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a framework for more in-depth analysis in the
context of a post-2012 climate regime

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Abstract: This paper reviews the corporate climate strategies of UK FTSE 100 companies as part of a series of steps to identify the range of policy options in a future climate regime that might be successful in terms of securing environmentally effective and efficient long-term business response to climate change. Firstly the paper explores some of the conceptual issues implicated in the notion of corporate climate strategy and then identifies a number of important variations in the carbon management approaches of FTSE 100 companies. The bulk of the paper is devoted to an account of the motivations and drivers as well as barriers to carbon management activities among the FTSE 100 group. Based on the review, as well as the analysis of extant literature, the paper then identifies a number of critical issues that need to be explored in greater depth in order to generate more precise understanding of the significance of current carbon management activities of corporate actors. It also attempts to develop an analytical framework that could help to explore the nature of linkages between different features of a post 2012 climate regime and the corporate carbon strategies of major business organisations.

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1. Introduction

Over the last few years, some interesting research on corporate climate strategy has begun to emerge (Skjaereth and Skodvin 2003; Levy and Newell 2000; 2005; Hofman 2001; Kolk and Levy 2001; Dunn 2002; Kolk and Pinske 2004; Hoffman 2004; 2006). The growth in the literature on corporate climate strategy is apparently related to the seeming shift in the orientation and roles of corporate actors in the global governance of climate change. The shift is firstly, in the form of a transition from an essentially adversarial relationship with other actors supporting climate regulation to a more co-operative relationship characterised by frequent professions of a commitment to mutual respect and the need to work together in the search for effective responses to climate change (Kolk and Pinkse 2004). Perhaps the most striking evidence of this shift is in the recent proliferation of Business-NGO partnerships for climate action, including those involving historically antagonistic NGOs such as Greenpeace and Friends of the Earth (Cowe 2004; Colingwood 2006). The second and related is in the movement away from merely trying to influence policy debates to the pursuit of practical actions in the form of the design and implementation of various carbon management programs under the general rubric of corporate climate strategy. Although there have been commitments made by industry in the past (e.g. 1997 Keidanren voluntary action plan in Japan), there is now an unprecedented level of activity with countless number of business and industries now actively engaging in various kinds of programs and measures to address climate change in the context of the international climate change regime and (Levy and Newell 2000; Kolk and Levy 2001; Kolk and Pinske 2004; Hoffman 2006).

The concentration of literature on corporate climate strategy has however been on general description of business actions and less of classification and analysis (e.g Hofman 2001; Dunn 2002). The other prominent variation of which the Carbon Disclosure Project reports (CDP 1-4) is paradigmatic involve a quantitative account of the emission profiles of major industries and corporations. Both approaches generate important contributions to knowledge. However, the attempt to understand the actual dynamics of corporate emission reduction programs and the key factors that either drive or inhibit action has been relatively sparse (exceptions are Kolk and Levy 2001; Kolk and Pinkse 2004; Hoffman 2006). Kolk and Pinkse (2004:305) recently pointed this out when they observe that, whilst there has been an immense shift in the range and depth of corporate climate activities in the past decade, existing classification for climate change strategies remain somewhat rooted in the ‘corporate (political) activity’ in the early stages of the international climate regime development.

At the same time, despite the close connection between the international institution-based effort to tackle climate change (that is through the UN Climate regime and its Kyoto Protocol) and the shift in the orientation of business to climate change, the exact links between various corporate carbon management activities and the key features of current or possible future climate regime remain under-explored. As a result, it is difficult to articulate how various policies and architectures of a post-2012 regime might affect or be affected by alternative business strategies for climate change.

A new Tyndall Centre for Climate Research project of which this review study is a part aims to address some of these gaps. . Specifically, the essay explores the motivations, drivers and barriers to climate action among the UK FTSE 100 companies based on a number of different desk sources. The expectation is that the exploration would generate insights into the actual dynamics of corporate carbon reduction programs and in particular lead to a better understanding of the specific factor-policy blend needed to further leverage corporate action against climate change. Moreover, it is expected that such insights would prove helpful in terms of a better appreciation of the critical underlying motive behind the recent shift in the stance of corporate actors on climate change. It is also intended that the review study will yield results that would facilitate an insightful selection of cases for more in-depth

studies.

The paper first provides a brief description of the data sample and method of analysis. This is followed by an exploration of some conceptual issues around the notion of corporate climate strategy with some indications of their relevance to the main focus of the paper. Next, we provide a brief outline of the specific steps that UK FTSE 100 companies are taking to tackle climate change. The rest of the paper focuses on the exploration of the different factors that motivate, drive and/or inhibit business climate actions. Finally, we conclude by suggesting an analytical framework that might be used to generate more specific policy insights needed to leverage corporate climate action in a future international climate co-operative arrangement.

SAMPLE AND DATA

For the purpose of this essay, attention is focused on the climate activities of UK FTSE 100 companies. The UK FTSE 100 is selected as the initial focus of the study partly because the group comprises some of the most climate proactive companies in the world (Levy and Newell, 2000; Varma, 2004). Also, the UK FTSE group constitutes a very significant entity in climate change governance both in terms of quantity of emissions as well as influence on international climate policy.

The group comprises the 100 most capitalized blue chip companies listed on the London Stock Exchange. Component companies must meet a number of requirements set out by the FTSE Group, including meeting certain tests on nationality and liquidity. However, there are still some controversies over how corporate nationality might be defined. The UK FTSE 100 companies account for approximately 81% of the UK equity market. The group also has quite a number of companies that are listed in the US and other stock exchange markets. As at January 31 2007, the FTSE 100 index accounts for about 9.3% of the world's equity market capitalization. The FTSE index is the leading share index in Europe.

With respect to emissions, the UK FTSE 100 group is an extremely important entity both in the global but especially in the UK context. According to the CDP 4 report, the group was responsible for about 73% of UK's total greenhouse gas emissions between 2003 and 2004 (CDP, 2006).¹ Furthermore, majority of FTSE 100 companies are global players with business concerns (and considerable emissions) that span across various countries around the world. The UK FTSE group comprises quite a diverse number of sectors including oil and gas, electricity, mining, chemicals, transport, utilities and insurance. However, because the constituents of the index are determined quarterly on the basis of capitalization, the exact distribution of sectors varies from time to time.

In the bid to gain insight into the carbon management programs of the FTSE 100 companies as well as the motivations, drivers and barriers against action, a number of desk sources were utilized. The first set of documents studied was the CDP reports (CDP1-4). The concentration of effort was however on CDP 4 which covers the emissions profile of companies between the period 2003 and 2004. The CDP reports do not make any claim as to the motivation of actors but they were important in terms of ascertaining the emission profiles of companies and identifying those that might be adjudged to be pursuing notable climate actions. There are currently (June 2006) 42 FTSE 100 companies in the

¹ Emission from the FTSE 100 amounted to 480 million tonnes of carbon dioxide equivalent (CO₂-e) in 2003/2004. The total UK emission within the same time frame is about 656 million tonnes of carbon dioxide equivalent (CO₂-e) which is equivalent to 2.2% of the total global emissions. It follows that the FTSE 100 accounts for about 73% of the UK total share of global emission. This figure also represents about 1.6% of the total global direct carbon emissions. It is important to note that there are other methods of emissions calculation that does not yield similar figures.

database the CDP. Only the actors that have made explicit greenhouse emission reduction commitments, or have indicated that they will make emission reduction commitments are included in the CDP database.

The second and the indeed the main source of information were the respective websites of the FTSE 100 companies. These include both those of the companies in the CDP database and the ones that are not. These websites were searched between December 2006 and April 2007 with the help of some undergraduate students. As already noted, the vast majority of companies report their climate activities under the corporate social responsibility section of their website. Another important source of information was a Tyndall Centre database which provides information on the emissions reduction activities of over 3000 actors including about 458 companies. Data from these three key sets of documents were supplemented with information from other sources including published materials, press releases, and other relevant websites.

2. Corporate climate activities: strategy or social responsibility?

There is a huge difference in the way the term “corporate strategy” is used in business organizational studies and how it is used in climate governance scholarship. The standard approach in organizational literature is to distinguish between business and corporate strategy (Grant 1996; Cibin and Grant 1996). Business strategy here refers to the ways in which a specific firm or business unit attempts to stay competitive within a particular market or industry while corporate strategy refers to the influence of corporate-level factors (effects of integration and association of multiple firms under a single corporate structure) on the variance of business-level profitability among similar firms or industries. In other words, corporate strategy, here, refers specifically to the relative importance of corporate factors (as opposed to single industry or business units) in determining profitability differences between firms (Ghemawat 1994; Bowman and Helfat 2001).

In climate governance scholarship, however, the term corporate strategy is used in a far less technical way and quite broadly to refer to all the activities (including lobbying, planning or real actions) undertaken by a given business (industry or corporation) in response to the challenges of global climate change (Kolk and Pinkse 2004; Levy and Newell 2002; 2005; Kolk and Levy 2001; Hoffman 2006). Hoffman (2006:3) defines corporate climate strategy as ‘the set of goals and implementation plans within a corporation that are intended to reduce greenhouse gas (GHG) emissions, produce significant GHG-reduction co-benefits, or to otherwise respond to climate related changes in the market, public policy or physical world’. Another definition, adopted in CDP 4 describes corporate climate strategy as the process of ‘evaluating a company’s emissions, understanding risks and opportunities, setting priorities for action and communicating the results to key stakeholders, including investors’ (CDP 2006:2).

What is important is that in both definitions there is no distinction between corporations and firms, as in organizational literatures. Neither is there any explicit attempt to firmly link climate strategies with profit and competitive advantage. Although, the findings of this survey indicate that the climate activities of most corporations are increasingly linked with profit and market advantages, it is nonetheless the case that much of the literature on corporate environmentalism suggests that businesses have not only commercial but also moral obligation to respond to the threat of climate change and indeed to reduce greenhouse gas emissions (Newell and Paterson 1997; O’Riordan 2000; Humpherys 2001; Clapp and Davuergne 2005).

The above discussion hints to a much deeper argument on whether the climate activity of corporations is a matter of strategic business management or an issue of corporate social responsibility. Of course,

the focus of this paper does not allow for this argument to be pursued in detail. However, it is important to underscore the point that this distinction is not a matter of mere theoretical significance but one that could have practical implications on the actual climate efforts of corporations and the ways these efforts are analyzed. Le Menestrel and de Bettignies (2002) for instance have proposed a model that characterizes the climate responses of oil industries in terms of trade-offs between ‘socially detrimental processes and self-interested consequences’. They argue that the climate strategies of oil companies can be differentiated on the basis of whether priority is given to the egoistic economic rationality of companies (strategy) or to ethical values and the common good (responsibility). They suggest that oil companies that pursue climate activities on the platform of a genuine sense of responsibility would undertake deeper cuts than the ones whose actions are based on economic rationality (cf. Hove et al 2002).

At the same time, there is also a deducible argument that conceptualising corporate climate actions in terms of responsibility and ethical obligations rather than strategy provides a better plank in the bid to link corporate commitment to emissions reduction with the rights of the people to a quality environment (Friends of the Earth (FOE) 2007) This, of course has clear implications not only in terms of transparency and accountability (FOE 2007; Clapp 2005) but also with respect to litigations, legislations and corporate climate governance structures (cf. Smith 2003; Ahman 2006).

On the other hand, however, it can be argued that treating corporate climate response as a part of corporate social responsibility could lead to less deeper cuts than if carbon management were integrated into the strategic mainstream of business activities (Hoffman 2006; cf. Köhler 2006; Maack and Skulason 2006). There is a case that a transition from the exogenous and peripheral concerns implied in the social responsibility characterisation towards incorporating climate change as an explicit aspect of strategic business management and as an endogenous component of business model is crucial in making progress towards a carbon neutral economy. It is interesting however to see that these alternative characterizations, and their implications, have not really been seriously considered in research and practice.

The survey, for example, indicates that majority of the FTSE 100 companies are not mindful of the meanings and tensions implicit in these characterisations. Or to the extent that they are aware, they have chosen not to reflect on this point in their reporting. About 86% of the FTSE 100 companies have parts of their website dedicated to their corporate social responsibilities and it is under this section that almost all of those that undertake carbon management action place their reports. At the same time, nearly all of them express the view that they undertake carbon management program on the basis of the conviction that it is good for business and that it adds long term value to the stakeholders and nearly all of them also indicate that they have started or at least nurse the desire to mainstream carbon management into the core strategic operation of the business. Aviva in one place in its website refers to environmental concerns as ‘these “extra financial issues”’ while at the same time stating its commitment ‘to become the first insurer to carbon neutralise its operations on a worldwide basis’ (Aviva 2006) Again, all of these suggest that the question of whether carbon management is an issue of corporate social responsibility or business strategy as well as the possible implications of answering one way or the other has yet to receive adequate attention among businesses (cf. Husted and Allen 2000).

In this paper some effort has been made to demonstrate sensitivity to this tension. The effort is mainly in the attempt to differentiate between factors that *motivate* and those that *drive* business climate activities. Currently, these two concepts are mostly used interchangeably in the literature to refer to any thing that prompts businesses into taking climate action (Skjaereth and Skodvin, 2003; Dunn, 2002; Kolk and Pinske, 2004; Hoffman, 2006). However, building on the conceptual argumentation presented above, I use the term motivations for the factors that closely relate to the inherent concern of business for profitability and comparative advantage while reserving the term drivers for the factors

that would seem to emanate from the wider concern of the public and policy makers on the environment. This differentiation is of obviously difficult to sustain in practice because of some important overlaps between the two categories. But the difficulty is not a sufficient reason not to try because such a differentiation, to the extent that it is possible, would have important theoretical significance. Moreover, such insights would also be of crucial value in understanding or at least opening up the critical space for more rigorous research on the main logic underpinning corporate climate activity. On a policy a level, such insights would be of critical value in determining how best to leverage corporate involvement in future climate governance arrangements. From a critical point of view, it is not sufficient to note that corporate actors have moved from opposing international climate action to taking firm-based specific actions. Rather, in this view, the question of the underlying motives or reasons for the shift is equally crucial and significant.

3. Carbon Management in FTSE 100: Disclosure, Goals, Targets and Baselines

Information from the Carbon Disclosure Project (CDP) sources indicates that 55% of the UK FTSE 100 has quantified emission data but that only 42% has emission reduction commitments. Only the 42 companies that have emission reduction commitments are listed in the CDP database (CDP 2006).²

One of the first things one realizes on surveying the FTSE 100 companies is that there are serious variations in the ways that companies analyze and present information on their greenhouse gas emission profile as well as their reduction strategies and achievements. These variations occur at three main levels. The first is the *scope* of emission inventory. This refers mainly to the extent of GHG emissions related to the company that is covered in the emission inventory but also to the range of greenhouse gases that are included in the inventory. The second is the *metrics* used in tracking and reporting emissions. This often reflects variations in the ways business communicate their goals, targets and achievements. The third is in the *baseline* used by companies. These variations show a general lack of comparability in reporting emission which in turn raises serious problems for studies interested in cross-company climate processes assessments or performance evaluation.

3.1 Scope of Emission Inventory

Companies are generally exposed to greenhouse gas emissions at three different levels. The first is direct emissions arising from the company's own operation. The most significant under this category are usually emissions from boilers, gas flaring and those associated with energy generation, mining operations and heavy chemical productions. The second is emissions arising from the consumption of purchased electricity, heat and steam within a company. The third level of exposure is emissions from upstream and downstream sources. These include emissions from company's supply chain and those linked to company's goods and services. The second and the third levels are often regarded as indirect emissions (Dunn 2002; Kolk and Pinkse 2004; CDP 2006; Hoffman 2006).

The World Resource Institute (WRI) and the World Business Council on Sustainable Development have jointly developed a Greenhouse Gas Corporate Reporting Standard based on these three levels of exposure (Scope 1, 2 and 3). Scope 1 is limited to direct emissions; Scope 2 covers secondary

² The Carbon Trust (2006). The Carbon 100: Quantifying the Carbon Emissions, Intensities and Exposures of the FTSE 100. http://www.sefi.unep.org/fileadmin/media/sefi/docs/industry_reports/SRICarbon100Report.pdf

emissions while the most extensive is scope 3 which includes the above two types plus the indirect emissions from upstream and downstream sources. However, in the absence of any regulation, companies are at liberty to adopt whatever system best suits them in *inventorising* and reporting of their emissions and general carbon management programs. For example some companies might account for the ghg emissions of their products while others do not acknowledge product emissions in their calculations. It is even possible for a company to conduct an inventory of its emission profile based on scope 3 and only make public reports based on scope 1. Shell for example reports that its direct emissions is about 105 million tonnes of CO₂-e per annum while the emissions arising from the use of its products is about 750 million tonnes of CO₂-e. Scottish Power on the other hand reports only is direct emission but is silent on the quantity of emission associated with the use of its products in millions of homes in UK and US.

Moreover, despite the comprehensive nature of the Greenhouse gas Corporate Reporting Standard, there are still some unresolved issues such as the status of divested portfolio, offsets, biological sequestration and emissions from material transporting and commuting. Another point under this rubric is the issue of whether energy saving measures should be counted in as climate strategy or whether these two should be treated separately.

3.2 Emission Tracking and Reporting

The second variation observed is in the way companies track and report their ghgs emissions and by extension the ways targets, goals, performance and achievements are communicated. Many companies report in their website that they are mindful that whilst CO₂ is the main greenhouse gas (60%), it is still important to keep track of the other greenhouse gases such as Methane (CH₄), Nitrous Oxide (N₂O), Hydrofluorocarbons (HFCs), Per fluorocarbons (PFCs) and Sulphur Hexafluoride (SF₆). The Carbon Disclosure Project reports however indicate that many companies still report only their CO₂ emissions rather than in CO₂-e. The CDP reports also indicate that even among the companies that provide their emissions in CO₂-e, majority do not take the pain to give a break down of emissions into the six greenhouse gases.

Moreover, there are variations in the kinds of metrics that are used by companies to report emissions and carbon programs. While some companies present their goals, targets, and achievements in absolute terms others use the index system whereby reductions or performances are correlated to financial, economic or production measures. Of the index system, three approaches are the most popular. The first is tracking emissions relative to the unit cost of production. The second is tracking emissions relative to the energy input and the third is tracking emissions relative to overall turnover (The CDP 2006). There are several companies among the FTSE 100 that use a combination of different approaches. Prudential reports that it achieved an absolute 35% reduction in CO₂ emissions between 2001 and 2003. Similarly, BP reports an absolute reduction in emission of 14% between 1998 and 2004. It has now set a new target of ensuring that net emissions do not increase between 2001 and 2012. Rio Tinto on the other hand communicates its climate efforts in index form. The company reports that it has reduced on-site GHG emissions per unit of production by 4.8% from 1990 levels by 2001. Similarly, SabMiller reports that from FY04 to FY05, it has achieved a 0.64% reduction in greenhouse gas emission per barrel of beer produced. Reckitt Benckiser and Alliance Boots are among the many companies that adopt a combined approach in tracking and reporting emission profiles. Reckitt reports that it reduced emissions greenhouse gases by 3% per unit of production in 2005 and actual emissions were reduced by 13% since 2001. Alliance Boots, in addition to reporting an absolute reduction of 22.9% from a 2001 baseline says that it has achieved a reduction of 37 tonnes per £million turnover against a target of 43.2 tonnes per million turnover. In addition to reports on

absolute reduction and reduction per unit production, Unilever also specifically reports energy efficiency reductions. The company announces a reduction of 7.7% in load of CO₂ per tonne of production, a 6.4% reduction in absolute load and 4.9% reduction in total energy use.

Lastly, there is also the problem of unit inconsistencies. While some companies use “tons” in reference to metric tons, others use the term “tons” in reference to short tons. In general companies are not sanguine about the total emission reductions so far achieved under their carbon management programs. Of the 42 companies that have formalized emission reduction program, only 14 provide data on the total emission reduction achieved to date (see CDP 2006).

3.3 Baselines

Surprisingly, a vast majority of companies tend to side-step the issue of base line in their reports. Of the 42 companies that have formalized emission reduction programs, only 20 provide a base year (The CDP 2006). The CDP survey shows that there is a difference factor of up to 16 years in the baselines reported by companies. The base year provided range from 1989 to 2005. The most common base year is 1990 followed by 2004. In terms of sectors, the chemical industry has the earliest base year of 1990. Conversely, there are only 10 companies out of the 42 companies that do not have an end date for their commitments. The end dates for commitments ranges from 2004 to 2014 with 2010 being the most popular end year.

4. Climate Response Activities of FTSE 100 companies

Previous attempts to classify corporate strategies, as Kolk and Pinkse (2004) have recently observed focused mainly on the development of a continuum. Most of these were based on the political stance of corporate actors on the climate debate. On this basis corporate climate strategies have been classified in terms of proactive, accommodative, opportunistic, defensive and reactive actions (Clarkson, 1995; Kolk, 2000; Kolk and Pinkse, 2004). In recent times, the focus has shifted to the development of typologies that aim to capture the firm-based emissions reduction activities of companies. To this end classifications such as product versus process oriented, internal versus external, direct versus indirect and radical versus incremental have all been adopted (Kolk and Pinkse, 2004; Hofman, 2002; Hofmann, 2002; 2006). In keeping with the ambition of the paper to open up the critical space into a deeper understanding of the actual dynamics of corporate carbon strategies, I do not adopt any of above mentioned typologies. Rather, I attempt to provide a list of the specific actions that companies are taking to reduce greenhouse gas emissions. However, while the list is intended to be helpful in terms of understanding the actual carbon management steps of corporate actors, it has to be said that the classification is still a bit arbitrary and contains many overlaps.

In practice, there are about 10 specific steps that companies take in response to climate change (cf. O’Riordan 2000; Hoffman 2006). These include:

1. *Basic (“non-fundamental”) technological change.* This step involves the instalment of new or replacement of existing office equipment and machinery with the bid to curtail in-house GHG emissions or increase energy efficiency. Basic (non-fundamental) technological change can be further divided into three categories on the basis of cost. Small: Low energy bulbs; motion sensors; compact florescent tubes; telephone conference video technology, installation of hand driers. Medium: Refurbishing of company’s property; changing operating systems; changing windows; re-organization of (working/office arrangements). High: Replacement of cooling towers, generators, boilers; insulations; installation of waste heat recovery facilities; heat traps; changing of smoke stacks; vehicle tailpipes.

2. *Basic (“non-fundamental”) behavioural change.* This step involves non-fundamental change in the behaviour of employees designed to reduce company’s GHG emissions. Examples include double-sided printing; reducing printing rate; switching off light during non-office hours; separating and recycling waste; turning off or turning low heating and cooling systems; use of hand driers; use of telephone and video conference technology; reduction in travelling rate. 1 and 2 are often said to be “*low hanging fruits*” because they are relatively easy to implement and often lead to reduction in energy consumption.

3. *Finding new use(s) or market for existing products.* Companies now make concerted efforts to explore the possibilities of developing alternative or multiple uses of their CO₂ products as part of their carbon management strategies. Shell reports that in 2005, its refinery in Pernis Rotterdam began supplying Dutch greenhouses with pure CO₂ produced from its hydrogen-making plant through a consortium called Organic CO₂ Assimilation for Plants. In so doing shell found a new market for its captured CO₂ thereby reducing its emissions. Shell is equally persuaded that the Dutch farmers are saving money and energy since the pure CO₂ it supplies works out cheaper than the use of gas heaters in the operation of their greenhouses. Shell reports that the total emission reduction is approximately 325,000 tonnes of CO₂ a year.

4. *Developing new products to satisfy emerging markets or developing of low-carbon products.* The global effort to combat climate change is steadily creating market for new products. In some cases need is emerging for completely new products; but in most cases the trend is in the creation of low carbon products to replace exiting carbon intensive ones. AstraZeneca for example claims that it has reduced the total emissions of CFCs emitted by their inhalers (used as a propellant in the inhaler) by 97% by 2006 and they expect to have eliminated all such uses by 2010 (AstraZeneca 2006). Unilever has recently commenced life-cycle assessment for their products to target certain energy intensive aspects in the manufacturing and use of their products with a view to exploring how to redesign to achieve greater carbon efficiency (Unilever 2007).

5. *Investment in sustainability portfolios.* This covers all investments in low-carbon and process related technology including renewables. Examples include investment in alternative energy such as wind farm, solar, biomass, and water. It also includes investments in large and medium scale waste management or recycling plants and schemes. The 3i Group recently made an investment of \$30 million in a Belgian renewable energy company called Electrawinds. Their recent portfolio includes over ten companies across three continents. They also have investments in a number of businesses developing fuel cells, wave power and water purification systems (3i Group 2006). There is also noticeable growth of interest in quoted sustainability small-medium capitalized growth companies such as those specializing in manufacturing, building, installation or services of carbon neutral products (Environmental Agency 2004).

6. *Acquisition of assets that balance company’s sustainability portfolio.* The acquisition of another company could have either a positive or a negative impact on the over all carbon emission profile of a company. Although profit rather than carbon profile might be the prime consideration in acquisition decisions, companies are increasingly giving thought to the extent to which an acquisition affects their

carbon profile. Similarly, a growing number of companies are now actively considering the option of disinvesting from carbon intensive industries. For example Aviva, the largest insurance group in the UK now has the policy of not investing in carbon intensive industries in favour of those with lower carbon technologies. They have increased their demand of renewable-sourced electricity - 100% in the UK, 20% in Ireland, and 20% in the Czech Republic.

7. Fundamental technological shift and innovations. This step is often described as the “game changers”. This could involve deep transformations in the operation focus or method of operation of companies. Such transformation might be traced to fundamental changes in feed stock, mode of manufacturing, redesign of process machines; recovery/conversion of major polluting unintended waste product into good use. Examples include bio-fuels, use of biomass feedstock, new generation nuclear energy plants, carbon capture and storage/sequestration, radical improvements in clean energy technologies, integrated gasification combined cycle (IGCC) technology.

8. Participation in internal or external emission trading and offsetting schemes. It is rather curious that there are less than 10 of the FTSE 100 companies that participated in the just ended voluntary UK emission-trading scheme. On the positive side many more of the companies are taking part in the ongoing European Union Emission Trading Scheme (EU ETS). On the other hand, carbon offsetting has become hugely popular among the FTSE 100 group in the last two years even though the extent to which offset should be regarded as an emission reduction measure remains a moot question. HSBC reports that it has offset its emission for the last quarter of 2005 (bought 170,000 tonnes of “offsets”) by investing in renewable energy projects such as wind farm in New Zealand and biomass cogeneration in India (HSBC 2007). Another bank, HBOS plc reports that it will be carbon neutral by the end of this year. The group claims that it’s operations are already 65% carbon neutral –mainly through the purchase of green electricity (HBOS 2005).

9. Clean Development Mechanism (CDM) and Joint implementation. The CDM allows companies to invest in low carbon projects in non-Annex I countries and to win emission credits based on the emissions that would have occurred without the project. Joint implementation operates on a similar system but is based on activities between (companies domiciled in) Annex 1 countries and Countries in Economic Transitions.

10. Public and school education. BP has announced plans to launch an education program called *Carbon Challenge* in secondary schools by September 2007. The programme, which will be integrated into the school curriculum, is designed to deal with topics such as carbon footprinting and energy saving strategies. BP reckons that the program will reach over 400 schools and target about 60,000 14-16 years old each year (BP 2007). Sky has developed a website called “The Bigger Picture” which shows news about the environment and climate change as well as how people could increase energy efficiency in their day to day lives (Sky 2007).

It is important to note that companies rarely adopt one method to the exclusion of the others. In most cases, the exact steps a particular corporate actor can take are dependent on a number of factors including location, sector, area of focus and unique challenges being faced by the company. One implication of this is that what counts as a major or fundamental step for one company might not count for a different corporate actor.

5. Motivations, drivers and barriers to change

An insightful analysis of the corporate climate strategies of companies requires not just an understanding of what companies are doing but also the underlying reasons for actions and the obstacles in the path of progress and change. Such an understanding is quite crucial in developing the mix of policies that would facilitate meaningful participation and substantial emissions reductions by industry actors.

This section outlines the key motivations, drivers and barriers to corporate climate actions among the UK FTSE 100 companies. As noted, most literature on corporate climate governance uses the terms motivation and drivers interchangeably to refer to the wide range of reasons and incentives for which corporate actors undertake climate response programs (Dunn, 2000; 2002; Hofman, 2002; Kolk and Pinkse, 2004; Hoffman, 2006: 21-22). I have earlier indicated that I adopt a slightly different approach here. The basic difference is that I attempt to distinguish between motivations and drivers. I use the term motivation to refer to the factors that can be said to emanate more or less directly from the innate inclination of business to maximise profit. Building on this, I suggest that motivational factors on their own are capable of inciting corporations to undertake carbon management actions *even in the absence of any form of direct external* (regulatory and public) *pressure*. Ethical considerations are included here to the extent that it is arguable that some companies are genuinely motivated to take climate actions for the purpose of the environment even without external pressure. However such ethically motivated actions are very well known to be pursued only insofar as they do not harm profit.

On the other hand, I reserve the term drivers strictly for the factors that have the potential to “force” corporations to take climate response *action even when they would not have ordinarily wanted to do so*. Clearly, the main source of such external pressures are usually governmental regulations and both public and NGO pressure. I however include investor’s pressure under this category because although this aspect is closely associated with profit, it has been shown in the past (whether, it be with respect to arms trade, child labour, women’s oppression etc) that investors generally demonstrate a greater level of sensitivity to wider social concerns than the core management. This is more so the case now that the reality of the global financial market operations makes it relatively easy for investors to transfer their investments (and loyalty) from one company to another in a matter of minutes. Of course, things are rarely “black and white” in practice and as such it has to be admitted that there remain some overlaps between the sub-categories. Nevertheless, the distinction between motivations and drivers, I suggest, is important not just for the purpose of facilitating a more robust conceptualisation of corporate climate activities but also because such an understanding can both inform policy and help in the prediction of change

5.1 Motivations

The broad review indicates that there are six key factors that motivate the FTSE 100 companies to undertake carbon management activities. These five include:

Profit

This is apparently the greatest motivation underpinning company’s carbon management programs. The need to make an economic case for corporate climate action is almost a slogan in the business community. It would appear that many managers feel as though this is the only way to communicate the need for climate action to their employees. Nearly 100% of the FTSE companies that report on climate

change actions on their website made a link between profit and carbon management. Interestingly, companies do not seem to be reticent in reporting on exact amounts of money saved due to carbon management programmes where such figures are available. Shell reports that energy efficiency measures taken in its refineries in 2005 resulted in an annual savings of about \$60 million (Shell 2005). Alliance Boots reports that its Carbon management programme resulted in savings of between £1million and £2 million out of an annual energy budget of about £20million. In the year ending December 2005 Aviva reported that it had reduced group-wide paper consumption by 967 tonnes (an 11% reduction from on the previous year) and that it's combined car fleet has reduced by 679 vehicles. All of these, the company says have resulted in massive financial savings for the company.

Credibility and Leverage in Climate Policy Development

Most FTSE 100 companies appear to understand that the concern for climate change at national and global levels would ultimately lead to some fundamental shifts in the way businesses conduct their activities. Although there are still some uncertainties, the trend and direction are becoming increasingly clearer. Crucially, business knows that climate change will have serious effect and even more importantly that, in the end, there will be losers and winners. Given this scenario, many appear to have taken the stand that it is better to be proactive rather than oppose the political currents. Their reasoning appears to be that by being proactive and pioneers in undertaking climate activities; they would gain credibility and the leverage that enables them to play active roles in deciding the exact direction of change. Shell is one of the companies that are explicit on this point. In its website, Shell emphasizes that it is uniquely equipped to contribute to the development of effective climate policy both nationally and at the international level because of its experience in "in-house emission trading scheme" (Shell 2007). Shell reports that it actively supported the establishment of the European Union Emission Trading Scheme (EU ETS) and offered valuable advice in the process. Similarly, Aviva reports that it is proud of its close relationship with UNEP and in particular of being a member of the UNEP's Financial Initiative Climate Change Working Group. The company also reports that it was in the forefront of coordinating the contributions of the Associations of British Insurers (ABI) input to the Stern Review on the Financial Cost of Climate Change and concludes that the experience it has gained from operating in 25 different countries around the world makes it "well placed to make a positive impact" in developing climate policies and educating others on the environment (Aviva 2007).

Ethical Considerations

There is an extensive literature on ethics and business strategy much of which predates but bears striking resemblance with the corporate climate strategy discourse. In this case the debate centres on the compatibility between ethics (morals) and corporate strategy conceived in terms of the desire to maximise profit. The original perception was that business strategy is primarily incompatible with ethics and morality (Smith 2003; Greenfield 2004). More recently, however, the literature and indeed many CEOs have begun to take side with the argument that ethics is not only compatible with, but is indeed an integral aspect of corporate business strategy (Husted and Allen 2000). Many organisations within the FTSE 100 companies make a clear link between their reputation and the value of their portfolio. Majority of these companies argue that the cost of doing the right thing (and being seen to be doing the right thing) is more than adequately compensated for by the trust they gain from the customers and the general public. Others go further to make it explicit that such trust very well translates into market advantages for their companies.

The implication of this, quite clearly, is that it is extremely difficult to quantify the extent to which

ethical consideration alone (that is the desire to do the right thing) accounts for the climate actions of the FTSE companies or any other group of corporate actors for that matter. Nevertheless there are reasons to believe that some companies are genuinely concerned with the impact their operations may have on the state of the environment and are willing to take positive actions to ameliorate the situation especially to the extent that such positive actions do not severely affect the fortunes of the companies.

Fiduciary Obligations

Most chief executives now admit that they are beginning to consider climate change as a matter of fiduciary concern (Hoffman 2006). Consequently, they feel that it is part of their responsibility as leaders of their organization to make a strategic assessment of the possible impact of climate change on their business and to take the range of actions that would benefit the company in the long run. The nature of fiduciary obligation is that a party reposes trust and confidence on another and subsequently expects such one to whom confidence has been reposed (the fiduciary) to act on behalf and in the best interest of the party by exercising his professional expertise and discretion. Chief executives who consider climate change a matter of fiduciary concern feel that even in the absence of immediate shareholder pressure or binding climate regulation, it still behoves them to exercise all the skill, care and diligence at their disposal to ensure that their businesses are not unduly disadvantaged in the long run as a result of their inaction on the issue of climate change (CDP 2006). In other words, corporate climate actions, on this occasion are justified on the basis of the desire to confer possible market advantage on a company or at least to steer such a company away from the possible losses that might arise as a result of future market shifts or regulations.

One other important reason for considering climate change as an issue of fiduciary concern in addition to possible future regulation and market shifts is legal action. Although there is not yet any precedence among the FTSE 100 companies, the climate impact of some corporations in the US has recently been a subject of litigation and there are reasons to believe that the trend will increase. In the event that the climate impact of a corporation might become an issue of litigation, most chief executives would feel that it is prudent to secure their businesses against the possible court charges that could possibly result from such legal actions.

Guiding against Risk

Majority of the companies have recently begun to emphasize the need to move away from seeing climate change only as a challenge and risk to business towards viewing it as presenting both challenges and opportunities. Those within this category reckon that climate change would not eliminate the need for business but rather that it would lead to the demand for new or different kinds of products, services and investments. Hence, rather than continue to resist these changes, more companies are beginning to anticipate the direction of change and attempting to position themselves in ways that would enable them to gain the competitive advantages that could accrue from taking the lead in the provision of these new generation goods and services in a carbon constrained economy. This idea is consistent with the view of the Chief Executive of Shell, James Smith, who recently noted that “the climate change market” is already growing, and that “the development of low carbon products now presents serious opportunities for businesses that can help to tackle climate change”. Furthermore, he avers that the core of Shell’s carbon management philosophy remains a desire to make the changes needed while simultaneously capturing the business opportunities that the emerging era might create.

5. 2 Drivers

As earlier indicated, the term drivers refers to the factors that seemingly have the capability of forcing companies and business to take climate action even if they would not have ordinarily wanted to. The initial review identifies five factors that drive corporate climate strategy. These include:

Energy Prices

It is common knowledge that oil and gas are the unmistakable lifeblood of western industrial economy (Gokay 2006; Whitman 2006). Since the industrial revolution, the pattern and pace of economic growth in advanced democracies have always been closely associated with energy availability and prices given that the bulk of modern business operations depend on energy usage. At the same time, energy related spending accounts for a significant portion of most companies recurrent expenditure (Arnberg. and Bjørner 2007). Hence, the efficiency, but also critically the bottom line of most corporations, is intimately dependent on the price of oil and gas. Even when a company's core operation is not so directly dependent on energy usage, such a company nevertheless remains vulnerable to changes in energy prices due to series of interdependencies with other businesses. Therefore it is certain that any major change in energy prices will seriously impinge on existing company's assets, running cost and capital expenditure all of which would lead to decreased discounted sum of profits (Evans 2005). It is thus a fairly straightforward argument that companies would undertake carbon management programs to the extent that such activities promise to deliver some energy efficiency benefits and the implied less energy related expenses and dependence on oil and gas.³

Market Shifts

Regardless of its ethical convictions, or its views on such things as fiduciary and corporate social responsibilities, a corporation is bound to make a strategic assessment of its carbon management options if there is evidence that climate change is driving a major transition in the market (Dunn 2002; Hoffman 2004; 2006). It bears no argument that no company can afford to ignore any trend that has the potential to affect its operations and market fortunes. For example, to stay competitive, an energy generating or supplying company must be sensitive to the future energy-source preferences of its present and potential customers. Similarly in order to retain their customers and stay competitive, major retailing outfits would all be interested in understanding the direction of public energy related preferences and be able to make effective adjustments to accommodate or exploit such changes (Batley et al. 2001) . In January 18 2007 TESCO the biggest supermarket in UK announced that it would spend £500 million to cut its overall energy use. It also announced an additional ambitious ten-point plan that it tends to pursue as part of its green initiative including labelling all products with their carbon foot print. Three days earlier, January 15 2007, Mark and Spencer had equally announced a similar ambitious 100-point plan as part of its "Eco-Plan" including a determination to go carbon neutral in the next 5 years. However, as exciting as these mainstreaming of business practices might be, the recurring question has been whether these developments actually stem from a concern to do the right thing or whether they are not "notional investments figures which will pay back and more over

³ Some have categorically argued that the climate action of most companies in the United States is driven not so much by any concern for the environment but rather by the price of gas (Evans 2005). Stephen Evans of the BBC concluded one of his articles on this issue by saying that while "the market may push Americans towards cleaner technology; shouting by green activists and politicians won't". (Evans 2005)

time” (Corporate Citizens Briefing (CSB) 2007:11).

There is little doubt that climate change is a fast becoming a major consumer issue (cf. Maddison 2001; Batley 2001). And while there might still be some areas of uncertainty, it is clear that the trend would ultimately place considerable value at risk for a range of sectors while leveraging other sectors and even specific businesses (Hoffman 2006). As the developments unfold, it is generally the case that none of the leading market companies would want to be severely disadvantaged by reason of its inaction or lassitude on this potential “game changer”.

Regulation and Government’s Directives

Regulation and informal prodding from state governments constitute a major driver of corporate climate strategy among the UK FTSE 100 companies. Nearly 100% of all the companies that report on their carbon management program admit on their website to the importance of present and future regulations as a key driver of corporate climate strategies. The UK government is a signatory to the Kyoto Protocol and a member of the EU which prides itself as the leader in advancing climate protection efforts in the international arena. The UK government is also on its own right a leader in promoting ambitious actions on climate change. All of these have led to business and industry being encouraged to partner with the government in meeting its binding targets and goals (Smith 2002). Almost all of the companies admit that they are pursuing their carbon management under the purview of existing national and international climate regulations. They also highlight cases and instances where they have met or surpassed existing regulatory standard or played major roles in setting up a piece of climate rated legislation. Shell is among the FTSE 100 companies that make explicit that it pursues its greenhouse gas reduction within the context of the Kyoto Agreement, the EU-ETS and the UK national action plans. Shell has 30 different facilities participating in the EU-ETS and both its emission reduction target and language mirrors that of the Kyoto Protocol.⁴ BP reports that it encouraged the establishment of EU ETS and played major role in refining the details. BA reports that it was the only Airline to join the UK Emission Trading Scheme covering domestic flights and buildings in 2001 and that it wants to see aircraft CO₂ included in the next phase of the EU ETS. Nearly all the companies say that they consider the nature and content of governments’ climate regulation as a key determinant of the future direction of corporate climate strategy. However, it is noteworthy that only less than 10% of the FTSE 100 companies are participants in the Phase I of the UK ETS which started in 2003 and is bid to end by 2007.⁵

Investors Awareness and Pressure

Investor awareness and pressure is arguably one of the most prominent forces driving corporate climate actions both in UK and the US. The nature of this driving force has been mainly in the form of major institutional investors requesting companies to disclose information through projects like the Carbon Disclosure Project and the Sustainable and Responsible Investment (SRI) fund. At the end of 2006 CDP had mobilized 155 institutional investors with over \$31 trillion to pressure companies especially from the world’s leading 500 companies to disclose their carbon impact (Carbon Trust

⁴ In 1997, Shell set a voluntary target to reduce its emission by 5% mirroring the Kyoto target. When it met this target in 2002, it set another target which requires that greenhouse gas emissions from its operation should be 5% lower in 2010 compared to a 1990 base line.

⁵ These companies include Barclays Bank, British Airways, Mark and Spencer, Rolls Royce, Shell UK and Tesco Stores. A great majority of the FTSE 100 companies have opted to join in phase II of the UK ETS that is due to start by 2008.

2006). The Carbon disclosure project is now in its fifth year. Last year, (CDP4) a total of about 2100 companies were polled. Although the response rate was around 47% it is clear that awareness has increased compared to previous years and that the trend is bound to continue (CDP 2006).

The Institutional Investors Group on Climate Change (IIGCC) – a forum for leading investment organisations and pension funds – has equally been at the forefront of pressuring the world's leading companies to undertake more detailed and transparent disclosure of their carbon impacts and management programs. The IIGCC which has over 25 members with assets under management of about \$1.5 trillion, organises an annual conference to equip members with tools and knowledge to integrate climate change into their investment practices. The group also performs an advocacy function as it consistently urges government and policy makers on the need for a more proactive and efficient transition to a low carbon economy.

The cumulative effect of these initiatives is that climate change has steadily acquired enormous investment significance and companies are being forced to respond. Moreover the investors themselves are also making significant commitments including devoting large sums for R&D in the area of climate change. For example, following the second institutional summit on climate change held in New York in May 2005, 24 institutional investors from US and Europe pledged to commit \$1 billion towards opportunities emerging from actions to reduce greenhouse gas emissions (Carbon Trust 2006:8).

Technological Change

Technology innovation is not so much of a driver of corporate climate actions but it represents one of the most important ways through which companies attempt to break from a continued lock-in into the oil economy and achieve massive reductions in greenhouse gas emissions (Kohler 2003; Nieuwenhuis et al. 2004; Kohler et al. 2006). The other significance of technology innovation in corporate climate strategy is that it has the potential to result in enormous reduction in cost of production and increased product performance and competitive advantage (Papathanassiou and Anderson 2001; Pries 2003). For this reason, companies are acutely aware of the dangers in allowing competitors to get far ahead in research and development. Finally there is also the point that some technological innovations from some companies can make it imperative that other companies adjust their business model in order to take advantage of the new product (Murray 2006). For example, the development of ultra-low sulphur diesels might warrant some modifications in car and airplane designs, which in turn might lead to important changes in the automobile and aviation industries.

There is already a wide range of products and services that are helping companies and individuals to reduce emissions. And some of these ranges are already changing the way businesses operate. But the ones that would have the most significant effects are technological innovations that are closely related to energy generation in power plants and energy use in the transport sector (Hoffman 2006). This is mainly because these are the ones that would have the biggest and most immediate effect on energy prices. Within this group are technologies associated with the regeneration of renewable energy, including wind, marine, solar and biomass. Others include coal gasification technologies such as the Integrated Gasification Combined Cycle (IGCC) and liquefied natural gas (LNG) technologies, carbon capture and storage, ultra low sulphur diesels, bio-fuels, hydrogen powered cars and fuel-efficient modern engines.⁶ Shell currently plans to double its production of LNG between 2004 and 2009. It

⁶ For example, a gas-fired power plant produces less local pollution and about half of CO₂ emissions compared to a modern coal-fired station.

estimates that using this additional LNG to produce power would result in 25 million tonnes less CO₂ emission per year compared with using coal.

5.3 Barriers

The main barriers identified in the literature and in the websites of the companies include the following.

Lack of strong policy framework

This is arguably the most significant barrier reported by the FTSE 100 companies. Majority of the climate proactive companies complain that the absence of a clear, long-term and robust policy framework imposes severe limitations on the range of decisions and choices they could make their climate strategies. For instance some companies believe that most of the technology required to transform from today's economy to a low-carbon future are already available and in the market place. There is a sense that what is required is to scale-up existing investments in these products and promote their use at a wider and more mature level in business operations. However the view is that the major barrier in doing this, at the moment, is lack of strong policy framework that creates long-term value for carbon emissions reductions technology while consistently supporting incentives for their improvements or the development of new technologies (Papathanassiou and Anderson 2001).

At the same time, given the huge amount of money associated with the change of energy infrastructure of most corporations and in the research and development of alternative technologies, companies with these competencies are keen to be assured that their investments in these areas would not be a waste. They are keen, as a recent memo from a group of Chief Executives put it, that "such capital intensive investments would produce long term benefits". Several of the companies complain that in the absence of a strong policy framework, it is difficult for them to justify to their boards or investors the need for the high up-front investments in low carbon technologies. BA is one of the many businesses that see a strong forward-looking policy framework as critical in stimulating wider and deeper emissions cut in the aviation industry. Specifically, it calls for the removal of market distortions; the harmonization and application of the ET ETs across Europe, the incorporation of aircraft CO₂ in emission trading, and the creation of a global framework given that aviation is a globally competitive business.⁷

Uncertainty about Governments Action

This factor is somewhat related to the point discussed above. A large percentage of businesses are of the view that there are presently serious uncertainties in the ways governments might choose to respond to the threat of climate change. They argue that these uncertainties make it extremely difficult to choose among alternative courses of corporate climate strategies. There are uncertainties about how much role international institutions and regulations will play as opposed to national and local regulations. There are uncertainties over how much of command and control instruments would be used as opposed to market instruments. There are uncertainties about what would be the role of

⁷ Even US companies are beginning to call for the establishment of a uniform national climate regulatory framework. Their argument is that the development of climate regulations in a patchwork form in various states is actually hindering rather than promotion g their business interests (see Business Week March 20, 2007).

economies in transitions and some major developing countries like China and India in future climate regime and in the overall transition to a low-carbon future world. Furthermore, there are uncertainties about the political stability of major oil supplying blocs and its effect on energy prices. There are uncertainties about the extent to which future governments would differ or abide by existing government visions and policies. And there are uncertainties about the extent to which present and future governments would be prepared to reward the leaders and costly climate actions by corporations.

Against this background, many companies feel that even if they have acquired significant competence in low carbon technology, it is still important to be very cautious and strategic in undertaking action. For example, a number of the giant oil companies have made a lot of advances in carbon capture and storage technology. However, while admitting that there are still some purely technical challenges, some of companies like Shell and Statoil insist that uncertainties about the inclusion of CCS into the next phase of EU ETS and CDM remains one of the barriers to concerted effort in refining and scaling up this technology.

Uncertainty about the Market Place

Again this relates to the two previous points made above but assimilates in a slightly different way. A strong policy framework and clear political signals would do a lot to motivate and reassure business but these factors on their own cannot determine how the market place would response to specific products and services (Papathanassiou and Anderson 2001). In addition to these factors the market response to an environmental product would be determined a complex mix of factors including public awareness and commitment, the overall state of the economy and the purchasing power of the general public, and the availability of alternatives. Some businesses feel as if though they are currently uncertain how much of their climate efforts would be rewarded by the market. Of course this is partly related to the uncertainty associated with forecasting the price of carbon. But also that there is little or no way of telling exactly how much the public would be prepared to pay for low carbon products. In other words, there is the fear that the increasing profile and public awareness on climate change might not directly translate to willingness to pay for low carbon neutral or low emission products and services (cf. Boardman 2004).

The development in the automobile industry presents an important example of how the market place rather than availability of low carbon technology determines the climate strategy and operation of corporate actors. Lave and MacLean (2002) and Adamson's (2003) survey have all recently indicated that the automobile market continues to develop along a more energy intensive pathway largely in response to consumer demands. The same reports indicate that while a range of low emission vehicles are available in the market place, only a small percentage of public seem willing to pay the premium for these environmentally friendly products. These findings would seem to endorse the bold statement by Cowan and Hulten (1996:13; cited in Kohler et al forthcoming) that 'regulation notwithstanding, the yes to the success of a technology lie in demanders and supplier – the market for it, and the supply of it'.

6. Generating more specific policy recommendations: A framework for analysis

A good understanding of the motivations, drivers and barriers to corporate climate actions on its own adds enormous value to global climate policy development. However, as indicated there is a need to go beyond this level to actually contemplating how these various factors might interact with notional key features of the emerging climate regime and what such various degrees of interaction might mean for policy design and implementation. At the moment there is a general preference for description or

quantitative data in current literatures on corporate strategies and only little attempt to place discussions in the context of the climate regime discourse in order to generate more specific policy options (Levy and Newell 2005; Hofman 2002); Kolk and Levy 2001); Dunn 2002; Kolk and Pinske 2004; Levy and Newell 2000; CDP Reports (1-4); Hoffmann 2006).

In this section, I will first outline some of the issues that could form the main focus of a more in-depth study on corporate climate strategies which is based partly on the results discussed in the previous sections and partly on the general understanding of the post-2012 climate policy discourses. I will then present an analytical framework that might serve to generate more precise policy insights on the interaction among different features of a post 2012 climate regime and aspects of corporate climate strategy. Obviously the usefulness of the framework can only be tested by the means of an empirical field work studies. The following are some of the main issues that require further investigation.

- It was noted that there are variations in scope of emissions included in company's emission inventories, in the metrics used for tracking and reporting and in the baselines used all of which create enormous comparability problems both in terms of understanding processes and evaluating performance. It is worthwhile to ascertain the rationale behind the choices made by companies. Some possible reasons for the choices might include the nature and peculiarities of individual businesses, the nature of expert advice received from the beginning and subsequent reluctance to change. Other might include differences in organizational structure, scope of operation, or even simply a perceived need to either emulate or deliberately differ from notable competitors. It is also possible that there are more mundane economically strategic reasons (such as cost or convenience) behind the choices that companies' make with respect to these issues.
- It is also a matter of speculation, at this stage, as to how thorough and robust current emissions inventories are. In-depth research is required to ascertain the role of transparency and third party verification in encouraging or discouraging, strengthening and harmonising corporate climate strategies. More research is also required to elaborate on the kinds of benchmark, metrics and baselines that might be appropriate to adopt as a matter of regulation; and the pros and cons of such approaches weighed against alternative options. Moreover, it is desirable to attempt to determine the exact environmental significance of companies carbon management programs in terms of the specific the amount of CO₂ that companies have removed from the atmosphere and how this compares to business as usual scenario.
- Although most of the FTSE 100 companies operate in different countries, virtually none of these companies report on where exactly emission reductions are taking place within their corporate structure. This is not a desirable practice since it makes verification difficult and hampers the possibility to correlate emission reductions and corporate climate strategies with wider political and socio-economic factors. Moreover the current practice increases the likelihood of double counting. In-depth case studies might be useful in understanding the emission reduction profile of a company in terms of its different installations as well as various areas of geographical operations. A related point is the current poor understanding of how companies set their emission reduction target. Most companies that report on their climate activities tend to perform very well against their set targets. But this leads to the question of whether these targets were set based on what companies knew they could achieve or whether they were set based on other external and more ambitious standards.

- More studies are required to verify that the categories utilized in the above survey (motivations, drivers and barriers) are both valid and comprehensive. The differentiation between motivations and drivers promises to bring in new insight on corporate climate strategies. However, in-depth studies would still be required to establish the veracity of this differentiation and any interdependent linkages that might exist. It should also be desirable to probe the relative importance of the factors as well as the existence (if any) of even deeper causal categories.
- It would be important to establish by means of in-depth studies the expectations and preferences of actors with respect to different existing and future options for a global climate regime. Specific issues here include among many others, views on the UK and EU ETS, the role of nuclear power, CDM and offsets in future regime, the influence of the US based corporations, the desirability and method of certifying big projects like carbon capture and storage and the feasibility of setting sectoral targets. There has been much discussion on the need to establish a global emission trading scheme but little is known on how to work out the details of such a complex regime and what might be its ultimate effect in terms of actual emission reductions.

Once a foundational understanding of the notional barriers, drivers and motivations for corporate climate strategies have been developed, the next crucial task will be to devise an analytical framework that makes it possible to gain insights into the possible dimensions of interactions between different aspects of climate change policy and corporate climate activities. This would then open the space for more qualitative discussion on the implications of business activities of and for a post 2012 climate regime.

The analytical task here, involves linking the identified drivers, motivations, barriers and directions to specific features of a post-2012 regime. One way of generating these insights is to adapt the cross-impact method of data analysis which is an analytical approach to the probability and potential interactions among forecasted items (Gordon 1994). Figure 1 depicts the logic model underlying the analytical framework.

Elements of post-2012 regime	Results of interviews & other analysis	Bridging concepts
Long term versus medium term targets Emission Trading System Clean Development Mechanism / offsets	Regulation Energy Price Investor pressure Technology change	Drivers
Technology Protocol	Uncertainty of government action Uncertainty of market place Lack of strong and long policy framework	Barriers
	Profit Reputation/ Credibility Fiduciary Obligations	Motivations

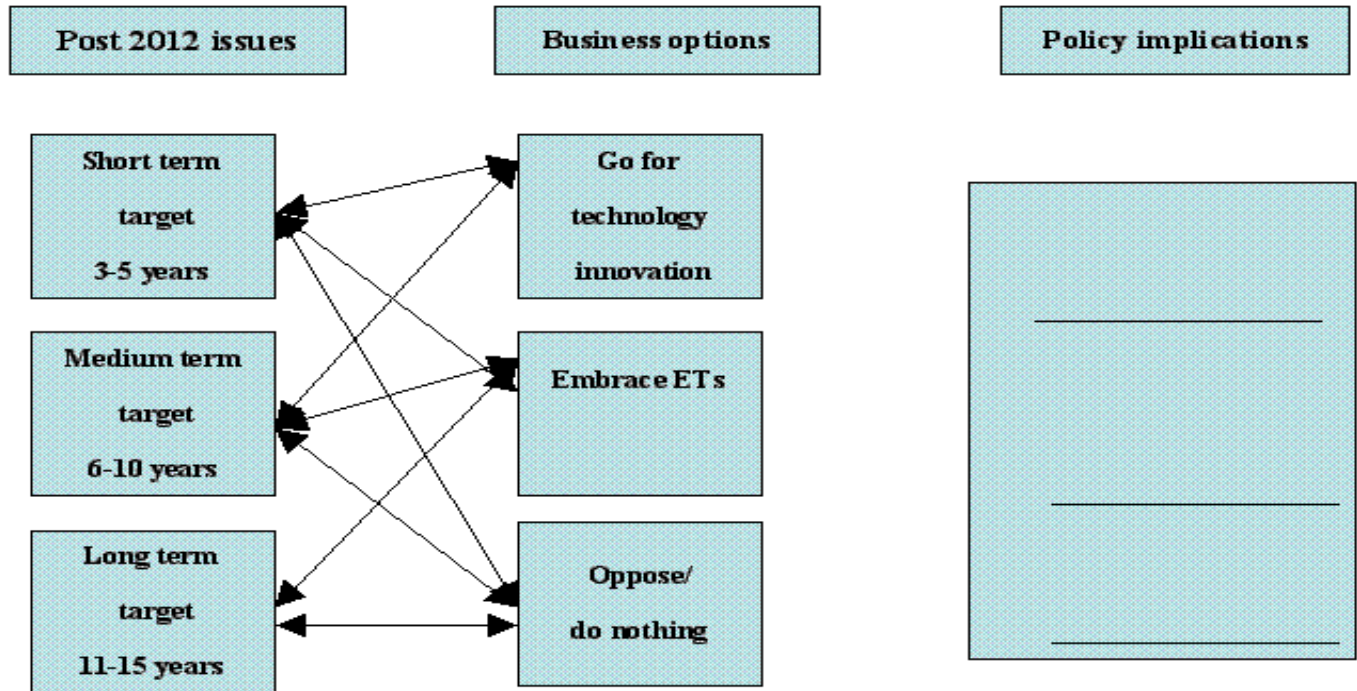
Figure 1: Analytical model for comparing the linkages between different post 2012 features and the factors affecting corporate climate strategies.

The figure gives the basis of a qualitative analytical framework for linking the drivers, motivations and barriers with the main elements of a post-2012 regime. In principle, there would be links between most of the elements identified in column two and column three, so the aim will be to select the most significant linkages/relationships and then explore what the implications are both in terms of which elements of a post-2012 regime would likely result in which action on the part of corporate actors. The other side is to explore how specific actions and preferences by corporate actors might impact a post 2012 regime. There are at least two approaches that might be utilised in the analysis. The first is to develop a code based on a list of relevant post 2012 issues and try to understand the thinking of corporate actors with respect to the various policy options and suggestions related to the issues. It should also be possible to develop a completely revised categorization after a series of interviews using a modified grounded theory approach. The other option is to build a stronger cross-link "hypothesises" about the interaction between the most prominent policy options and various corporate responses with respect to these critical issues. These hypotheses would then be explored, revised or refuted through the empirical work.⁸

Take for example the issue of Regulation and Target. One could hypothesize that government has the option to set: (a) a short term target (3-5 years); (b) a medium term target (6-10 years); and (c) a long term target (11-15 years). One could then imagine that business might have a number of ways in which they could respond to any of these time lines. Examples could be: (a) increase in emission

⁸ Each approach would seem to have some strengths and weakness. The first approach would seem to be more open and better suited to capture a wide range of concerns of corporate actors but the second would appear more suitable in terms of generating specific policy results.

trading; (b) pursuit of technology innovation; (c) get frustrated and oppose legislation (d) do nothing. This might be pictured in this way:



Obviously, it is not possible to speak in great details now about the ways these terms will interact and what influence they will have on other elements partly because there is need to verify through the interview the relative weight or significance of the bridging factors and partly because more work is needed to clearly identify the exact characterization of the post-2012 regime we should adopt in the research.

7. Conclusion

One of the curious twists in the history of corporate environmentalism is the dramatic change from opposing a global climate regime to a much more proactive stance including in some cases advocacy. Yet in the midst of this so little is known of the extent to which climate corporate climate activity is informed by a commitment to global environmental integrity, an intention to confuse the public or an outright commitment to profit. Clearly, corporate actors can serve as important drivers for change with an enormous capability of influencing everyday choices of ordinary people through the range of products they make available in the market place as well as through their own corporate social responsibility attitudes. But, at the same time, business is notorious for its prime concern for profit, sometimes at the expense of environmental integrity and public welfare. The emphasis on bottom line improvement especially in the context of stiff market competition makes most businesses prone to resist or evade climate policies that are perceived as not yielding competitive advantage or even as constraints to economic growth and profit. On the other hand there have been indications in the past that business might be willing to do more to mitigate climate change if governments were more forthcoming in offering support robust especially in the form of financial incentives or strong policy framework. Either way, there is need, despite the new wave proliferation of carbon management activities by companies, for a thorough analysis that can help uncover the real motivations and drivers

for action remains as urgent. Although one can easily envisage that it would be difficult to fully investigate this, there is no reason why such attempts should not be made.

The paper has examined the key reasons why companies undertake carbon management programs as well as the obstacles in the path of actions. It was found that companies are prompted to take climate actions for a wide variety of reasons. These range from self-interested and profit oriented reasons through governmental and public pressure to ethical considerations. There is cause to believe that these reasons are mutually exclusive. Rather, they appear to interact in different mixes to influence companies' carbon strategic choices. Moreover, the actual reasoning and particular factor-mix that underpin companies' carbon management program are determined by several factors including location, sector, area of operation, historical experience, area of focus and the unique challenges being faced by the companies.

This review has thrown up many pertinent issues that need attention in deepening our understanding of the interactions between corporate climate strategy and some of the key features of a possible future climate regime. However more work is needed to map the nature and direction of linkages between these policies and business climate strategy. This knowledge might prove vital in the design of a post 2012 climate regime where business can make environmentally effective without necessarily sacrificing their competitive interests. The most important message of this paper is that while there has been a seeming transition in corporate environmentalism from adversarial to more proactive stance, a lot of work is still required to investigate the link between commitments and actual reduction. Similarly the review clearly suggests that corporate climate strategy is a complex issue the understanding of which requires a thorough analysis of a range of political, economic and business organizational factors.

Bibliography

3I Group plc (2006) corporate responsibility report, 2006. Available at: http://www.3i.com.CR_report_withcover.pdf

Adamson, K. A. (2003) An examination of consumer demand in the secondary niche market for fuel cell vehicles in Europe. *International Journal of Hydrogen Energy* 28, 771-780.

Ahman, M. (2006) Government policy and the development of electric vehicles in Japan. *Energy Policy* 34, 433-443.

Arnberg, S. and Bjørner T.B. (2007) Substitution between energy, capital and labour within industrial companies: A micro panel data analysis. *Resource and Energy Economics* 29 (2), 122-136

AstraZeneca (2006) Corporate responsibility 2006, summary report. Available at: <http://www.astrazeneca.com/sites/7/imagebank/tytpeArticleparam511715/astrazeneca-cr-report-2006.pdf>

Aviva (2006) Corporate Social Responsibility Report, 2006. <http://www.aviva.com/csr06/index.asp>

BHP Billiton (2005) Corporate social responsibility report, 2005: Message from the Chief Executive. Available at: <http://sustainability.bhbilliton.com/2005/environment>

Batley, S. L., Colbourne, D., Fleming, P. D. and Urwin, P. (2001) Citizen versus consumer: challenges in the UK green power market. *Energy Policy* 29 (6), 479-487

- Boardman, B. (2004) New directions for household energy efficiency: evidence from the UK. *Energy Policy* 32 (17), 1921-1933.
- Bowman, E.H. and Helfatm, C. (2001) Does Corporate Strategy Matter. *Strategic Business Journal* 22, 1-23.
- Carbon Disclosure Project Reports 2-4 (2002-2006). www.cdproject.net
- Chatterjee, P. and Finger, M. (1994) *The Earth Brokers: power, politics and world development*. Routledge, London.
- Cibin, R. and Grant, R. M. (1996) Restructuring Among the World's Leading Oil Companies, 1980-92. *British Journal of Management* 7, 283-307.
- Clapp, J. (2005) Global Environmental Governance for Corporate Responsibility and Accountability. *Global Environmental Politics* 5 (3), 23-33.
- Clapp, J. and Dauvergne, P. (2005) *Path to a Green World: The Political Economy of the Global Environment*. Cambridge: MIT Press.
- Collingwood, V. (2006) Non-governmental organizations, power and legitimacy in international society. *Review of International studies* 32 (3), 439-454.
- Corporate Citizenship Briefing (CCB) (2007) Issue 91 December 06/January 07.
- Corus Group (2005) Corporate responsibility report, 2005: striving to make a difference. Available at: http://www.corusgroup.com/file_source/StaticFiles?Functions?HSE/CorusCRR05.pdf
- Cowan, R., and Hulten, S. (1996) Escaping lock-in: the case of the electric vehicle. *Technological Forecasting and Social Change*, 53, 61-79.
- Dobrev, S. D., Kim, T.Y., and Carroll, G. R. (2003) Shifting Gears, Shifting Niches: Organizational Inertia and Change in the Evolution of the U.S. Automobile Industry, 1885-1981. *Organization Science* 14(3), 264-282.
- Drake, F., Purvis, M. and Hunt, J. (2004). Meeting the environmental challenge: a case of win-win or lose-win? A study of the UK baking and refrigeration industries. *Business Strategy and the Environment* 13 (3), 172-186.
- Dunn, S. (2002) Down to Business on Climate Change: An Overview of Corporate strategies. *Greener Management International* 39 (Autumn), 27-41.
- Eisner, M. A. (2004). Corporate Environmentalism, Regulatory Reform and Industry Self-Regulation: Towards Genuine Regulatory Reinvention in the United States. *Governance* 17 (2), 145-167.
- Environmental Agency (2004) Environmental Disclosures: In the Annual reports and Accounts of all companies in the FTSE All-Share. www.environment-agency.gov.uk

- Evans, S. (2005) Oil Prices 'drive US action on climate' BBC News Thursday, 30th June, 2005. <http://news.bbc.co.uk/1/hi/sci/tech/4634539.stm>
- Frederick, W.C. (1994) From CSR1 to CSR2: The Maturing of Business-and-Society Thought. *Business and Society* 33 (2), 150-164.
- Friends of the Earth (2007) Towards Binding Corporate Accountability. <http://www.foei.org/publications/corporates/accountpr.html>
- Ghemawat, P., and Ricart I Costa, J.E. (1993) The Organizational Tension between Static and Dynamic Efficiency. *Strategic Management Journal*. 14 (Winter, 1993), 59-73.
- Gokay, B. (2006) 'How Oil Fuels World Politics', in: *The Politics of Oil: A Survey*. B. Gokay (ed.). London: Routledge.
- Grant, R.M. (1996) Toward a Knowledge-Based Theory of the Firm. *Strategic Management Journal* 17 (Winter), 109-122.
- Greenfield, W.M. (2004) In the name of corporate social responsibility. *Business Horizons* 47 (1), 19-28.
- Greer, J. and Bruno, K. (1996). *Greenwash: The Reality Behind Corporate Environmentalism*. Apex Press, New York.
- Hoffman J. A. (2004) *Climate Change Strategy: the business Logic Behind Voluntary Green house Gas Reductions*. Ross School of Business Working paper series Working Paper No. 905.
- Hoffman, A.J. (2006) *Getting Ahead of the Curve: Corporate Strategies that Address Climate Change*. Prepared for the Pew Centre on Global Climate Change.
- Hofman, S. P. (2001) Becoming a First Mover in Green Electricity Supply: Corporate Change Driven by Liberalization and climate Change. *Greener Management International* 39 (Autumn), 99-108.
- Hove, v. D., Menestrel, L. and Bettignies, H. C. (2002) The oil industry and climate change: strategies and ethical dilemmas. *Climate Policy* 2 (1), 3-18.
- HSBC (2005) *HSBC carbon neutral pilot project*. Available at: http://a248.e.akamai.net/7/248/3622/d591a64b87c83c/www.img.ghq.hsbc.com/public/groupsite/assets/csr/carbon_neutral_brochure_oct05.pdf
- HSBC (2007) *Environment*. Available at: <http://www.hsbc.com/hsbc/csr/environment>
- Husted, B. W. and Allen, D. (2000) Is it Ethical to Use Ethics as Strategy? *Journal of Business Ethics*. 27 (1-2), 21-31.
- Kolk, A. and Levy, D.L. (2001) Wind of Change: Corporate Strategy, Climate Change and Oil Multinationals. *European Management Journal* 19 (5), 501-509.

- Köhler, J. (2003) Long run technical change in an energy-environment-economy (E3) model for an IA system: A model of Kondratiev Waves, *Integrated Assessment* 4(2), 126-133.
- Köhler, J., M. Grubb, D. Popp, and O. Edenhofer (2006) The Transition to Endogenous Technical Change in Climate-Economy Models: a Technical overview to the Innovation Modeling Comparison Project. *The Energy Journal Special Issue, Endogenous Technological Change and the Economics of Atmospheric Stabilization*, 17-55.
- Köhler, J., Whitmarsh, L. Michie, J. and Oughton, C. (forthcoming) Can the car makers save the planet? In *Innovation in Energy Systems: Learning from economic, institutional and management approaches*. Cambridge: Cambridge University Press.
- Kolk, A. and Pinske, J. (2004) Market Strategies for Climate Change. *European Management Journal* 22 (3), 304-314.
- Laufer, W. S. (2003). Social Accountability and Corporate Greenwashing. *Journal of Business Ethics* 43 (3), 256-261
- Lave, L. B., and MacLean, H. L. (2002) An environmental-economic evaluation of hybrid electric vehicles: Toyota's Prius vs. its conventional internal combustion engine Corolla. *Transportation Research Part D* 7, 155-162.
- Le Menestrel, M. and de Bettignies. H-C. (2002). Processes and Consequences in Business Ethical Dilemmas: The Oil Industry and Climate Change. *Journal of Business Ethics* 41 (3), 251-266.
- Levy, D. L. and Newell, J. P. (2002) Business Strategy and International Environmental Governance: Towards a Neo-Gramscian Synthesis. *Global Environmental Politics* 2 (4), 84-101.
- Levy, D.L. and Newell, J.P. (2000) Oceans Apart: Business Responses to Global Environmental Issues in Europe and United States. *The Environment* 1, 10-21.
- Levy, L. David and Newell, J. P. (2005) *The Business of Global Environmental Governance*. Cambridge: MIT Press.
- Lyon, T. P, and Maxwell J.W. (2006). Greenwash: Corporate Environmental Disclosure under Threat of Audit. <http://hdl.handle.net/2027.42/48742>
- Maack, M. H., and Skulason, J. B. (2006) Implementing the hydrogen economy. *Journal of Cleaner Production* 14, 52-64.
- Maddison, D. (2001) In Search of Warmer Climates? The Impact of Climate Change on Flows of British Tourists. *Climatic Change* 49 (1-2) 193-208
- Margolick, M. and Russell, D. (2001) *Corporate Greenhouse Reduction targets*. A publication of the Pew centre on Global Climate Change.
- Matten, D. and Crane, A. (2005) Corporate Citizenship: Toward an Extended Theoretical Conceptualization. *The Academy of Management review* 30 (1), 166-179.
- Murray, J. (2006) Roll-out, awareness and impact of the colour-coded fuel economy label, one year on. Presentation for Low Carbon Vehicle Partnership workshop. Available from lowcvp.org.uk.

Newell, P. J. and Paterson, M. (1997) A Climate for business: global warming, the state and capital. *Review of International Political Economy* 5, 679-703.

Nieuwenhuis, P., Vergragt, P. J., and Wells, P. (2004) Technological change and regulation in the car industry. *Greener Management International* (GMI), Autumn, 5-11.

O'Riordan, T. (2000) Climate Change and Business Response. University of East Anglia, CSERGE Working Paper GRC 2000-24.

Papathanassiou, D. and Anderson, Dennis (2001) Uncertainties in Responding to Climate Change: On the Economic Value of Technology Policies for Reducing Costs and Creating Options. *Energy Journal* 22 (3), 36-76.

Pries, L. (2003) Emerging production systems in the transnationalisation of German car manufacturers: adaptation, application or innovation? *New Technology, Work and Employment* 18(2), 82-100.

Scottish Power (2006) Corporate Responsibility: Performance 2005/2006. Available at: <http://www.scottishpower.com/p4.asp>

Shell (2005) The Shell Sustainability Report. Available at: http://www.shell.com/static/evandsoc-en/downloads/about_this_site/shell_sustainability-report_2005.pdf

Shell (2007) Environment and Participating in the Debates. Available at: <http://www.shell.com/home/PrintFramework?siteId=envandsoc-en&FC3=/home/envandsoc.pdf>

Skjaereth, J. and Skodvin, T. (2003) *Climate Change and Oil Industry: Common problems varying strategies*. Manchester: Manchester University Press.

Sky (2007) *The Bigger Picture*. Available at: <http://www.jointhebiggerpicture.co.uk/home.aspx>

Smith, A. (2002) Policy transfer in the development of UK climate policy for business. Working Paper No. 75 Science and Technology Policy Research (SPRU) University of Sussex.

Smith, C. N. (2003) Corporate Social Responsibility: Whether or How? *California Management Review* 45 (4), 52-76.

Tokar, B. (1997) *Earth for Sale: Reclaiming Ecology in the Age of Corporate Greenwash*. South End Press, Cambridge.

Unilever (2007) Climate Change; Unilever's impact: http://www.unilever.com/ourvalues/environmentandsociety/env_social_report/environment/environmentalissues/climatechange.asp

Varma, A. (2004). UK's Climate Change levy and Emission Trading Scheme: Implications for Businesses' Productivity and Economic efficiency. In *Emission Trading and Business* eds. R. Antes, B. Hansjürgens, and P. Letmathe. Physica-Verlag HD, Leipzig.

Whitman, D. (2006) 'As Good as Gold: Oil and the Global Political Economy', in: *The Politics of Oil: A Survey*. B. Gokay (ed.). London: Routledge.

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