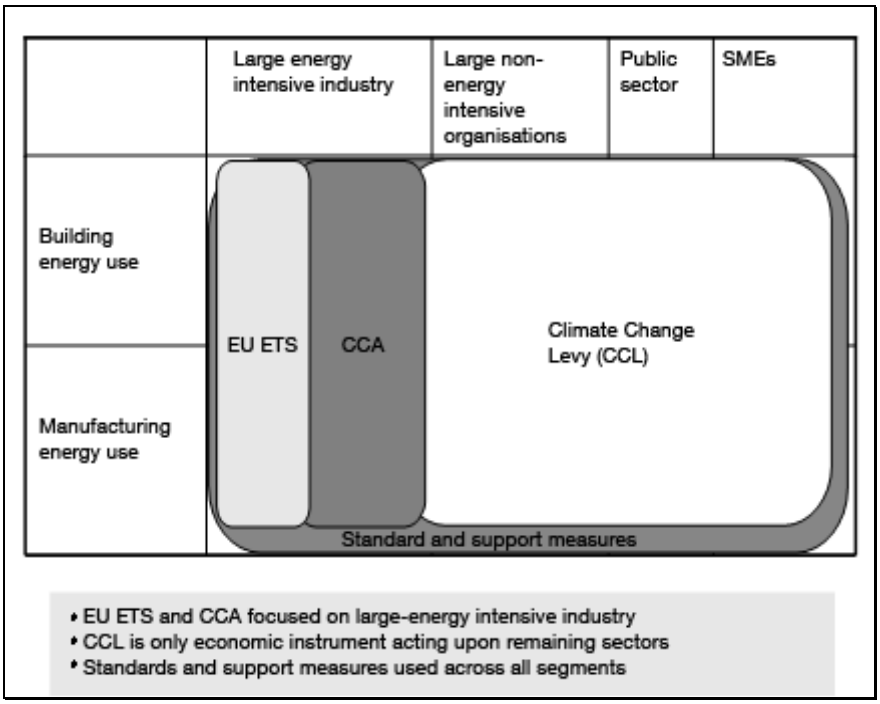

Figure 4. Coverage of EU ETS and existing UK instruments
Source: Carbon Trust (2005) [7]

The theory was that this would be achieved through price – the Climate Change Levy. However, this is a misalignment of policy with the analyses of barriers. The dominant barriers in these sectors, by contrast to the barriers in energy intensive industries, have little to do with price. In large non-energy intensive organisations and in the public sector, issues of market misalignment and organisational structures dominate. For SMEs, transaction costs and the lack of skills in many companies to manage their energy are major factors. There is econometric, economy-wide evidence of a significant 'awareness' impact from introducing the CCL (Cambridge Econometrics, 2005 [11]), however consultation with these less energy-intensive sectors indicated overwhelmingly that the CCL, some years after its introduction, was in fact largely treated as an unavoidable cost at site level, with little enduring influence on actual behaviour.

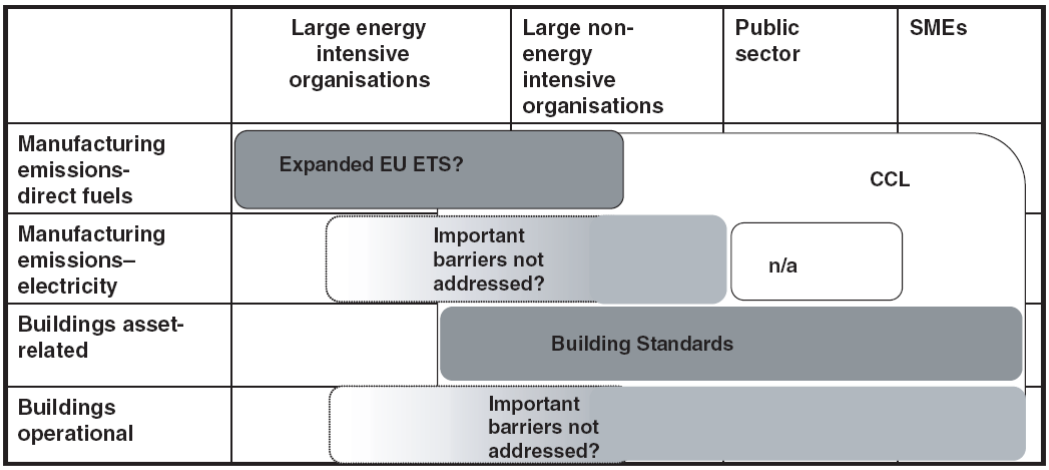

Figure 5. Key gaps in coverage of the UK Climate Change Programme
Source: Carbon Trust (2005) [7]

Thus, the three-way mapping of energy use, barriers, and policies, revealed significant gaps as summarised in Figure 5 – in the operational use and leasing decisions around buildings, and also with respect to electricity use in some parts of manufacturing not involved in the Climate Change Agreements, principally the less energy-intensive parts. The challenge is to identify instruments other than those based purely on price, to leverage the management attention and investment of non-energy intensive organisations to address the wastage in their energy use.

4. A dedicated, consumption-based cap-and trade proposal

> *"If you really want our companies to address energy and carbon, you have to get emissions into the financial reporting systems through which the company management structures work."*
>
> (Participant at consultation with large non-energy-intensive sectors hosted by the Confederation of British Industry)

This analysis suggests that a different approach is required if the less energy intensive sectors are to realise more fully their potential for improving energy efficiency. The most promising approach appears to be a mandatory trading scheme that caps direct and indirect emissions from large non-energy intensive companies in the business and public sector – those that are currently outside the scope of the existing EU ETS and CCAs. Like the original pilot UK ETS – and unlike the EU ETS - it would include the 'embodied' emissions associated with their electricity consumption (that represent around 70% of the sector's emissions) but would otherwise be quite distinct, and simpler.

The defining features would be:

- A company level trading scheme, in which companies must acquire allowances to cover their total emissions from sites across the country and may freely trade them between all other companies in the scheme;

- Both direct and electricity-related direct emissions would be included (electricity could be accounted at grid average carbon intensity, or supplier-specific intensities);

- Transaction costs would be minimised by:

    - Focusing the scheme on large companies (e.g. based on either energy consumption, turnover or employment threshold);

    - Basing the emissions on good metered energy bill data (e.g. sites with 1/2hr electricity metering, which is only generally provided to sites with energy consumption above a specific threshold)

- Results to be published in company and public sector annual reports in consistent fashion: year on year total emissions, sales and purchases of allowances etc.

The simplest implementation would auction all the allowances to avoid the complexities and administrative costs of company-specific negotiation. From a purely economic perspective, the cost impact is very much like the Climate Change Levy. The key rationale lies in the analysis of behavioural and organisational factors above. The instrument requires organisations to collect and aggregate information from their sites across the UK, to project the implied CO_2 emissions, and to be held transparently accountable for those emissions through the requirement to purchase allowances.

Note that, in addition to the sectoral scope and inclusion of 'electricity-embodied' emissions, this focus on *organisational*-level commitment also makes the scheme fundamentally different from the EU ETS, which regulates emissions from individual facilities. It is crucial for two reasons. First, it minimises transaction costs – all the contractual and procedural issues associated with compliance can be aggregated across all sites operated by the single organisation. Second, in accordance with the behavioural analysis, it unavoidably puts the issue of carbon footprint and its management – and associated costs – at Board level, rather than simply leaving hundreds of sites around the country to pay energy bills as a written-off incidental cost.

The basic proposal, originally titled the "UK consumption-based emissions trading scheme (UK CETS)" was taken up and developed by the government and presented in the UK *Energy Review* (DTI, 2006 [12]) as one of the two main options for tackling the growth of service sector CO_2 emissions (the other being mandatory reporting). Renamed the "Energy Performance Commitment" (EPC), it was then opened for formal consultation, that closed early in 2007. Following this, after refinement to define more carefully the target sectors taking account of transaction costs, it was adopted as probably the most significant new policy instrument in the UK Energy White Paper (DTI, 2007 [6]) and renamed again as the "Carbon Reduction Commitment" (CRC). The rest of this paper outlines the 'political journey', and the final design to emerge.

5. Checking the logic: Options analysis

The adoption of the Carbon Reduction Commitment itself forms an interesting case study in the politics of energy efficiency policies.

As a semi-official input to the Climate Change Programme Review, the original Carbon Trust analysis was conducted with a Steering Committee that included government representatives. Officials in the UK Department for Environment, Food and Rural Affairs (DEFRA) in particular were persuaded by the analysis of a significant gap in the coverage of existing policy instruments, and began a discrete campaign to flesh out the idea and pursue it with colleagues in DEFRA and other departments.

To check the logic and build a politically more robust case, the government commissioned consultants to undertake a thorough review of all policy options in the space (DEFRA, 2007a [13]). Many of the other options considered involved extension of already applied measures to non-energy intensive organizations, for example the EU ETS, the UK ETS and Climate Change Agreements. Figure 6 presents the summary table from the study. Each column indicates effectiveness according to different criteria such as coverage, the extent and certainty of CO_2 reductions and the capacity to improve energy efficiency.

The consultants concluded that the Energy Performance Commitment (EPC) (as then termed) distinguished itself from the other policies by being successful in each category; and even where not ranked highest for a given criteria, it represented at least one of the best solutions. This suggested the EPC to be the most suitable policy to apply to control CO_2 emissions in the target sectors.

In fact, only a few options really entered the fray for serious consideration. Extending the Climate Change Agreements was a possibility, but the transaction costs of trying to extend a sector-by-sector negotiated targets approach would hugely constrain its scope in the commercial sector. Another option considered was placing the obligation on energy suppliers – in effect extending the existing Energy Efficiency Commitments through which suppliers are required to help households (e.g. by offering free low energy light bulbs); however this would take responsibility for energy management out of the hands of the major energy consuming companies

and force it to a measures-by-measures approach, with high transaction costs and uncertain returns.

Indeed, having accepted that there was a serious gap in the existing coverage that had to be addressed, the only other option that survived through to the UK Energy Review (DTI, 2006 [12]) was a mandatory requirement for service sector companies to report their carbon emissions. The UK Department of Trade and Industry argued that if the driving argument was the behavioural impact of the EPC proposal, then most of this could be achieved simply through the reporting function without the need for an actual cap-and-trade structure. In the final analysis, this argument lost out. Analytically, the case was made that energy efficiency decision-making could not be reduced to an 'organizational or economics' choice – the financial incentive would reinforce the organizational changes of the reporting requirements, and vice-versa. And politically, as one insider remarked – the EPC would be adopted in the UK Energy White Paper (DTI, 2007 [6]) because, at the end of the day, it was almost 'the only big new thing' that the government had available to announce as a concrete new outcome from its years of analysis since launching the CCP Review.

Policy	Coverage	Promotion of Energy Efficiency	Extent of CO_2 Reductions	Certainty of Reductions	New and Existing Stock	Minimises Administrative Burden	Overall NPV
EPC	✓✓✓✓	✓✓(✓)	✓✓✓(✓)	✓✓(✓)	✓✓	✓✓✓	✓✓✓
EU ETS	✓✓	✓✓	✓✓	✓✓(✓)	✓✓	✓	×
CCAs	✓✓	✓✓✓	✓✓(✓)	✓✓	✓✓	✓✓(✓)	✓✓
Mandatory Reporting	✓✓✓✓	✓(✓)	✓(✓)(✓)	✓	✓✓	✓✓✓✓	✓✓
Stronger Building Rules	✓✓	✓(✓)	✓✓	✓	✓	✓✓(✓)	✓(✓)
UK ETS	×	✓	×	✓	✓✓	×	×
Carbon Trust	✓	✓✓	✓	✓✓	✓✓	✓✓✓	✓(✓)
Business Rates	✓✓	✓	✓(✓)	✓	✓✓	✓✓✓✓✓	✓
Target Group EEC	✓✓	✓(✓)	✓✓	✓✓✓	✓✓	✓	✓
Supplier cap-and-trade	✓✓✓✓	✓(✓)	✓✓(✓✓)	✓✓(✓)	✓✓	✓✓✓	✓(✓)

Figure 6. Summary Assessment of Policy Options

Source: DEFRA (2007a) [13]

In moving from concept to specific design, three main issues dominated the debate.

5.1. Auctions and money

The first concerned money. The original Carbon Trust proposal was that all allowances should be auctioned, to avoid all the complications of allocating free allowances, but that this should be done in a revenue-neutral way, in part because the sectors were already paying the CCL (and also, due to pass-through of EU ETS costs). The obvious way to do this was to offset auction costs against reduced payments of the CCL. The government retained the commitment to revenue neutrality, but the UK Treasury made it plain that CCL revenues were sacrosanct and it would not accept their replacement by a new and less certain source of revenue.

This led to a tortuous debate about options for returning auction revenues to the participating sectors. The final decision on the design of the CRC stipulates that the revenue raised through the sale of allowances will be recycled to those participants qualifying for the first phase of the scheme proportional to their 2010 emissions. In addition, the auction revenue will be adjusted by a bonus or penalty depending on performance in a CRC league table. The bonus/penalty rate will start at +/- 10% and will increase each year until it reaches +/- 50% in year 5 of the introductory phase.

The main metric for the league table will be a rolling average of participants' emissions which will relate to the previous 5 years. A 5-year rolling average rather than a long-term average allows for a fairer assessment of organisational performance that is not unduly affected by growth or decline outside of the 5-year period. An early action metric will also be included in the introductory phase of the CRC only. This metric rewards organisations for voluntary efforts undertaken before the programme launch; it will be calculated according to the proportion of total emissions covered by Automatic Meter Reading (AMR) and those covered by the Carbon Trust Energy Efficiency Accreditation Scheme (EEAS).

The intent is that recycling revenue by incorporating a performance-based bonus or penalty will provide further incentives for emissions reductions and energy efficiency improvements. The substantial net present value benefits identified in the CRC Partial Regulatory Impact Assessment (PRIA) are dependent on strong incentives to drive energy efficiency among CRC organisations. (DEFRA, 2008a [14]; DEFRA, 2007b [15]).

From an early stage, the question was raised as to risks of allowance prices rising to extreme levels, given the perceived uncertainties in trends and implementing effective emission reductions from the relevant sectors. Suggestions that companies should be allowed to comply by purchasing offsets (credits from domestic or international emission-reduction projects) were resisted. Requests for the qualifying carbon intensity of electricity to be varied depending upon the supplier, allowing zero carbon from 'green tariffs', were also rejected: since renewable electricity is incentivised through other mechanisms, green tariffs are frequently no more costly than normal tariffs and thus counting these as zero carbon would have largely removed the incentive to improve electricity efficiency, which was a core objective of the scheme, and raised unfathomable questions about the additionality of such attributed emission savings.

However, two steps were taken to mitigate the risk of price spikes: a 3-year phase in with fixed prices is established (as explained below), to build up a track record of data and experience; and when the CRC subsequently moves to auctions, it will have a one-way 'safety valve' link to the EU ETS, enabling participants to comply by purchasing and retiring EU ETS allowances through the scheme administrator – the Environment Agency. The EU ETS price will thus set a ceiling on CRC allowance prices, and through this the CRC will also be indirectly linked to elements of the emerging global carbon market.

5.2. Scope: coverage, administrative costs and definition of participants

The second area of debate concerned the scope to which the instrument should apply, a debate largely driven by the extent of coverage and the potential administrative costs. With implementation burden a common concern of business, one early study commissioned by the government as it began to consider the idea was to examine how these costs might vary for different organisations. By estimating the time spent on participation procedures, consultants produced a matrix indicating the risk that these costs would actually exceed the potential value of additional energy savings, as a function of the overall energy bill and the number of sites.

This was an interesting approach in several respects. It sought explicitly to evaluate and monetise the administrative load on companies, but traded this off against the assumption that participation in the scheme, through the behavioural impacts and additional supports (e.g. information services) associated with participation, would lead these companies to save 5-10% on their energy bills. The fact that such savings, which were intrinsically identified as 'cost effective' in their own right, were attributed to scheme participation and not significantly challenged, seems a testament to the conviction that became attached to the behavioural analysis. No explicit value was attached to the value of emission savings, however the approach was clearly in line with an informal attempt to identify and avoid applications in areas of seriously 'diminishing returns' from small participants that could contribute little to aggregate energy and emission savings.

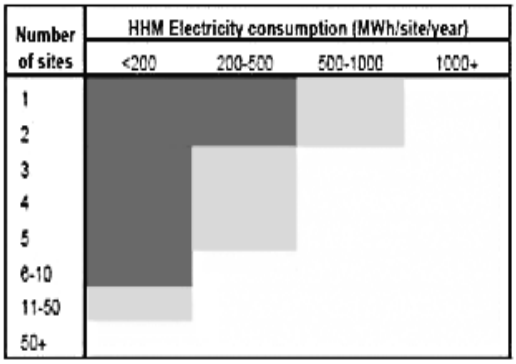

Figure 7. Risk of administrative costs exceeding the value of energy savings arising from participating in the CRC.

Source: DEFRA (2006) [16], Chart ES-2

Note. HHM = Half Hourly Metered electricity consumption. Assumes full cost of day of management time is £500 and that the person-day requirements for participation are as detailed in source. Companies in top left (dark) segments would still be worse off if they reduce fuel bills as a result of participation by 10% (i.e. administrative costs would exceed 10% of their energy bills); those in middle region if they saved 5%. Others (lighter shading) would be net beneficiaries if they save at least 5% of their energy consumption as a result of participating in the CRC (at c.2004 energy prices).

Basic infrastructure decisions also played a big role in the final decisions on scope. Notably, there is much greater confidence in data from sites that have half-hourly electricity meters. There are over 100,000 such sites in the UK, accounting for around 160,000 GWh of electricity consumption, and the analysis estimated measurement errors of less than 1%. This provided a convenient focal point for defining scope. In the final design, the CRC will involve all public sector and commercial organisations in Great Britain and Northern Ireland that (i) have at least one half-hourly electricity meter settled on the half-hourly market and (ii) consume more than 6,000 MWh of electricity per year – a very conservative interpretation of Figure 7, focusing the scheme on the bottom right couple of segments. Organisations that have voluntarily installed half hourly metering will also be included as many of these have been installed because the organisation's consumption was at one time over the threshold. Qualification for the scheme is based solely on

electricity usage, however once the scheme begins organisations will be required to calculate all UK-based CO_2 emissions from all fixed point energy sources, i.e. electricity, gas and other fuel types such as LPG and diesel.

In terms of the emissions that will be included within a company, a *de minimis* approach is used to avoid undue monitoring and administrative cost, so that certain small sources can be omitted. Reporting is based on sources of emissions rather than on specific sites and organisations are required to include all of the following 'core CRC sources':

- Electricity from half-hourly meters. All electricity consumed through meter profile classes 5-8.
- All daily-read gas meters
- All non-daily-read gas meters consuming more than 73,200 kWh per annum

The carbon intensity of electricity will be based on the five-year rolling average emissions factor for the national grid, currently 0.523 kg/CO_2/kWh. Emissions factors will be revised only at the start of each phase and it is envisaged that using a relatively short rolling average will keep any changes between phases to a minimum. Using a single electricity emissions factor also takes emphasis away from how the electricity has been generated and places it firmly on the energy efficiency actions of the CRC organization. National standard emissions factors will be used to convert all other energy use into CO_2 emissions as was the case under the UK ETS. For example, the UK ETS emissions factors for natural gas, coal and petrol were 0.19, 0.30 and 0.24 kgCO_2/kWh respectively.

At least 90% of CRC organization emissions must be included in the CRC, EU ETS or CCAs, not including transport which falls outside the scope of the CRC. Any organization not meeting this threshold through inclusion of the 'core CRC sources' will be required to include other smaller emissions sources to reach the 90% level (DEFRA, 2008a [14])

The other issue then to be addressed was the actual definition of the legal entity to be held accountable. Given the complexity of corporate ownership structures (and public sector interrelationships) and given the foundation of the CRC in the analysis of organisational behaviour, this was important in

determining how responsibility for emissions would be assigned and how energy efficiency would ultimately be managed. The final design adopts a top-down approach where the highest UK parent organisation is responsible for participating on behalf of the entire organisation defined as the CRC participant. Unless an alternate is agreed, the highest UK parent, is then responsible for reporting all energy use emissions covered by the scheme, emitted by all its subsidiaries, and for buying and surrendering allowances and receiving the recycling payments.

Legally speaking, the responsibility for energy-use emissions will lie with the organisation that is 'counterparty to the contract for the supply of that energy'. This will refer in most cases to the organisation that is contractually liable for the debt for the energy. In certain scenarios, such as procurement, franchises, and private finance initiatives (PFI), responsibility will vary depending on the contractual arrangements in place.

Following a top-down approach in this way is in line with the main aim of the scheme: to ensure energy efficiency is placed at senior management level within CRC organisations. Focusing not just on financial incentives but also on corporate social responsibility drivers is necessary to achieve this aim, largely because energy costs typically represent only 3% of total operating costs and also due to budgetary complexities, including in the public sector. Indeed there was considerable resistance to including public sector organisations in the scheme – which frequently have worse energy management than companies. Eventually however, Ministers accepted that it would be politically untenable to exempt public sector organisations from such a scheme, and overruled objections from, for example, Education and Defence departments. The government proposes that Health Service (NHS) bodies that are legally distinct and meet the qualification criteria should participate in their own right, although the details are currently under government consultation (DECC, 2009a [18]). The requirements to report on emissions and to use benchmarks in order to compare performance will open a new level of transparency not only between organisations, but also between public and private sector energy and emissions performance.

5.3. Timing, phase-in and auction design

One big lesson from the EU Emissions Trading Scheme was the difficulty of launching a scheme with inadequate data, and the time it took companies

to get used to the systems involved. The idea of an immediate mandatory cap on direct and indirect emissions from the service sector was daunting and full of risks if base data and systems turned out to be inadequate. For these reasons it was agreed to phase in the scheme with a 3-year period of fixed price allowances, after which it will switch to auctions under an absolute cap.

The Climate Change Act (2008) [19], which became law in November 2008, contains enabling powers to introduce new trading schemes, such as the CRC, through secondary legislation. Following the Acts passage into law, the UK government issued a final consultation on CRC draft regulations, this time focusing on the draft legislation that will implement the CRC. During 2009, the Environment Agency, who will be administering the CRC, will contact all UK billing addresses with half-hourly meters in preparation for the three-year introductory phase which will commence in April 2010.

During the introductory phase, allowances will be sold at a fixed price, provisionally set at £12/tCO_2. The phase is designed to allow organisations the time to become familiar with the way the scheme operates. It will also generate emissions data that will help the government to set an appropriate cap in the subsequent phases of the scheme. The Committee on Climate Change will act as advisor in the cap-setting process. The first sale of allowances will take place in April 2011, on a financial year basis. Participants will be allowed to use allowances from the first sale to cover their actual emissions from 2010/2011 and their forecast emissions for the 2011/2012 financial year. For all subsequent years of the scheme, allowances can only be used to cover current or forecast emissions, not to make up for previous shortfalls. The first recycling payment will take place at the end of October 2011; the gap between the allowance sales and recycling of allowance revenue will thus be reduced to 6 months (DEFRA, 2008c [20]), compared to the initial 18 month gap implied by the initially proposed structuring.

From 2013 – co-incident with Phase III of the EU ETS - auctions will take over from fixed prices. A limit will be placed on the number of allowances available to participants and the number available will decrease each year in line with the emissions reduction targets to 2020. During the capped phases, participants will be required to bid for allowances according to a sealed bid, uniform price auction. Under this type of auction design, participants submit a simple bid schedule specifying the amount of allowances they

would be willing to purchase at a range of different prices according to predicted energy use and carbon abatement strategies. The bids are aggregated to form a scheme-wide demand curve for allowances to establish the market-clearing price. Each participant is then awarded the number of allowances bid for at this price.

6. Potential energy and CO_2 impact of the CRC

The impact of individual policy instruments is complex, evolves over time, and also interacts with other instruments. Total impacts can only be plausibly assessed with models that capture many of these factors, including the overlaps between instruments. To test the potential impact of the CRC, DEFRA commissioned consultants to investigate the costs and benefits of various CRC scenarios in order to take forward the design of the policy initially proposed by the Carbon Trust. On the basis that the costs of participating for many small organisations would outweigh the benefits, the government's updated Partial Regulatory Impact Assessment in 2007 included only two scenarios: the first includes all organisations with electricity consumption greater than 3,000 MWh and the second only those with consumption greater than 6,000 MWh. These two scenarios were compared with a business as usual approach and also a voluntary benchmarking and reporting scheme.

The analysis of the impacts of the CRC applies a combination of BRE's abatement cost curves for the non-domestic sector and the ENUISM model for manufacturing energy use. Overlaps with existing policies, e.g. the EU ETS, Energy Performance of Buildings Directive (EPBD), and smart metering policy for business are taken into account in the estimation of benefits. The final Impact Assessment [21] estimates that implementation of the CRC from 2010 for all organisations above the 6,000 MWh threshold – i.e. those covered under the final policy design described earlier – covers approximately 14.5 MtC and is estimated to lead to around 0.4 MtC savings per year by 2015, and around 1.1 MtC by 2020 (about 4MtCO2). These carbon savings translate into savings on energy bills of approximately £1,779 million at a 10% private discount rate, or £2,132 million at a 3.5% social discount rate. Furthermore, it is estimated that the CRC will contribute to an improvement in the climate for energy efficiency investments where there is a landlord-tenant relationship. This

improvement will enable the EPBD to be more effective and is estimated to produce a further 0.1 MtC per year from the sector by 2020.

The allowance price assumed in the analysis is £16/tCO_2; CRC organisations are assumed to adopt abatement opportunities at all prices up to the marginal abatement cost. The assumed time horizon for the CRC is 15 years and energy and carbon savings are still counted for up to 8 years after the end of the scheme. Based on a private discount rate of 10%, the CRC is estimated to have an overall net present value (NPV) of £1,034 million; and using the social discount rate of 3.5%, the NPV is estimated to be £1,412 million (DEFRA, 2007b [21]).

7. Conclusions

The CRC is an intriguing policy development. Against a background of long-identified technical potential for energy efficiency as the most cost-effective means to reduce emissions, contrasting with a general policy preference and belief in the efficiency of markets-based policies, the CRC itself is something of a hybrid: an emissions trading approach designed largely to address a behavioural barrier. It was borne out of a survey of the coverage and impact of existing instruments, which identified a gap relating to one of the fastest growing areas of UK energy demand. The proposal is based squarely on empirical evidence; the theoretical justification, in terms of satisficing-type behavioural and organisational theories, was largely acknowledged afterwards.

Turning the basic idea into a practical application required addressing numerous issues around scope and detailed design. Some of the resulting complexities – such as the need to define boundaries for emissions and the legal definition of participants – are unavoidable. A phase-in period for such a new instrument makes sense. Other complexities are borne of the specific UK circumstances. Notably, the revenue recycling mechanism makes the system far more complex than would have been the case without the need for revenue neutrality, or indeed if this had been achieved simply by giving participants a discount on (or exemption from) the CCL. By making the revenue recycling explicit and linked to the performance league table, the civil servants involved sought to turn this difficulty into an opportunity to reinforce the incentive effects. It is however unavoidably more complex

than would be the case for a simple auction, perhaps with other sectors subject to a broadly equivalent tax payment (as would have been the case if CRC participants had been exempted from the CCL).

The relationship of the CRC to other instruments will also be of interest. The existence of the CRC reflects that the EU ETS is intrinsically designed for large, industrial point sources, and is wholly inappropriate to the less-intensive, distributed emissions from light industry and service sectors; the 'safety valve' link with the EU ETS does however make the financial credibility of CRC caps dependent on the credibility of the EU ETS in Phase III. In the UK landscape, the boundary issues are complicated by the Climate Change Agreements that set (non-tradable) targets for a broad range of manufacturing industry prior to the EU ETS. The original Carbon Trust proposal suggested that successful introduction of the CRC could obviate the need for extension of the CCAs – whose targets originally extended to 2011 - and that instead CCA companies could move to either the EU ETS or the CRC, radically simplifying the UK policy landscape. The government has subsequently decided against this, and proposes to extend the CCA targets out to 2018 with a new round of negotiations.

The overall impact of the CRC remains to be seen, and it is to be hoped that the government will monitor its effects closely to learn as much as possible about the extent to which the hypotheses underlying its introduction prove valid. This will be hard to establish, not least because of the paradoxical effect of sharply rising energy prices during the period of scheme development. On the one hand, this means that the cost-effectiveness of the scheme overall is likely to be greatly enhanced, in terms of the value of energy savings relative to energy costs. At the same time, it will make it much harder to attribute any new and additional actions on energy efficiency specifically to the establishment of the CRC - thus the additionality of any actions will be much more difficult to establish. Still, if surveys and other sources do provide concrete evidence that the CRC is delivering managerial and behavioural changes – changes that may ultimately lead to 5MtCO_2 of cost-effective savings by 2020, along with associated benefits in terms of reduced national energy costs and emissions – it will prove to have been a major new addition to the toolbox of energy efficiency policies.

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