Would a fixed internal carbon fee help the UK reach net zero emissions by 2050?

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Abstract

This thesis looked to answer the question 'would a fixed internal carbon fee help the UK reach net zero emissions by 2050?'. An Internal Carbon Fee, also known as an Internal Carbon Tax, is one of the four preeminent methods that companies use to implement an internal carbon price. Internal carbon fees charge business units for their emissions and reinvest the revenue generated to support investment into clean technologies and/or carbon reduction projects. It was hypothesised that the introduction of a mandatory internal carbon fee on UK businesses would help the UK government meet its 2050 net zero carbon emissions goal. The objectives of the study were to review current literature on carbon pricing in relation to corporate and UK Government net zero strategies and assess the impact of internal carbon pricing mechanisms through statistical analysis of responses to the Climate Disclosure Project (CDP) 2018 questionnaire.

The literature review found that current UK climate policies are not enough to meet the UK 2050 net zero ambitions. Experts state that additional climate mitigation actions are required, and pricing carbon is an effective tool in reducing carbon emissions. Climate change is seen as market failure, as its true economic and environmental cost is not included in the current market price of polluting activities and products. Taxing polluters on each tonne of carbon (CO_2e) they emit is one method of balancing the disconnect. One of the main constraints in implementing such schemes is concern that imposition of national carbon taxes will increase business cost and impact competitiveness in a global market.

Internal carbon pricing mechanisms are currently being used by companies as a risk management and carbon transition tool. Information disclosed to CDP includes corporate climate governance, emissions, energy consumption and carbon reduction initiatives. The results of statistical analysis of CDP data found that there is a significant relationship between internal carbon price and carbon reduction initiatives. It observed that on average, as internal carbon price increases, investment and projected carbon savings increase. The relationship was found to be stronger for energy intensive industries.

Internal carbon pricing mechanisms are currently voluntary. This study found that it is a flexible tool that enables companies to reduce carbon emissions, especially when used as part of a holistic corporate climate agenda. Mandatory legislation requiring companies to assign a fee to their carbon emissions and re-invest money generated in low carbon initiatives could help the UK Government achieve climate goals without imposing the perceived risks of carbon taxation. It is envisaged that the implementation of this approach would receive less resistance than existing carbon tax proposals.

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List of Acronyms

GHG – Green House Gas

CO_2e – Carbon Dioxide equivalent

CDP – Climate Disclosure Project

CRC – Carbon Reduction Commitment

SECR – Streamlined Energy and Carbon Commitment

CCL – Climate Change Levy

UN – United Nations

GDP – Gross Domestic Product

NDCs - Nationally Determined Contributions

UK – United Kingdom of Great Britain and Northern Ireland

ETS – Emission Trading Scheme

MACC - Marginal Abatement Cost Curve

CDM - Clean Development Mechanism

Chapter 1. Introduction

1.1 Background

1.1.1 Climate Change

UN Secretary-General António Guterres, speaking the UN Security Council in February 2021, described climate change as a "crisis multiplier" that has profound implications for international peace and stability. In a video, telecast at the start of proceedings, leading naturalist Sir David Attenborough spoke to the council labelling climate change as "the biggest threat to security that modern humans have ever faced" cautioning that there is still time for governments to act to limit the extent of the threat (United Nations, 2021).

Climate change warnings are nothing new. Margaret Thatcher in her speech to the 1989 United Nations General Assembly was one of the first leaders of a major economy to note the impact of anthropogenic actions on the planet, stating that:

"What we are now doing to the world … is new in the experience of the Earth. It is mankind and his activities that are changing the environment of our planet in damaging and dangerous ways."(Thatcher, 1989)

The 2006 Stern Review assessed a wide range of evidence on the economic cost and impacts of climate change. The report concluded that climate change is a global threat to the basic elements of life, potentially causing hunger, coastal flooding, and water shortages. The report estimated that the cost of inaction to mitigate the effects of climate change would be equivalent to losing at least 5% of global GDP each year now and forever (Stern, 2006). Ominously, the report finds that if a wider range of risks and impacts are accounted for then this figure could rise to 20% of GDP annually (Stern, 2006). The report emphasised the need for urgent action to mitigate the worst impacts of climate change, it estimated that in doing so, the worst impacts of climate change could be limited to around 1% of global GDP each year

The review determined that to limit the worst impacts of climate change, the levels of Greenhouse Gases (GHG)[1] in the atmosphere need to be stabilised to between 450 and 550ppm CO_2 equivalent[2] (CO_2e). In 2006 when the report was released, GHG levels were 430ppm. In 2018 the total

[1] "A greenhouse gas (or GHG for short) is any gas in the atmosphere which absorbs and re-emits heat, and thereby keeps the planet's atmosphere warmer than it otherwise would be (Brander, 2012)."
[2] "CO_2e is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas (GHG), CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact (Brander, 2012)."

concentration of all GHG reached 457 parts per million CO_2 equivalents (European Environment Agency, 2020). The European Environment Agency (2020) analysis of the current trend in atmospheric GHG concentrations found that if the trend continues, within the next few years, GHG levels will exceed the estimated level required to increase global temperatures by 1.5°C by the end of the century. The startling concern is that today, the 1.5°C goal set in the 2015 Paris agreement is the aspirational target, only achievable with concerted effort between nations (United Nations, 2015).

At the UN General Assembly in 2018, Secretary-General António Guterres stated that "Climate change is moving faster than we are" (IPCC 2018). To meet the Paris agreement target of limiting global temperature to well below 2 °C (United Nations, 2015), emissions should have reduced from 2010 at a rate of 1.4% each year (I4CE, 2016). Between 2009 and 2019 they increased at rate of 1.5% per year (Hausfather, 2019). Figure 1 is a chart produced by Climate Action Tracker (CAT, 2021), it projects that current policies will lead to a temperature increase of between 2.7 to 3.1 degrees Celsius by 2100.

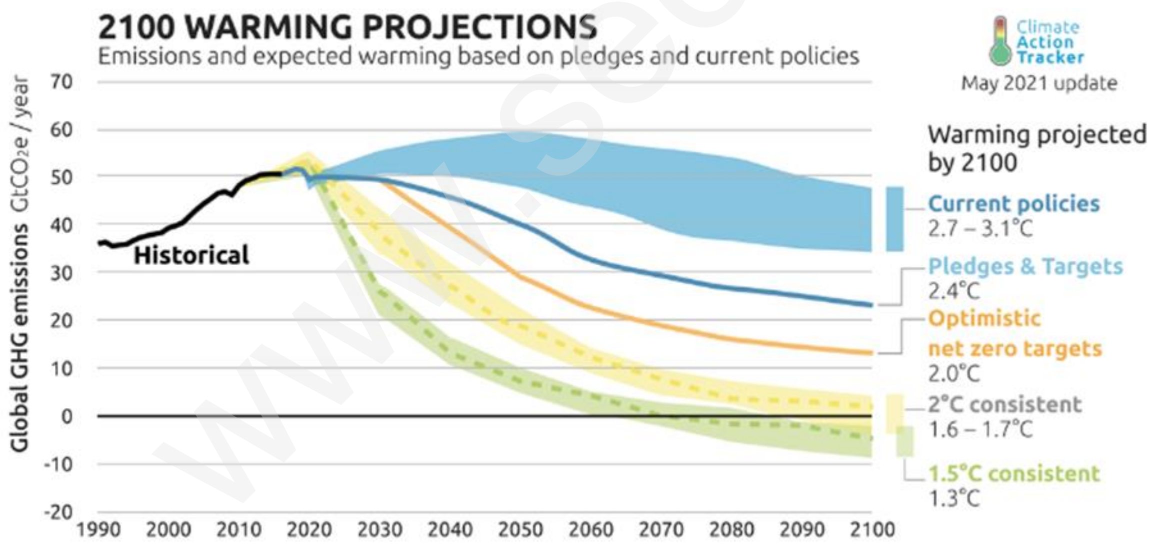


Figure 1. Projected Global Warming

1.1.2 Current international climate change agreements.

The most recent international accord on climate change is the 2015 Paris Agreement. Signatory countries agreed to limit global warming well below 2°C preferably to 1.5°C, compared to pre-industrial levels (United Nations, 2015).

To achieve emissions pledges, the Paris Agreement requires all parties to set national emission reduction targets, known as Nationally Determined Contributions (NDCs). Every five years countries are to assess their emission progress though a mechanism known as the global stock take, the first is planned for 2023. Importantly, the agreement sets no enforcement actions if national targets are missed. Criticism of the agreement centres around the voluntary nature of NDC's. China, which accounts for approximately 28% of global emissions (more than the US, Britain, and Europe combined) NDC only commits it to start reducing its emissions from 2030 onwards (Bledsoe, 2020).

1.1.3 UK Net Zero Target

The Climate Change Act 2008 (2050 Target Amendment) Order 2019 enshrines in law the requirement of a 100% net reduction of UK GHG emissions by the year 2050. Net-zero is defined as cutting greenhouse gas emissions to at least 100% below 1990 levels (Evans, 2021). The revised target is in response to the Committee on Climate Change (CCC) 2019 report Net zero: the UK's contribution to stopping global warming which recommended a new emissions target for the UK of net-zero greenhouse gases by 2050. The recommendation was influenced by the 2018 Intergovernmental Panel on Climate Change (IPCC) report underlining the importance of limiting global warming to 1.5 degrees. The UK was the first major economy to commit to ending its contribution to climate change entirely by 2050 (HM Government, 2020). Building on this, the UK Government recently announced it would go further, faster, pledging to enshrine in to law a commitment to reduce its 2035 emissions by 78% from 1990 levels (UK Government, 2021b). To help achieve this, the UK Government has set out its ambitions to work with industry to decarbonise and create 'green' employment opportunities.

1.1.4 The Social Cost of Carbon (CO_2e)

One of the primary issues with mitigating climate change is the abstract nature of the problem. There is no direct link to an company emitting carbon emissions (CO_2e) and the impact that the emissions will have on the planet. The projected costs of the ecological and economic damage caused by carbon emissions are currently not reflected in the cost paid by the polluter. The concept of the Social Cost of Carbon links climate change to economics by assigning a value to the impact climate change will have on the planet and society (Nordhaus, 2017). Barron and Parker (2018) stated that an optimal carbon tax should be set to reflect the present value of carbon emissions on society. Hanley and Splash writing about the concept in 1993, noted the problems and complexities of calculating the actual costs of carbon emissions and that careful examination was needed in regulating carbon and setting carbon taxes at appropriate levels (Hanley and Spash, 1993).

1.1.5 Carbon Pricing

As noted, the effects of climate change are of disconnected from the polluter. This disconnect should not just be considered on a geographical scale, the long-term cumulative nature of climate change is likely to be generational. Many economists consider climate change a market failure (Bowen, 2018) as the costs and risks of pollution are not included in the current market price of polluting activities and products. Carbon pricing internalises the cost of such activities, accounting for the environmental and social harm of all GHG pollution. In 2016, Jim Yong Kim, World Bank Group president wrote ‘There is a growing sense of inevitability about putting a price on carbon pollution’ (World Bank, 2016). A carbon price is a cost applied to carbon pollution. It is a mechanism to make the polluter pay for their GHG emissions (referred to as carbon equivalent (CO_2e)) and incentivise emission reductions.

Concept of applying a cost to carbon emissions is not as new as might be expected. The 2006 Stern Review laid bare the economic cost climate change. The cost was not an abstract apocalyptic scenario but a careful systematic analysis of evidence to provide an economic appraisal of the impact of climate change.

1.2 Problem statement

The UK government recognises through legislation and rhetoric the need to reduce Carbon emissions to net zero by 2050. In 2020, there were 61 carbon pricing initiatives in place or scheduled for implementation, covering 12 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) or about 22 percent of global GHG emissions (World Bank Group, 2020). This is an increase of 2% from 2019. They are either a carbon tax, or an Emission Trading Scheme. Both systems impose a fixed cost on businesses for their carbon pollution. One of the major stumbling blocks in imposing stricter carbon emission regulation, is the political scope for implementing such measures (Pearce, 2006). World leaders have a difficult balancing act of implementing policies to limit the likely impact of climate change whilst ensuring increased climate taxation and mitigation requirements do not prove advantageous to overseas competitors who are no subject to the same regulation and costs.

Climate change and how it is being incorporated into business planning is an increasingly important concern for investors (World Bank Group, 2020). In 2014 the top 50 companies in the world (Global 50) and their value chains emitted 16.5 billion tonnes of CO_2e, equivalent, accounting for over 40% of worldwide emissions (I4CE, 2016). The potential catastrophic impact of climate change at social, environmental, and economic levels is prompting many large investors to review their portfolios, factoring in the development and implementation of low-carbon strategies (World Bank Group, 2020). In January 2020, Blackrock, the world's largest investor signed Climate Action 100+ investor engagement initiative that aims to ensure the world's largest corporate greenhouse gas emitters act to reduce climate change (Greenfield and Jolly, 2020).

Companies worldwide are adopting the internal carbon price for an array of purposes. Reasons include accounting for the social cost of carbon emissions, mitigating the impact of future carbon taxes and planning for likely increases in energy prices. Carbon pricing can be both a proactive and reactive response to the likely impacts of climate change, incorporating climate change into business models and corporate social responsibility commitments. Carbon pricing is a tool that allows companies to assess the environmental impact of business activities, target emission reductions and introduces a price signal into a company's business activities (I4CE, 2016).

This study focuses on the implantation of a type of carbon pricing known as an internal carbon fee. An internal carbon fee, also known as an internal carbon tax, is one of the four preeminent methods that companies use to implement an internal carbon price. Internal carbon fees charge business units for their emissions and reinvest the revenue generated to support investment into clean technologies and/or carbon reduction projects. Microsoft is a well-known proponent of an internal carbon fee. Since 2012, Microsoft has been carbon neutral using the money it has raised from its carbon fee to reduce its emissions by 9.5 million tonnes of CO_2e (Gold Standard, 2020).

The hypothesis of this research project is that a mandatory internal carbon fee would help the UK achieve its 2050 net zero target quicker and with less economic impact. If companies can retain the carbon fee and invest it in carbon and energy reduction initiatives in their value chains, the organisations would be directly benefiting from the investment. This could increase efficiencies, improve commercial competitiveness, and place the reduction in carbon emissions at the heart of business activities. It is envisaged that such a system would be politically more palatable, allowing a higher carbon price to be set.

1.3 Aim and objectives

The central aim of this study is to explore if a mandatory Internal Carbon Fee would encourage businesses to greater investment in energy efficiency technologies, provide more robust and accountable carbon emission reductions and help the UK meet is GHG reduction commitments.

The decision to choose carbon fee methodology over other internal carbon pricing mechanisms (as detailed in section 2.3.5 Types of Internal Carbon Price) is twofold. 1. Requiring companies to calculate total emissions, applying a fixed carbon fee to those emissions and re-invest the money generated represents a similar mechanism to that of an externally applied carbon tax. The difference is that the 'fee', instead of being paid to the Government, is directly re-invested by the company. 2. Legislating the use of other pricing mechanism such as using shadow carbon pricing in investment decisions would be difficult if not impossible to monitor and enforce. Consequently, the aims of the study are:

1 Evaluate current approaches by UK government and large companies to meeting 2050 net zero targets.
2 Perform a literature review to evaluate current carbon pricing mechanisms and associated impacts on reducing carbon emissions.
3 Analyse if investment in carbon reduction and mitigation is influenced by the internal carbon pricing mechanisms.
4 Review the analysis results and investigate if setting a fixed internal carbon fee could incentivise emissions cuts and help the UK achieve it net zero emission aspirations.

This research is limited to large multinational companies that disclosed their annual emissions and carbon reduction initiatives to the Climate Disclosure Project (CDP) in 2018.

Objectives 1 to 2 was achieved by undertaking literature review of current carbon reduction policies both within the UK and Internationally. It identifies the perceived effectiveness of such methods in achieving verifiable carbon emission reductions.

Quantitative analyses provide the basis for analysing the practices of setting a fixed internal carbon price and emission reductions. The results are used to determine if there is a correlation between internal carbon price and investment focus as well as the extent that a fixed internal carbon price can incentivise emission cuts (related to objectives 3 and 4).

1.4 Outline of the dissertation

Chapter 1 introduces the problem statement and the aims and objectives of the study.

Chapter 2 is a literature review into current carbon pricing policy and how it is implemented at international, national, and corporate levels. It looks at current research in to how it can help Governments, in particular the UK Government to achieve climate goals. The review also focuses on internal carbon pricing mechanisms that are currently employed by businesses and how and why increasing numbers of companies are implementing these schemes.

Chapter 3 presents the analytical research methods employed in the study. It looks to justify the methodology chosen and detail observed limitations.

Chapter 4 provides the results of the statistical analysis of CDP data, briefly highlighting and commenting on notable points and observations.

Chapter 5 discusses the findings of the literature review and statistical analysis amalgamating the two methods to answer the research question.

Chapter 6 concludes the study, briefly summarising the work undertaken, noting significant findings and recommendations.

Chapter 2. Literature Review

2.1 The economics of carbon

2.1.1 What is Carbon Pricing

Carbon pricing is an amalgamation of economics and science. Science has modelled and explained the likely impacts of climate change caused by anthropogenic sources which are inevitably caused by economic activities. The Stern Review is considered the first major step in understanding the relationship between economics and climate change. Kate Gordon, vice chair of climate and sustainable urbanisation at the Paulson Institute, when discussing the Stern Review's impact, noted that even though more than 10 years have passed since its publication, moving the climate issue from one of science to one of economics is still critically important (Gordon, as cited in Kahn, 2016). Andrew Steer, president of the World Resources Institute supports this view stating 'it [the Stern review] provided a massive leap forward in our understanding of the economics of climate change. The conclusions have stayed correct, but the messages would be much stronger if it were written today than they were then (Steer, as cited in Kahn, 2016).'

The Stern Review led by economist Nicholas Stern, was a landmark review released by the UK Government in 2006. Entitled 'The Economics of Climate Change: The Stern Review', the report ran to over 700 pages and gathered evidence from a wide range of sources and perspectives.

The Stern Report (2006) recommended actions that policy makers should implement to limit the increase in global temperature to 1.5°C. Part of the recommendations included harnessing global markets for mitigation. The report recommended that legislative bodies agree a target to limit the amount of Green House Gases (GHG) released into the atmosphere. The report advised that a price driven tax or trading instruments would incentivise and drive down emissions. It was hypothesised that taxes and tradable quotas could establish an international common market price, noting that the price signal should reflect the damage caused by emissions.

Criticism of the Stern Review centres on the low discount rate of approximately 1.4% used to calculate the projected costs of climate change (Cole, 2008). The London School of Economics defines Social Discount Rates as a tool 'to put a present value on costs and benefits that will occur at a later date' (LSE, 2018). The reason future savings/costs are discounted are twofold. One is the assumption that society will get wealthier over time, so a £1 now is worth more than £1 in the future. Second, is the assumption that people prefer a pound in their pocket now rather than tomorrow, known as propensity (LSE, 2018). Cole (2008) calculated that the Stern Reviews 1.4% discount rate multiplied projected climate change costs by two orders of magnitude over a more traditional six-percent interest rate for discounting future consumption. However, Neumayer (2007), contended that while the rate was lower than most other climate economic studies at the time, the review missed the opportunity to account for the non-substitutable loss of Natural Capital. Neumayer (2007) argues that if included this would justify the low discount rate used in study.

The Stern review focused on limiting global temperature increase to 1.5°C. The Paris agreement set a goal of limiting global warming to well below 2°C, preferably to 1.5 °C. Many signatories of the 2015 Paris agreement considered agreed 2°C limit to be unsafe and invited the IPCC to assess the impacts of limiting temperature increase to 1.5°C. The IPCC Special Report on Global Warming of 1.5°C was formally approved by the world's governments in 2018, it examined 6,000 peer-review publications and determined that whilst it is still technically possible to limit warming to 1.5°C, it would require unprecedented transitions in all aspects of society. The IPCC noted that without rapid societal transformation and ambitious greenhouse gas reductions measures the target of 1.5°C will be hard to achieve. The report emphasised that achieving the ambition of limiting temperature increases to 1.5°C should go hand in hand with achieving and overall sustainable agenda, underlining that temperature increase above 1.5°C will cause irreparable loss to the most fragile of ecosystems.

To meet a target of 1.5°C the report notes 'the world would require a major shift in investment patterns' McCollum et al., (2018) (as cited in IPCC, 2018) and found that explicit carbon pricing is relevant but needs to be complemented with other policies to meet a 1.5°C target.

2.1.2 Why price carbon?

There is a growing consensus that internal carbon pricing is essential in the transition to a low-carbon economy (Bento and Gianfrate, 2020). The Carbon Pricing Leadership Coalition reported that 'a well-designed carbon price is an indispensable part of a strategy for reducing emissions in an efficient way' (Stiglitz and Stern, 2017). In addition to making the polluter pay, the coalition argued that carbon pricing is an effective tool for incentivising investment in low carbon technologies and initiatives and reduce future abatement costs. However, the report also noted that carbon pricing by itself may not be sufficient to meet the 2°C warming target set in Paris. The report concludes that 'explicit carbon pricing can be usefully complemented by shadow pricing in public sector activities and internal pricing in firms' (Stiglitz and Stern, 2017).

The OECD wrote that explicit carbon pricing in the form of carbon taxes and emission trading schemes is a cost-effective carbon management policy. This is because they incentivise low carbon initiatives. On the other hand, implicit carbon pricing through other policies that effect a countries CO_2e emissions, such as taxes to combat air pollution, may introduce higher costs (OECD, 2013). An additional positive of carbon pricing is that it incentivises polluters to reduce emissions quickly.

Burke et al. (2019) finds that carbon pricing is easier to get right than regulation and ensures carbon emissions are reduced as cheaply as possible. Giles and Hook (2020) writing in the Financial Times state that evidence on the effectiveness of carbon prices is clear, industries that are already subject to carbon taxes such as the European Emission Trading Scheme (EU ETS) emissions are falling fast. The same cannot be said for industries that are subject to stable taxes such aviation. The World Bank states that a carbon price sends financial signals of the value of low carbon investments (World Bank Group, 2020).

2.1.3 How to price carbon?

One of the main issues of pricing carbon is at what level should it be priced. A carbon tax that is too high will likely have political implications and therefore would be resisted by Government. These implications could include a resistance by industry to legislation that could give an unfair advantage to overseas competition who are not subject to such regulation. In contrast, a carbon price that is too low could send weak market signals for long term investment (Bento and Gianfrate, 2020). In 2017, only 15% of the worlds carbon emissions were subject to carbon pricing. Of that 15%, three quarters were subject to mechanisms that valued carbon at less than \$10/kgCO_2e (Stiglitz and Stern, 2017).

At the 22nd Conference of the Parties (COP) of the United Nations Framework Convention in 2016, the Carbon Pricing Leadership Coalition accepted a request to chair a high-level commission on carbon prices with the intention of driving forward the Paris agreement objective. The subsequent 'Report of the High-Level Commission on Carbon Prices' was published in 2017. The commission reviewed multiple sources to determine at what price level would carbon pricing achieve the temperature objective of the Paris Agreement. The Commission concluded that the explicit carbon-price level should be at least US\$40–80/tCO_2e by 2020 and US\$50–100/tCO_2e by 2030, providing supportive environmental policies are in place (Carbon Pricing Leadership Coalition, 2017).

Burke et al (2019) report 'How to Price Carbon', recommended that 'it is sensible to implement a politically feasible 'medium level' carbon price that is higher than today's price'. It also recommended that there is flexible approach to carbon pricing as polluters have varying degrees of scope for reducing in their emissions, therefore, pricing should but set at an industry level. Burke et al. (2019) also found that whilst carbon pricing does discourage emissions, it does not necessarily encourage negative emissions[3]. The report recommends that a complementary price mechanism should be set up to encourage the development and use of negative emissions technology. Burke et

[3] Negative emissions technology: A technology that removes carbon dioxide from the atmosphere and stores it on land, underground or in the ocean.

al. (2019) recommended for non-energy intensive industry, a carbon price in the order of £40/tCO2 by 2020, rising to £100 by 2050 would ensure a zero-carbon outcome. Burkes comment of carbon pricing ensuring a zero carbon outcome is a bold statement as most other papers agree that carbon pricing alone would not achieve the net zero target.

2.1.4 International Carbon Pricing Policy/Mechanisms

There are several mechanisms for implementing a carbon price. These include cap and trade system, such as EU ETS, or a direct carbon tax. In 2020, there were 61 carbon pricing initiatives in place or scheduled: 31 were Emission Trading Schemes and the remaining 30 carbon taxes. Each applied quite different levels of cost to each tonne of carbon emitted. Figure 2 details national carbon price values, converted to GBP (£) in 2018. Sweden has the highest pricing policy of £104/tCO_2e, however, there are numerous exemptions available to emitters in Sweden which means that only 40% of the total emissions are subjected to this high tax rate (Jonsson, Ydstedt and Asen, 2020).

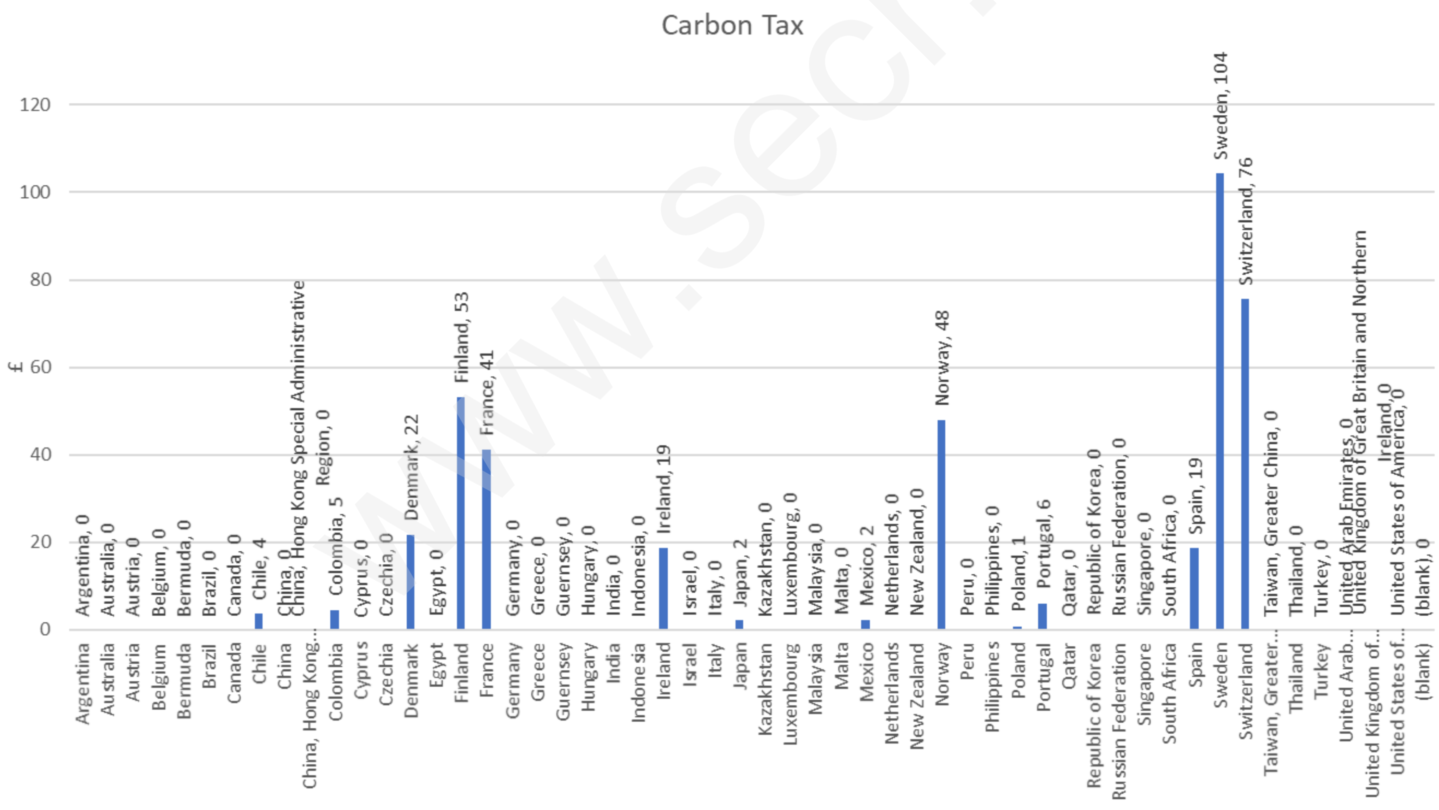


Figure 2. 2018 carbon tax value (£). Limited to countries of CDP respondents. Source: (World Bank Group, 2019)

2.1.5 Carbon leakage

A key debate in the introduction of carbon taxes is how local carbon taxes effect a company's ability to compete globally. Burke *et al.*, (2019) writes that 'it will be more difficult for industrial sectors that are exposed to global competition to reach net zero than those that are not, which has a material impact on the extent to which countries are willing to implement low carbon strategies.'

Current carbon taxes are implemented at a national level. A primary concern of implementing and/or increasing local carbon taxation is that the manufacturing of high carbon products could move to countries that have less stringent carbon taxes and therefore produce products at a lower cost. This is referred to as carbon leakage. A possible solution is the implementation of carbon border adjustment mechanisms that would effectively impose tariffs on products imported from countries with low carbon costs (World Bank Group, 2020).

The Carbon Pricing Leadership Coalition (CPLC), part of the World Bank, recognises that carbon pricing creates an advantage for low-emissions firms, sectors, and countries. The CPLC found that there is little evidence of carbon pricing leading to relocation of the production of goods and services or investment to countries with lower carbon taxes (CPLC, 2019). This finding is hard to reconcile with current manufacturing trends. In 2019, average UK industrial electricity prices were 11.53p/kWh (UK Government, 2021a), in China, it was approximately 8p/kW (CEIC, 2021). Therefore, industrial electricity costs in China, where a significant proportion of products consumed in the UK are manufactured, are approximately 30% cheaper. It is reasonable to assume that lower energy costs help lower manufacturing costs, therefore, increasing China's competitive advantage over UK manufacturing. UK Renewable Obligation and Feed in Tariff levies are passed on to customers by suppliers. They account for approximately 75% of the levies imposed on consumers. In 2018, taxes and levies accounted for approximately 50% of the cost per kWh of electricity (UCL, 2018). Whilst partial exemptions are in place for large energy consumers, the implementation of these implicit carbon taxes is likely to have a knock-on effect on UK competitiveness. In balance to this argument, Germany has higher electricity costs than the UK, yet its manufacturing output was approximately twice that of the UK in 2016 (Elliot, 2016).

The impact and level of change required will vary by industry and company. If correctly managed, the introduction of carbon pricing could drive innovation, reduce costs and in some sectors drive growth. The CPLC recommends that concern over competition should not be overstated as the risk is primarily associated with energy intensive and trade exposed industries which can be protected by locally tailored legislation (CPLC, 2019).

2.2 UK Carbon Pricing Policy

2.2.1 Context

The UK Governments' report 'UK Business Competitiveness and the Role of Carbon Pricing' recognises that the implementation a national carbon pricing policy poses risk to UK industries from international competitors. Implementation of the ambitious 2050 net zero strategy presents many opportunities by making the UK at the forefront of a global low carbon economy (BEIS, 2020). The report states the carbon pricing will be a key tool in implementing the UK carbon strategy and will present both positive and negative impacts to UK competitiveness. Possible downsides include an indirect increase in product costs due to increased environment compliance burdens and abatement costs. Possible upsides include spurring innovation, focusing long term investment, increasing sustainability, and creating increased demand for low carbon sustainable products. In agreement with similar reports and academics, the report concludes that a suite of complementary policy measures in addition to carbon pricing are likely to be required to reach net zero (BEIS, 2020).

Burke et al. (2019) analysed the UK governments current statutory greenhouse targets and actual emission performance to date. They found the polices are inconsistent with achieving 2050 targets set in legislation. Burke *et al.*, (2019) notes that the UK governments shadow price is currently set to achieve the original 80% cut from 1990 levels by 2050 (further details on shadow price are explained in section 2.3.6 Shadow price Carbon). To meet the net zero target, the UKs shadow pricing mechanism needs to be set at the upper range of the High-Level Commission Report coupled with incentives for negative emission technology. A new shadow price of around £50 (£40–100)/tCO_2e in 2020, reaching £75 (£60– 140)/tCO_2e in 2030 and £160 (£125–300)/tCO_2e in 2050 is recommended (Burke et al., 2019).

2.2.2 Evolution of UK carbon pricing schemes

The UK reduced its territorial emissions[4] by 30% between 2008 and 2019 and consumption emissions[5] (accounting for carbon leakage) by 18% between 2008 to 2017 (Gummer *et al.*, 2020). Whilst positive, the UK Governments Climate Change Committee's 2019 progress report asserts that 'the government's own projections demonstrate that its policies and plans are insufficient to meet the fourth or fifth carbon budgets (covering 2023–2027 and 2028–2032)' (Gummer *et al.*, 2019).

[4] Territorial emissions only include emissions which occur within the UK's borders

[5] Consumption emissions are associated with the consumption spending of UK residents on goods and services, including embedded supply chain emissions from imports.

The UK has long been an advocate of the development of carbon pricing internationally. It established Europe's first emissions trading scheme in 2002, which served as a pilot for the EU Emissions Trading System (EU ETS), and established London as a global centre of carbon trading.

2.2.3 EU Emission Trading System

The EU Emission Trading System has proved an effective carbon pricing policy in driving down emissions from the EU's largest polluters. Bayer and Aklin (2020) found that the EU ETS reduced total EU-wide emissions by 3.8% between 2008 and 2016 despite scepticism about the trading systems due to its perceived low price of carbon. Brexit now means that the Government is considering ways to implement a similar UK only system which will introduce a transitional Auction Reserve Price (ARP) of £15 (nominal) to ensure a minimum level of ambition and price (HM Government, 2020). This is considerably less than April 2021 EU ETS carbon pricing levels reaching over €45 per tonne (Chestney, 2021).

2.2.4 CRC energy efficiency scheme

The UK Governments CRC Energy Efficiency Scheme operated between 2010 and 2019 and applied to UK entities that consumed more than 6000MWh/year. It required participants to purchase allowances for each tonne of CO_2e emitted. This could be done in advance of the reporting year for a reduced cost (Forecast Sale Price) or after the reporting year (Compliance Sale Price), allowances could also be traded on a secondary market. In its final year 2018/19, the forecast and compliance price per tonne was £17.20/tCO_2e and £18.30/tCO_2e respectively (BEIS, 2017). In 2016 following a Government consultation the UK government declared that it was to abolish what it described as a burdensome and bureaucratic tax which would be replaced with a new streamlined reporting. To recover revenue that would be lost through the abolition of the CRC scheme the Government announced that from April 2019 a single energy tax levied through increases in the Climate Change Levy (CCL) would drive energy efficiency by incentivising industry to greater energy efficiency (HM Treasury, 2016).

2.2.5 Climate change levy (CCL)

Introduced in 2001, CCL is a UK-wide tax on electricity, gas, LPG and solid fuels supplied to businesses and public sector consumers (HM Government, no date). CCL tax burden is theoretically designed to be cross-subsidising since income from the scheme is used to reduce employer contributions to social security. Pearce (2006) notes that due to the varied nature of industry, there will inevitably be disparity between net savings and costs dependant on business type and commercial activities.

Business energy suppliers are required to charge applicable businesses CCL as they supply the taxable commodity. Reduced rates are available to energy intensive industries under climate change agreements (CCA). A CCA is a voluntary agreement where industries commit to reduce energy and carbon emissions against agreed targets over 2-year target periods (Environment Agency, 2020). To account for loses from the closure from the CRC scheme, CCL is set to increase as detailed in Table 1. CCL charges.

Table 1. CCL charges

Taxable commodity	**Rate from 1 April 2018**	**Rate from 1 April 2019**	**Rate from 1 April 2020**	**Rate from 1 April 2021**
Electricity (£ per kilowatt hour (KWh))	0.00583	0.00847	0.00811	0.00775
Gas (£ per KWh)	0.00203	0.00339	0.00406	0.00465
LPG (£ per kilogram (kg))	0.01304	0.02175	0.02175	0.02175
Any other taxable commodity (£ per kg)	0.01591	0.02653	0.03174	0.03640

Source: https://www.gov.uk/guidance/climate-change-levy-rates#main-rates

2.2.6 Streamlined Energy & Carbon Reporting

In April 2019, the UK government replaced the CRC Energy Efficiency Scheme with a new reporting obligation entitled Streamlined Energy & Carbon Reporting (SECR) (Defra, 2019). Notably, SECR expanded the scope of companies that had to report under CRC. In addition to listed companies already obligated to report under CRC, companies that meet the definition of 'large' must now disclose their annual energy consumption and carbon emissions and energy saving actions completed during the reporting year. In addition to energy and GHG emissions, quoted UK companies are now required to report their global GHG emissions.

2.2.7 UK carbon taxes

Both Implicit and Explicit carbon taxing currently occurs in the UK, and most experts agree that its implementation and strategy is discombobulated (Giles and Hook, 2020). The proceeds of environmental levies such as the renewables obligation, contracts for difference, and feed-in tariffs are significant. These taxes alone were forecast to reach £12 billion in 2020/21 (Johnson, 2016). A central criticism of the UKs carbon tax system is the inconsistency of its application and the effective subsides it imposes on high carbon emissions. Examples include agriculture, which accounts for 10% of the UK's carbon emissions, currently receives 50% red diesel fuel duty subsidies (Giles and Hook, 2020). Natural gas is another heavily subsidised emitter, Johnson (2016) argues that when the low VAT rate of 5% is considered, a negative carbon price is operating.

2.3 Internal carbon pricing

2.3.1 What is internal carbon pricing?

The institute for Climate Economics describes internal carbon price as 'a cost value attributed to carbon emissions that companies voluntarily set for themselves, to internalise the economic cost of their greenhouse gas emissions' (I4CE, 2016). The Carbon Pricing Leadership Coalition (CDLC) explains that internal carbon price mechanism is a useful tool to help decision makers invest in low carbon technologies and initiatives. The application of an internal carbon price helps make low carbon investment decisions economically more attractive, helping to make smarter business decisions, encourage innovation, and reduce carbon emissions (Stiglitz and Stern, 2017). In addition to driving a company-wide low carbon agenda, an internal carbon price is used by organisations as a risk management tool to enable greater resilience to regulatory climate polices and be more favourable to emission reduction targets (I4CE, 2016).

2.3.2 Why companies are applying a carbon price?

The Climate Disclosure Project (CDP) found that the approximately 80% of companies that have set an internal price, do so as a risk management tool. The remaining 20% use internal carbon pricing as a transition tool (CDP, 2017). In addition to financial risks imposed by regulators, companies are increasingly aware of the environmental risk of climate change. Companies are using carbon pricing as a tool to account for the scientific projections of the impacts of climate change on a business's supply chain and customer base (CDP, 2017).

Internal carbon pricing used as a risk management tool enables businesses to internalise the existing and expected cost of carbon. World Economic Forum (2016) Global Risks Report ranks "failure of climate change mitigation and adaptation" as one of the most significant risk impacting companies for the years to come. Risks include physical risks such as the effect of increased extreme weather events on supply chains and regulatory risks, for instance, the increase carbon taxes by governments.

Royal Dutch Shell, commonly known as Shell, is an Anglo-Dutch multinational oil and gas company. Shell has been using carbon price since 2000 and introduced carbon price of $40/tonne in 2008. The primary focus of Shell's internal carbon price is its scope 1 emissions as that is where they perceive highest regulatory risk (Moorhead, 2015). Scope 1, 2 and 3 emissions are explained in section 2.5 Corporate carbon accounting

Companies are not just applying carbon pricing to scope 1 and 2 emissions. Manufacturers of carbon intensive products such as the car maker VW are identifying significant risks in both upstream and downstream scope 3 emissions (Moorhead, 2015). Risks include potential regulations from downstream use of manufactured products, to concern over security of supply of raw materials. Dasaklis and Pappis (2013) warn that climate change has the potential to impact all aspects of the supply chain.

In 2013, the multinational commodity trading and mining company Glencore, had investments in coal and oil that accounted for 1.5-2% CO_2e of global emissions (Moorhead, 2015). In 2020 Glencore set out its 'pathway to net zero in 2050' committing to reducing its emissions by 40% across all scopes from a 2019 baseline by 2035, reaching net zero by 2050 (Glencore, 2020). In 2020, Glencore's scope 3 emission were 271 million tCO_2e, of this, 253 million tonnes were attributed to downstream use of the fossil fuels it produced (Glencore, 2020). In comparison, its combined scope 1 and 2 emissions accounted for 24.3 million tCO_2e (Statista, 2020). Therefore, reducing its scope 3 emissions that account for 91.8% of total emissions to net zero by 2050 will require significant divestment from high carbon industries/products, plus other mitigation efforts such as carbon offsetting. Glencore states that Marginal Abatement Cost Curve (MACC) methodology to map its route to net zero emissions. MACC enables companies to visualise and quantify carbon reduction opportunities by assigning a price to emissions (£/tCO_2e), helping to target reductions across all scopes (Tempest, 2016).

2.3.3 Internal Carbon Pricing Trends

Over 80% of companies that reported to the CDP in 2018 identified climate-related risks facing their business (CDP Europe, 2018). Between 2014 to 2017, the number of companies reporting to CDP setting an Internal Carbon Price increased from 150 companies to 600, by 2019 this had increased to 1600 companies (CDP, no date b). The Institute for Climate Economics in their 2016 report on internal carbon pricing, cautioned that whilst the rapid increase in organisations applying an internal carbon shows a genuine interest in its use as a tool for supporting climate strategy, there are quite different versions of carbon pricing and its application (I4CE, 2016). The CDP provide a more optimistic view finding 'there is growing consensus that carbon pricing is the most flexible and the most cost-effective approach to mitigating the impacts of climate change (CDP, 2017)'

2.3.4 Internal Carbon Pricing & Corporate Governance

Bento and Gianfrate (2020) analysed CDP disclosures between 2015 and 2017 to determine what influenced internal carbon pricing. The study found that there is a positive relationship between energy intensive industries, geographical location, role of corporate governance and higher internal carbon price. This reinforces the IPCC findings that diversity beyond explicit carbon pricing and implementing effect policies are of maximum importance in achieving a climate target of 1.5°C (IPCC, 2018). To quantify corporate governance quality, Bento and Gianfrate (2020) compared carbon prices with an organisation's percentage of independent directors and percentage of female directors. The results showed a positive and statistically significant relationship with prices (Bento and Gianfrate, 2020). Whilst the correlation may occur, the paper does not discuss that the nature of the business activities undertaken by those companies. These activities could be the driving force behind having both a high carbon price and greater board diversity and that the two could be independent variables and not necessarily interlinked.

Bento and Gianfrate (2020) also found that there is statistically significant correlation between organisations that have headquarters in a country that has a high GDP per capita and high carbon prices which is further strengthened when the headquarters is in country that have climate policies in place (carbon-tax or cap-and-trade scheme). An additional variable not fully explored by Bento and Gianfrate is how high carbon pricing could be linked to greater consumer choice and influence that companies must manage in high GDP countries. An important conclusion of Bento and Gianfrate (2020) study is that where lax national climate policies exist then lower Internal Carbon Prices are implemented, re-enforcing the Institute for Climate Economics statement that Internal carbon pricing takes its lead from Government pricing policies (I4CE, 2016).

2.3.5 Types of Internal Carbon Price

There are four leading methods that companies use to implement an internal carbon price, however some companies apply a hybrid approach by applying a mix of methods to meet their specific business requirements (Gajjar, 2018).

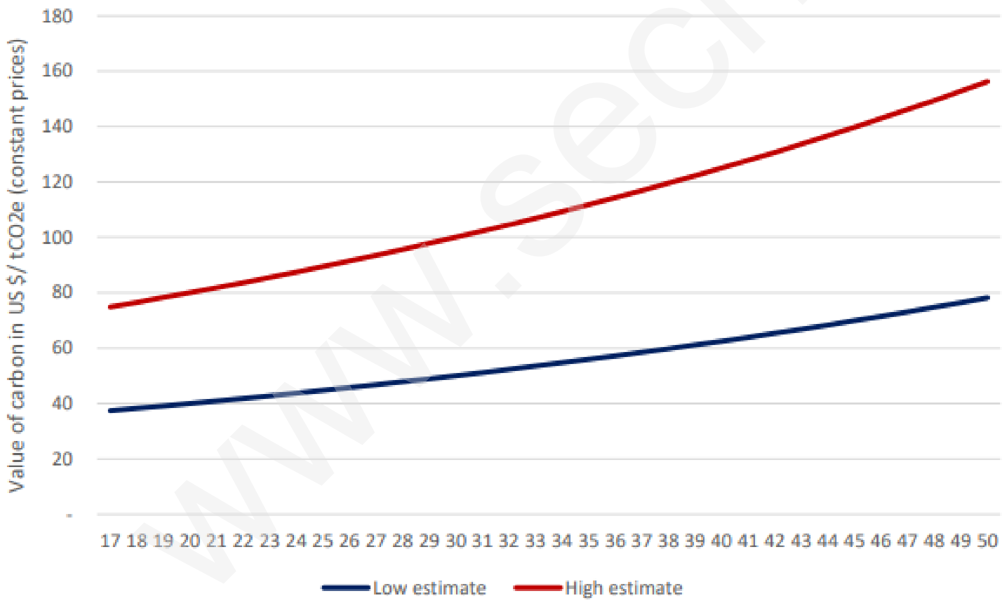
These methods are:

- Shadow Price
- Internal Carbon Tax and Fee
- Implicit Carbon tax
- Internal Cap and trade,

2.3.6 Shadow price Carbon

The shadow price of carbon is an accounting mechanism that accounts for the social and environmental impact of carbon emissions. The concept is that if businesses and organisations accounted for the true cost of their emissions it might change how they invest and conduct business.

The shadow price links the carbon cost to investment decisions. Large investment organisations such as the European Bank for Reconstruction and Development (EBRD) and the World Bank recognise that the market does not fully capture the cost of pollution, especially in areas where fossil fuel use is subsidised (EBRD, 2019b). To account for these impacts, institutions now apply shadow price methodology where funding is rejected if the cost benefit analysis is negative when the cost of carbon emissions is included in the appraisal. The EBRD calculates the cost of carbon emissions by simply multiplying the carbon emissions of the whole lifetime of the project by the high and low values from the range of prices recommended by the High-Level Commission on Carbon Prices, see Figure 3. (EBRD, 2019).



Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Low	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
High	75	77	78	80	82	84	86	87	89	91	94	96	98	100	102	105	107

Year	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Low	55	56	57	58	60	61	63	64	65	67	68	70	71	73	75	76	78
High	109	112	114	117	120	122	125	128	131	134	137	140	143	146	149	153	156

Figure 3. High-Level Commission on Carbon Prices recommended Shadow Price of Carbon. Source: (EBRD, 2019)

There is growing awareness in the private sector that the shadow price of carbon should be included investment decision making (CDP, 2017). Recognising the social and business necessity of limiting the impacts of climate change, some companies are going further the High-Level Commission pricing recommendations and utilising higher shadow price figures. For example, Swiss retailer Coop sets their internal price of CHF 150 (£125)/kgCO_2e (Gold Standard, 2020).

2.3.7 Internal Carbon Tax and Fee

Internal taxes or carbon fees go a step further by charging business units for their emissions and using the revenue generated to support investment into clean technologies and/or carbon reduction projects that help the transition to a low-carbon economy. As well as internal investments, some companies that generated income from internal carbon taxation, invest in purchasing external carbon credits to further reduce the carbon impact of their business activities (I4CE, 2016).

2.3.8 Implicit Carbon tax

A retroactively applied cost determined by calculating the cost of emission reduction projects the company has implemented. The data can then be used to set an internal carbon price which can be used by the company to shift investments toward lower carbon initiatives.

2.3.9 Internal Cap and trade

A system similar the EU Emission Trading Scheme (EU ETS) where carbon allowances are set and traded internally.

2.4 Internal carbon pricing difficulties & criticism

The Institute for Climate Economics (2016) in its internal carbon pricing report states that 'carbon pricing policies cannot exist without political decisions taken by governments.' Whilst Government policies are strong drivers, the growing awareness of climate change impacts and consumers preference for low impact products and services are strong influences in companies desiring to engage in more environmentally friendly practices (Bento and Gianfrate, 2020). As a result, some organisations have opted to apply an Internal Carbon Price themselves without waiting for national or international regulations. Why organisations voluntarily apply internal carbon pricing is dependent on several factors including business activities, culture, operating locations, and strategic goals in terms of decarbonisation (I4CE, 2016).

A primary problem with internal carbon pricing is the variety and scale of businesses. Physical and regulatory risks associated with climate change are likely impact each differently. Energy intensive industries are more likely to set high internal prices (Bento and Gianfrate, 2020) as carbon regulation is likely to have a bigger impact on them compared to organisations where energy spend is a relatively insignificant proportion of turnover. In addition, companies that have global supply chains that are susceptible to extreme weather events are also likely to adopt higher carbon prices. This variety muddies the analysis of what internal carbon pricing and the levels that it should be set at to help organisations and Governments achieve business and climate goals.

An additional problem is the level of discount rate should be applied to Internal Carbon Price calculations. The US Government calculated the social cost of carbon (SCC) using discount rates of 5%, 3%, 2.5% plus an estimate of the high-end tail of the estimates of the SCC at a 3% discount rate (US Government, 2016). As is clearly visible in Table 2 the impact of different discount rates has a significant effect on the cost of carbon.

Table 2. Projected carbon price at different discount rates. Source: (US Government, 2016).

	Discount Rate			
Year	5% Average	3% Average	2.5% Average	High Impact (95th pct at 3%)
2015	$13	$42	$65	$122
2020	$14	$49	$72	$143
2025	$16	$54	$79	$161
2030	$19	$58	$85	$177
2035	$21	$64	$91	$196
2040	$24	$70	$98	$213
2045	$27	$75	$104	$230
2050	$30	$80	$111	$247

Variation in price could inadvertently cause more damage than good. By under accounting the social cost of carbon companies could be inadvertently giving themselves a licence to pollute. Barron and Parker (2018) argue that 'setting an Internal Carbon Price, does not offer a single authoritative estimate of the damages of climate change.'

Bento and Gianfrate (2020) study on the motivation of companies to implement carbon pricing concluded that greater study is required on how the practice of internal carbon pricing is implemented. To date, there is no set methodology or regulatory auditing process for how companies instigate internal carbon pricing mechanisms (I4CE, 2016). This lack of clarity and uniform application could reduce the value of carbon pricing. Greenwashing, where a company spends more time and effort marketing their green credentials rather than applying them could exacerbate the problem. An organisation may wish to improve its reputation, increase sales, or attract external investment by disclosing that they use an internal shadow price, but they may not actually apply such prices to decisions (Bento and Gianfrate, 2020).

2.5 Corporate carbon accounting

There are several methods and systems that organisations can use to measure and report their carbon emissions. The most notable methods include:

- GHG Reporting Protocol - Corporate Standard.
- International Organisation for Standardization, ISO (ISO 14064-1:2018).
- Climate Disclosure Standards Board, CDSB.
- The Global Reporting Initiative Sustainability Reporting Guidelines

Most methods split emissions in to three categories: Scope 1,2 and 3 emissions.

Scope 1 (direct emissions) are emissions released straight into the atmosphere by activities owned or controlled by an organisation.

Scope 2 emissions (energy indirect) are emissions being released into the atmosphere associated with an organisation's consumption of purchased electricity, heat, steam and cooling.

Scope 3 emissions (other indirect) are emissions that are a consequence of a business's actions, which occur at sources not owned or controlled by the business and are not classed as scope 2 emissions. Most methodologies state it is voluntary to report Scope 3 emissions.

To calculate emissions an organisation would multiply their energy consumption by the appropriate conversion factor to obtain a $kgCO_2e$ figure. In the UK, Greenhouse Gas conversion factors are updated and published each year by the Government. An additional carbon source that needs to be accounted for are fugitive emissions from refrigeration and process activities. Calculation of these emissions requires users to multiply the amount of refrigerant lost or gases emitted during process activity by the relevant conversion factor to obtain $kgCO_2e$.

2.6 Options to reduce GHG emissions in companies

2.6.1 Internal reductions

Companies looking to reduce internal emissions can do so through efficiencies, abatement, and procurement. Efficiencies can reduce the emissions form business activities. Examples include, the purchase of low emission vehicles, upgrading heating/cooling plant to energy efficient alternatives and better management and control of energy consuming/emission producing activities. Abatement includes the removal/reduction carbon emitting sources from the business portfolio e.g. Glencore divesting from coal/oil production. Implementing low carbon procurement practices can motivate organisations to purchase market-based electricity from low carbon sources and require suppliers to reduce the carbon impact of their value chain.

Companies can further reduce emissions from their value chain by carbon insetting. Carbon insetting is where companies invest in carbon reduction activities of their suppliers and consumers. This approach arguably provides a much more tangible mechanism for companies to reduce the environmental impact of the organisations entire business activities.

2.6.2 External reductions (carbon offsets)

External carbon reductions, known as carbon offsetting, is the practice of an organisation or individual investing in carbon reduction activities from around the globe to mitigate their own carbon footprint. A carbon offset, or ‘credit’, usually equates to 1 tonne CO_2e (tCO_2e) that has been sequestered or prevented from entering the atmosphere (Goldstein, 2016). All carbon offsets are based on the concept of additionality where the emission reductions must occur because of the implemented activities funded by the purchase of the carbon credit. In most instances the offsets are sold by companies such as ‘Gold Standard’ and ‘Climate Action Reserve’ that certify the additionality of the credit being purchased. Motivations for the purchasing credits include increasing annual net carbon savings, mitigating carbon emissions where reduction is not financially viable or practical and marketing goods and services that are sold as net zero emissions.

Carbon offsetting has increased significantly in recent times. In 2019 the carbon offsetting market was estimated to be worth $500m per year. There is significant criticism of the carbon offsetting, with some experts are arguing that carbon offsetting is proving to be a dangerous “get out jail free card” which is potentially reducing investment in low carbon technology and energy efficiency (Knapton and Horton, 2019). Low-cost carbon credits that require little effort from the purchaser are potentially sending wrong market signals. Another major concern is the validity of the carbon saving claims. A recent study by the European Commission found that 85% of offset projects funded by the EU Clean Development Mechanism (CDM) failed to reduce emissions (Cames *et al.*, 2016).

Chapter 3. Methodology

3.1 Research Methods

The primary aim of this research is to determine if a mandatory, fixed internal carbon fee applied to business carbon emission would help businesses and the UK Government achieve climate targets. The previous chapters literature review found that current climate mitigation actions/policies implemented by most Governments, including the UK, are considered inadequate to meet climate objectives.

To evaluate if there is a correlation between businesses pricing carbon and carbon emissions reductions, it was determined the research should examine companies that have both applied and not applied a voluntary internal carbon price. It is hypothesised that if a link is found between the implementation of an internal carbon price and GHG emission reductions, this will present a convincing argument that the national application of mandatory internal carbon fee, would help the UK Government reach its climate objectives.

To achieve objectives 3 and 4, submissions by companies to the Climate Disclosure Project (CDP) were analysed. The CDP is a not-for-profit organisation that operates a global environmental disclosure system for investors, companies, cities, states and regions to manage their environmental impacts (CDP, no date a). This study focused on responses in 2018 from large multinational companies that voluntarily disclosed their information to the CDP project. The reasons why companies choose to disclose are varied, they include investor and customer demand, identification of climate change risks and improved resilience to future environmental taxes and policy changes (CDP, no date c).

The number of companies disclosing to CDP since 2018 has risen rapidly. In 2020, over 9600 companies disclosed environmental data to CDP in 2020, accounting for over 50% global market capitalisation CDP collects environmental data from companies through an online questionnaire. The questionnaire gathers information on corporate climate governance, emissions, energy consumption and carbon reduction initiatives. The questionnaire is split into the following sections:

- Governance
- Risks and opportunities
- Business strategy
- Targets and performance
- Emissions methodology
- Emissions data

- Energy
- Additional metrics
- Verification
- Carbon pricing
- Engagement

3.2 Data collection

This research analysed 1804 questionnaire responses submitted to CDP in 2018. Appendix A: CDP Questionnaire Questions provides a list of questions respondents are required to answer (where possible). The data provided both discrete and continuous variables allowing for quantitative analysis to be undertaken.

3.3 Data sources and variables

To achieve objectives 3 & 4 of this research, the total carbon savings from Questions C4.3 and total annual investment costs from Q4.3b_6-7 were compared against Q11.3b_C4 carbon price level to determine carbon price influence on investment and carbon savings.

3.3.1 Variable Selection

The data included Nominal and Scale variables. To determine what influences the effect of internal carbon price on annual investment and estimated carbon savings the following variables were selected for analysis:

Scale Variables:

1. Total (tCO_2e) Savings: This is the cumulative carbon savings of all projects listed in response QC4.3a_C2. Question (C4.3a) required participants to identify the total number of initiatives at each stage of development and the estimated annual metric tonnes CO_2e saving from those initiatives. The stages of development were 'Under investigation', 'to be implemented', 'Implementation commenced', 'Implemented', 'Not to be implemented'. 'Not to be implemented' & 'under investigation' were discounted from the analysis as it was determined not to be relevant to the study. The combined carbon savings from each of the remaining implementation stages were used to determine each company's 'Total Carbon (tCO_2e) Savings'. The figure includes projected future carbon savings which introduces addition levels of uncertainty. It was decided to include future savings for two main reasons: 1. There will inevitably be a time lag between implementation of a carbon reduction action and carbon savings and 2. it

provides an indication of an organisations carbon saving objectives.

2. Internal Carbon Price: This is the actual price recorded by the respondent in question C11.3a_C4. Respondents stated the carbon price in their country of origins currency. This was converted to GBP using average exchange rates for 2018. Where responses stated carbon prices of greater than £200/tCO_2e the companies publicly available environmental reporting literature was reviewed. In all cases, the reported figure was determined to be inaccurate and discounted from the analysis.

3. Investment Subject Year: Question C4.3b_C7_ required respondents to detail investment in the carbon reduction initiatives listed in Question C4.3b_C1 for the subject year. Investment Subject Year is the cumulative total of these figures.

4. Annual savings through investment in Subject Year: Question C4.3b_C6_required respondents to estimate the annual monetary savings they would achieve through the initiatives listed in Question C4.3b_C1. Annual savings through investment in Subject Year is the cumulative total of these figures.

5. Total (tCO_2e) savings from Projects in subject year: This is the cumulative total of the projected carbon savings (C4.3b_C3) for the carbon reduction initiatives listed by respondents in question C4.3b_C1. This is different to response C4.3a_C2. As it does not include 'to be implemented', 'Implemented' figures.

6. Combined Scope 1 and 2 emissions (tCO_2e): This is the combined Scope 1 (C6.1_C1) & Scope 2 (C6.3_C1 Location & C6.3_C 2Market Based) carbon emissions as detailed by respondents for the subject year.

7. Scope 3 emissions (tCO_2e): The total Scope 3 emissions for the subject year provided by respondents answer question C6.5_C2

8. Adjusted Intensity figure tCO_2e/(GBP): Adjusted intensity figure is the Combined Scope 1 & 2 emissions divided by GBP. The original figures were entered in the currency of currency of origin. This was adjusted to GBP using average currency exchange rates for

2018 (*Historical Rates Tables | Xe*, no date).

9. Percentage Spend of revenue on energy: Question C8.1 requires respondents to provide a percentage figure of proportion of revenue that is spent on energy. Respondent are required to select a percentage range in which their result would fall (e.g. >0%<5%, >5%<10%). In order to allow analysis, the highest factor in the range was selected. For example, if a respondent selected >5%<10%, 10% was the figure selected.

10. Total MWh: This is the total energy consumed by the respondent during the subject year in MWh as entered in response to question C8.2a_C4.

11. Carbon Credits (tCO_2e) Purchased: If the respondent purchased carbon credits during the subject year, this is the total carbon value of all credits purchased in metric tonnes of CO_2e and entered in response to question C11.2a_C5.

Nominal Variables:

1. Board-level oversight: Question (C1.1) required respondent to respond Yes/No if there it board level oversight for climate-related issues within the organisation?
2. Management Incentives: Question (C1.3) required respondent to respond Yes/No if employees are incentivised for the management of climate related issues including the provision of incentives?

3.3.2 Models

As noted in the previous chapter, explicit and implicit carbon pricing mechanisms are influenced by a company's location, industry type/sector and national/international carbon regulations (Bento and Gianfrate, 2020). To assess the influence of carbon price on carbon savings and investment (objectives 3 and 4) the data was split and analysed by country and by industry. Further to this the influence of the multinational ETS scheme was analysed by splitting the data by ETS and none ETS areas.

Additional analysis included splitting responses by Internal Carbon Price level. Discounting responses that did not apply a carbon price, and the discounting in stages those that applied a carbon price of less than £10, £20, £30, £40, £50, £75, £100.

3.3.3 Analysis Methods

The data was considered to be non-parametric due to observed outliers. To the reduce the impact of outliers on results, the data was manipulated using two methods. 1. univariate outliers with values outside the range +/-3.29 standard deviations from mean were removed. 2. natural log transformation was conducted. The results are presented in 4.1.1 Data observations and transformation'.

Dependent variables selected were internal carbon price (C11.3a_4), projected total carbon savings (tCO_2e) savings though current and planned carbon reductions initiatives (C4.3a_C2), investment in carbon reduction initiatives in the subject year (C4.3b_C7), projected annual monetary savings through those investments in the subject year (C4.3b_C6). The subject year refers to 2018. To determine their effect on each other, dependant variables were analysed as both dependant and independent. The remaining variables listed in section 3.3.1 Variable Selection', were analysed as independent variables.

Log regression was conducted to model the relationship between the dependant and independent variables.

To explain the relationship between independent variables (outliers removed) and their effect on the dependent variables 'Total tCO_2e Savings (outliers removed)', Baron and Kenny mediation analysis was completed. Three regressions were completed on each data set. For mediation to be supported the following criteria must be met: Regression 1 result: the independent variable must have a significant effect on the dependent variable. Regression 2 result: the independent variable must have a significant effect on the mediator variable. Regression 3 result: the mediator must have a significant effect on the dependant variable when the independent variable is included, and the independent variable should no longer have a significant effect on the dependant variable (Baron and Kenny, 1986). The results are presented in Table 6, located in chapter 4, detailed results are presented in Appendix B: Baron Kenny Mediation Analysis Results (Full).

Spearman's ranks analysis was used to evaluate the strength of relationships between the variables subjected to natural log transformation. The result will always be between 1 and minus 1. The closer the relationship is to +1 the stronger the positive monotonic relationship (Lund and Lund, 2015). To evaluate the strength of relationship the results were separated in to three groups according to Cohen's Standard (Cohen, 2013) Group 1, 'Small Effect' (coefficients between.10 and .29), Group 2 'Moderate Effect' (coefficients between.30 and .49), Group 3 'Large Effect' (coefficients above .50). The results are presented in Table 7 & Table 8 , located in chapter 4.

3.4 Limitations/Omissions/Assumptions

As the CDP project is voluntary, the study is acknowledged to be inherently biased towards large companies where climate change is already high up in the corporate agenda. Respondent companies must have the resources available to respond to the questionnaire which suggests they have in-house environmental teams or have employed external experts.

The report analyses Total tCO_2e savings. This is a combination of current and projected carbon savings from carbon reduction initiatives. It is not possible to verify the figures presented by respondent, therefore it must be assumed there will be errors in the data provided.

None of the data provided by the respondent is required to be verified by a third party. The qualifications and experience of the respondents calculating and reporting the information is unknown. The high carbon prices of several responses were obviously incorrect as they were out by several orders of magnitude. These responses were discounted from the data set.

2020 CDP data set consisted of over 9600 responses, significantly more than 2018's 1804 responses. A larger data set which would likely improve the accuracy and results from the models. Due to prohibitive costs of obtaining the data from CDP, it was not possible to analyse a more recent data set.

Chapter 4. Analysis of results

4.1.1 Data observations and transformation

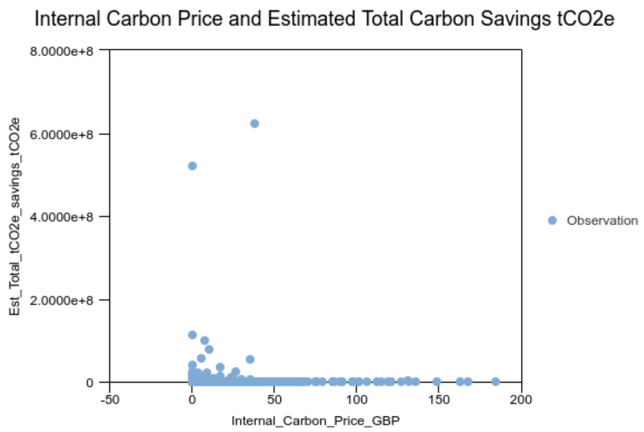


Figure 4. Internal Carbon Price against Estimated Total tCO_2e Savings

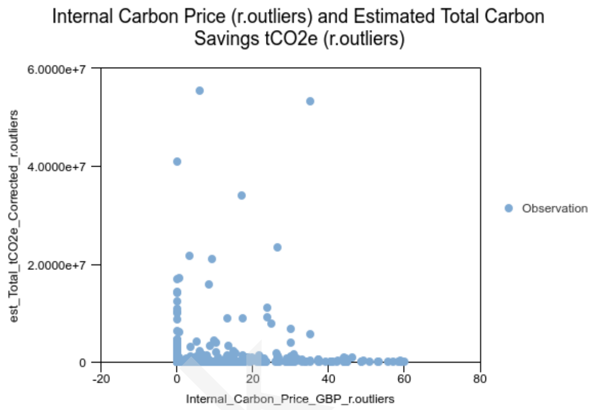


Figure 5. Internal Carbon Price against Estimated Total tCO2e Savings (Outliers Removed)

A linear regression analysis was conducted to assess whether Internal Carbon Price significantly predicted Estimated Total tCO_2e savings. The result was found to be not statistically significant F(1,1755) = 2.26, p = .133, R2 = 0.00. Figure 4 is a scatter graph of the data showing significant outliers. It was hypothesised that outlier was likely due to input errors by respondents. Linear regression analysis was repeated using data that has been modified by removing univariate outliers returned significant results $F(1,1714) = 18.33$, $p < .001$, $R^2 = 0.01$.

Table 3 details the descriptive statistics of the original data. Log transformation was conducted to reduce the variability of the data (Feng *et al.*, 2014). Table 4 shows the results of the natural log transformation of the data that significantly reduced data skewness and Kurtosis.

Table 3. Descriptive statistics of variables

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Investment Subject Year (GBP)	7.57×10^{7}	9.08×10^{8}	1773	2.16×10^{7}	0	2.73×10^{10}	22.37	572.08
Scope 3 emissions- tCO2e	1.02×10^{8}	3.15×10^{9}	1773	7.49×10^{7}	0	1.31×10^{11}	40.44	1667.71
tCO_2e savings from Projects in subject yr	1.10×10^{6}	2.48×10^{7}	1773	588010.9	0	8.97×10^{8}	31.94	1072.61
Total MWh	3.11×10^{7}	3.13×10^{8}	1773	7.43×10^{6}	0	1.21×10^{10}	33.38	1258.72
Combined Scope 1 and 2 emissions	2.69×10^{8}	4.74×10^{9}	1436	1.25×10^{8}	0	1.13×10^{11}	20.97	463.29
Total tCO2e savings tCO_2e	1.24×10^{6}	1.99×10^{7}	1773	471597	0	6.23×10^{8}	27.64	804.18
Percentage spend on energy?	9.61	12.92	1773	0.31	0	100	4.16	20.62
tCO2e Carbon Credits Purchased	50536.32	519738.5	1773	12343.28	0	1.58×10^{7}	21.62	560.25
Internal Carbon Price (GBP)	5.44	16.96	1757	0.4	0	184.53	5.24	34.48
Intensity figure tCO_2e/(GBP)	7.45×10^{6}	1.30×10^{8}	1360	3.51×10^{6}	0	3.78×10^{9}	22.29	574.6
1 2 3 Scopes Emissions	3.22×10^{8}	5.32×10^{9}	1757	1.27×10^{8}	0	1.31×10^{11}	20.5	441.81
Annual Savings (GBP) through Investment in Subject Year	1.21×10^{7}	1.93×10^{8}	1773	4.57×10^{6}	0	7.14×10^{9}	31.89	1110.49

Table 4. Descriptive statistics of variables - Log transformation

Variable	M	SD	n	SE_M	Min	Max	Skewness	Kurtosis
Internal Carbon Price GBP log	0.619	1.236	1757	0.029	0	5.223	1.793	1.853
Est Total tCO2e savings tCO_2e log	8.245	4.252	1757	0.101	0	20.25	-0.596	-0.17
Investment Subject Year GBP log	10.544	6.643	1757	0.158	0	24.032	-0.693	-0.985
Scope 3 emissions tCO_2e log	11.14	5.2	1757	0.12	0	25.6	-0.84	0.12
1 2 3 Scopes Emissions log	12.86	4.19	1757	0.1	0	25.6	-1.12	2.24
Annual Saving through Investment in Subject Year GBP log	9.981	6.005	1757	0.143	0	22.689	-0.801	-0.832
Combined Scope 1 and 2 tCO_2e log	11.835	3.909	1424	0.104	0	25.452	-1.185	2.802
Carbon Credits Purchased tCO_2e log	1.935	4.008	1757	0.096	0	16.573	1.796	1.659
Intensity figure tCO2e (GBP) log	0.589	1.972	1349	0.054	0	22.054	6.381	54.972
Total MWh log	13.534	3.728	1757	0.089	0	23.218	-1.646	4.403
Total tCO_2e savings tCO_2e log	8.086	4.238	1757	0.101	0	20.25	-0.563	-0.212
Est Project Year tCO_2e savings log	7.597	4.053	1757	0.097	0	20.614	-0.471	-0.263

3.3.4 Carbon price type

If respondents selected that their organisation uses an internal price on carbon (Question C11.3), question C11.3a_C6 asks how it was determined. The disclosures identified a variety of methods as detailed in Figure 6 below. Figure 6 details the average value that each method, or combination of methods was reported in the disclosures. The highest average carbon price was reported by companies that use both Internal Carbon Fee and Internal Trading carbon pricing mechanisms.

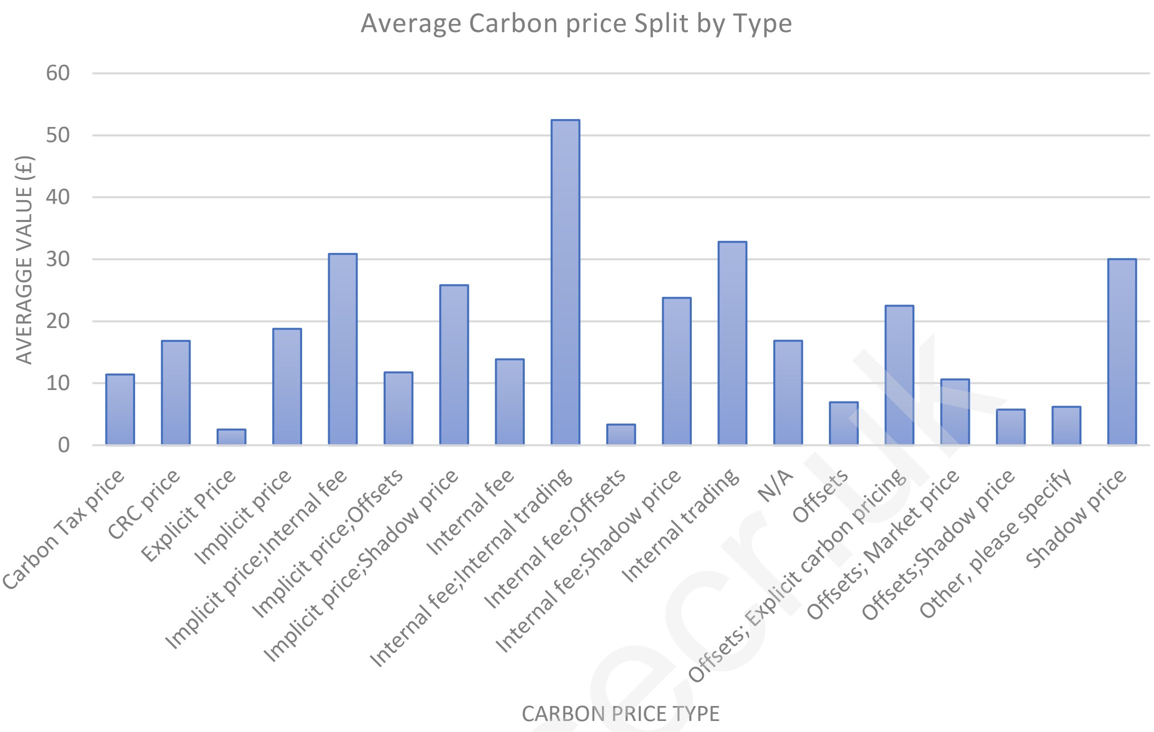


Figure 6. Carbon Price Type & Value (£). Source: CDP data 2018

Table 5 presents the results of regression analysis of variables in which outliers have been removed. R-squared (R^2) represents the proportion of variance of the dependent variable that is attributable to the effect of the independent variable (*Intellectus Statistics*, no date).   All results show very weak/weak effect on variance (Moore, D. S. 2008). However, statistically significant ($p=<0.05$) coefficients with low R^2 continue to represent the mean change in the dependent variable given a one-unit shift in the independent variable (Frost, no date).

A statistically significant increase in one unit of 'Percentage revenue spend on energy' resulted in an average increase of 71617 total carbon savings (Total tCO_2e Savings), therefore, companies that spent more of their revenue on energy, on average, they have higher annual and projected carbon savings. 'Internal Carbon Price' had a significant effect on 'Total tCO_2e Savings'. The results indicated that on average an increase of one unit (GBP) of Internal Carbon Price increased total carbon savings by 30643.1 tCO_2e.

When 'Investment in Subject Year' was selected as the dependant variable. 'Internal Carbon Price' significantly predicted 'Investment in Subject Year' indicating that on average, a one unit increase in

Internal Carbon Price increased investment in the subject year by £2,182,794.8. Regression of 'Percentage revenue spend on energy' against 'Investment in Subject Year' resulted in a similar unit increase in. It suggests that on average when the proportion of a respondent's revenue which is spent on energy increases by 1% then the Investment in the subject year increase by £2,709,048.

No significant relationship was found between 'Total MWh', 'Combined Scope 1 & 2 emissions', 'Percentage revenue spend on energy' on 'Internal Carbon Price'. This indicates that that on average there are no statistically significant relationships between these variables and the price at which a company chooses to set its Internal Carbon Price.

Table 5. Regression analysis of variables in which outliers have been removed

		Outliers Removed		
Independent Variable	Dependent Variable	B	R^2	P
Internal Carbon Price	Total tCO_2e Savings	30643.14	0.01	p < .001
Total MWh	Total tCO_2e Savings	0.02	0.22	p < .001
Combined Scope 1 & 2 emissions (tCO_2e)	Total tCO_2e Savings	0.00	0	p .720
Investment Subject Year	Total tCO_2e Savings	0.00	0.06	p < .001
Percentage revenue spend on energy	Total tCO_2e Savings	71617.34	0.04	p < .001
Scope 3 emissions	Total tCO_2e Savings	0.00	0	p .104
Scope 1,2,3 emissions	Total tCO_2e Savings	0.00	0	p .356
Total MWh	Internal Carbon Price	0.00	0.02	p < .001
Combined Scope 1 & 2 emissions (tCO_2e)	Internal Carbon Price	0.00	0.01	p .004
Percentage revenue spend on energy	Internal Carbon Price	0.07	0	p .241
Scope 3 emissions	Internal Carbon Price	0.00	0	p.011
Scope 1,2,3 emissions	Internal Carbon Price	0.00	0	p .246
Internal Carbon Price	Investment Subject Year	2182794.80	0.01	p < .001
Total MWh	Investment Subject Year	0.53	0.04	p < .001
Combined Scope 1 & 2 emissions (tCO_2e)	Investment Subject Year	0.00	0	p < .001
Percentage spend on energy	Investment Subject Year	2709048.71	0.01	p < .001
Scope 3 emissions	Investment Subject Year	0.07	0	p0.37
Scope 1,2,3 emissions	Investment Subject Year	0.01	0	p.489
Internal Carbon Price	Annual Savings Through Investment	357387.47	0.01	p < .001
Total MWh	Annual Savings Through Investment	0.09	0.05	p < .001
Combined Scope 1 & 2 emissions (tCO_2e)	Annual Savings Through Investment	0.00	0	p .996
Scope 3 emissions	Annual Savings Through Investment	0.01	0	p .103
Scope 1,2,3 emissions	Annual Savings Through Investment	0.00	0	p .597
Percentage revenue spend on energy	Annual Savings Through Investment	430900.16	0.01	p < .001

Table 6 details the results of Baron and Kenny mediation analysis completed on data with univariate outlier removed. B 'Unstandardised Beta' represents the predicted increase/decrease in the modelled relationship between the Independent and Dependent variables (*Intellectus Statistics*, no date). The mediator variable is shown in the second column of Table 6. The mediator is an intervening variable which explains the relationship between a dependent and independent variable (Statistics Solutions, no date). Notable results include the effect of Internal Carbon Price on the linear regression analysis between Total MWh (total energy consumed by organisations) and 'Total tCO_2e Savings' (total predicted carbon savings). The results showed that 'Internal Carbon Price' and 'Total MWh' predicted 'Total tCO_2e Savings', increasing total carbon savings by 148,329 for each unit of increased energy consumption. Only partial mediation was supported due to a small observed effect of 'Total tCO_2e' Savings on 'Total MWh' (see Appendix B: Baron Kenny Mediation Analysis Results (Full)). This is noteworthy as in the previous Table 5 there was only a slight increase of 0.02 in 'Total tCO_2e Savings' if 'Total MWh increases', suggesting that when Internal Carbon Price and energy consumption increase in conjunction, greater carbon savings are achieved. Linked to this, 'Internal Carbon Price' significantly increased the predicted 'Investment Subject Year' increments when included in the 'Total MWh' regression calculations. This indicates that on average, companies that consumed more energy and had higher internal carbon price mechanisms, invested more in the subject year than those that were high energy consumers but did not have a high internal carbon price. Related to this, the inclusion of 'Internal Carbon Price' increased the predict effect of 'Total MWh' on Annual savings through' by 264161/£ increase, significantly higher than 0.09 when 'Internal Carbon Price' was not included in the calculations.

Of note, the inclusion of Internal Carbon Price decreased the effect (B) of 'Percentage spend on energy' on 'Annual savings through investment' and 'Investment Subject Year'. Percentage of revenue spent on energy CDP data was inputted by respondents as a percentage range (e.g. >5%<10%). The use of the higher value of this range could have skewed the results.

Table 6. Results of Baron and Kenny mediation analysis

Independent Variable	Mediator Variable	Dependent Variable	B (Baron/Kenny)	P	Mediation Supported?	B (Regression)	% Difference
Percentage spend on energy	Internal Carbon Price	Total tCO2e Savings	5331	0	No		
Total MWh	Internal Carbon Price	Total tCO2e Savings	148329	0	Partial	0.02	741644750%
Combined Scope 1 & 2 emissions (tCO2e)	Internal Carbon Price	Total tCO2e Savings	32479	< .001	No		
Investment Subject Year	Internal Carbon Price	Total tCO2e Savings	19896	< .001	Partial	0.00	663200900%
Percentage spend on energy	Internal Carbon Price	Investment Subject Year	1734483	< .001	Partial	2709048.71	-36%
Total MWh	Internal Carbon Price	Investment Subject Year	1653011	< .001	Partial	0.53	311888807%
Combined Scope 1 & 2 emissions (tCO2e)	Internal Carbon Price	Investment Subject Year	2425629	< .001	No		
Percentage spend on energy	Internal Carbon Price	Annual savings through investment	22719	0	Partial	430900.16	-95%
Total MWh	Internal Carbon Price	Annual savings through investment	264161	< .001	Partial	0.09	293512011%
Investment Subject Year	Internal Carbon Price	Annual savings through investment	267299	< .001	Partial	0.04	668247200%
Combined Scope 1 & 2 emissions (tCO2e)	Internal Carbon Price	Annual savings through investment	75977	0	No		

Table 7 details the results of Spearmans Correlation (Rs) analysis to determine the strength of monotonic relationship between variables (*Intellectus Statistics*, no date). As detailed in Table 7, Internal Carbon Price has a moderate effect (Rs 0.33) on 'Total tCO_2e Savings'. Therefore, as 'Internal Carbon Price increases', 'Total tCO_2e Savings' tends to increase. Other variables such as Total MWh and scope 1 & 2 emissions have a higher Rs figures which suggests these variables have stronger monotonic relationship. There is a strong monotonic relationship between 'Annual savings through investment' and 'Total tCO_2e savings', this was anticipated as cost savings generated by energy efficiencies are likely to correlate with carbon savings.

Table 7. Spearmans Correlation (Rs) analysis to determine the strength of monotonic relationship between variables

	Total tCO2e savings	Internal Carbon Price (GBP)	Investment Subject Year (GBP)	Annual Savings (GBP) through Investment in Subject Year	Combined Scope 1 and 2 emissions	Scope 3 emissions- tCO2e	tCO2e savings frm Projects in subject yr	Adjusted Intensity figure tCO2e/(GBP)	Percentage spend on energy?	Total MWh	tCO2e Carbon Credits Purchased
Total tCO2e savings	1										
Internal Carbon Price (GBP)	0.33	1									
Investment Subject Year (GBP)	0.52	0.23	1								
Annual Savings (GBP) through Investment in Subject Year	0.59	0.24	0.71	1							
Combined Scope 1 and 2 emissions	0.62	0.27	0.37	0.41	1						
Scope 3 emissions- tCO2e	0.53	0.32	0.41	0.46	0.49	1					
tCO2e savings frm Projects in subject yr	0.87	0.31	0.58	0.65	0.57	0.5	1				
Adjusted Intensity figure tCO2e/(GBP)	0.05	0.04	0.01	0.02	0.19	0.05	0.06	1			
Percentage spend on energy?	0.27	0.16	0.1	0.15	0.35	0.12	0.22	0.08	1		
Total MWh	0.63	0.29	0.39	0.44	0.87	0.55	0.58	0.16	0.34	1	
tCO2e Carbon Credits Purchased	0.16	0.30	0.09	0.12	0.06	0.14	0.16	-0.07	0.05	0.07	1

[=] small effect size   [=] moderate effect size   [=] large effect size

To better understand what influences the monotonic relationship between internal carbon price and total carbon savings (Total tCO_2e savings), the data was further split by primary industry type (Table 8).

Table 8. Spearmans Correlation (Rs) analysis to determine the strength of monotonic relationship between variables split by industry type

Primary Industry Type	Rs	P
Power Generation	0.37	p = .004, 95% CI [0.12, 0.57]
Fossil Fuel	0.28	p = .030, 95% CI [0.03, 0.50]
Services	0.18	p < .001, 95% CI [0.10, 0.26]
Apparel	0.21	p = .398 95% [-0.27, 0.60]
Biotech, health care & pharma	0.22	p = .040, 95% CI [0.01, 0.42
Food, beverage & agriculture	0.3	p = .004, 95% CI [0.10, 0.47]
Hospitality	-0.09	p=.648, 95% [-0.43, 0.28]
Infrastructure	0.41	p < .001, 95% CI [0.27, 0.54]
Manufacturing	0.39	p < .001, 95% CI [0.31, 0.47]
Materials	0.37	p < .001, 95% CI [0.17, 0.54]
Minerals	0.6	p < .001, 95% CI [0.33, 0.78]
Retail	0.16	p=.178, 95% [-0.07, 0.37]
Transport	0.25	p = .042, 95% CI [0.01, 0.46]

[=] small size effect
[=] moderate size effect
[=] large size effect
not significant p> 0.05

Apart from Apparel, Hospitality and Retail all industries showed significant positive correlations between 'Internal Carbon Price' and 'Total tCO_2e savings'. There are considerable variations between the strength of correlation for each industry type. The strongest correlation was observed in mineral industries. Fossil fuels showed only a small size effect on correlation which was unexpected due to the energy intensive nature of the industry. It is hypothesised that the small size effect might be due to the fact emissions by fossil fuel companies are already highly regulated and influenced by external carbon price mechanisms such as the EU Emissions Trading System (ETS). It is also likely that the results are skewed due to variation in the size of datasets for each industry. For example, there were 445 manufacturing companies in the dataset, but only 45 Mineral Extraction companies.

3.3.4 Robust Regression

As the regressions data in Table 5 shows weak effect of variance by all variables, robust regression was conducted to see if internal carbon price effected total carbon savings. The results were significant ($p<0.001$) and found that Internal Carbon Price has a positive effect on Total tCO_2e Savings of 316.27. This can be interpreted that on average, when Internal Carbon Price set by organisations increased by £1, carbon savings increased by 316.27 tCO_2e.

The effect of Internal Carbon Price on Investment in subject year was also subject to Robust regression. It was found to have a positive effect of 167,888.80 with 0% chance of error ($p<0.001$). This can be read as when the Internal Carbon Price set by a company increases by £1, on average, the investment increase in the subject year increased by £167,888.80.

Earlier regression models presented high unstandardized Beta (B) values and weak/very weak R^2 values. It is hypothesised that as the data and assumptions inputted by respondents were not subject to external verification and validation, it resulted in significant discrepancies causing outliers and increased scatter about the line of best fit. Robust regression reduced the impact of outliers further. The analysis showed significant, positive results for both 'Total CO_2e Savings' and 'Investment Subject Year' when modelled against 'Internal Carbon Price'. However, the unstandardized Beta (B) results were significantly lower than linear regressions models of the full dataset and with outliers removed, see Table 9. This confirms the assumption that outliers are having a significant effect on the results. Future studies of verified carbon savings and internal carbon pricing mechanisms should yield more reliable results to draw conclusions from. It also suggests that predicted carbon savings and investment levels are likely to be lower.

Table 9. Robust regression to assess if Internal Carbon Price effected Total Carbon Savings

Independent Variable	Dependant Variable	(B) Liner Regression	R^2	(B) Liner Regression Outliers Removed	R^2	(B) Robust Regression	R^2
Internal Carbon Price	Total tCO_2e Savings	976834.38*	0.00	30643.14	0.01	316.27	0.01
Internal Carbon Price	Investment in subject year	61467337.4	0.00	2182794.8	0.01	167888.8	0.01

* Not significant p=.113

Significant p=<0.05

Figure 7 is a chart detailing the average carbon price and average sum of investment split by industry type. The chart highlights that high Internal Carbon Price does not always equate to high investment.

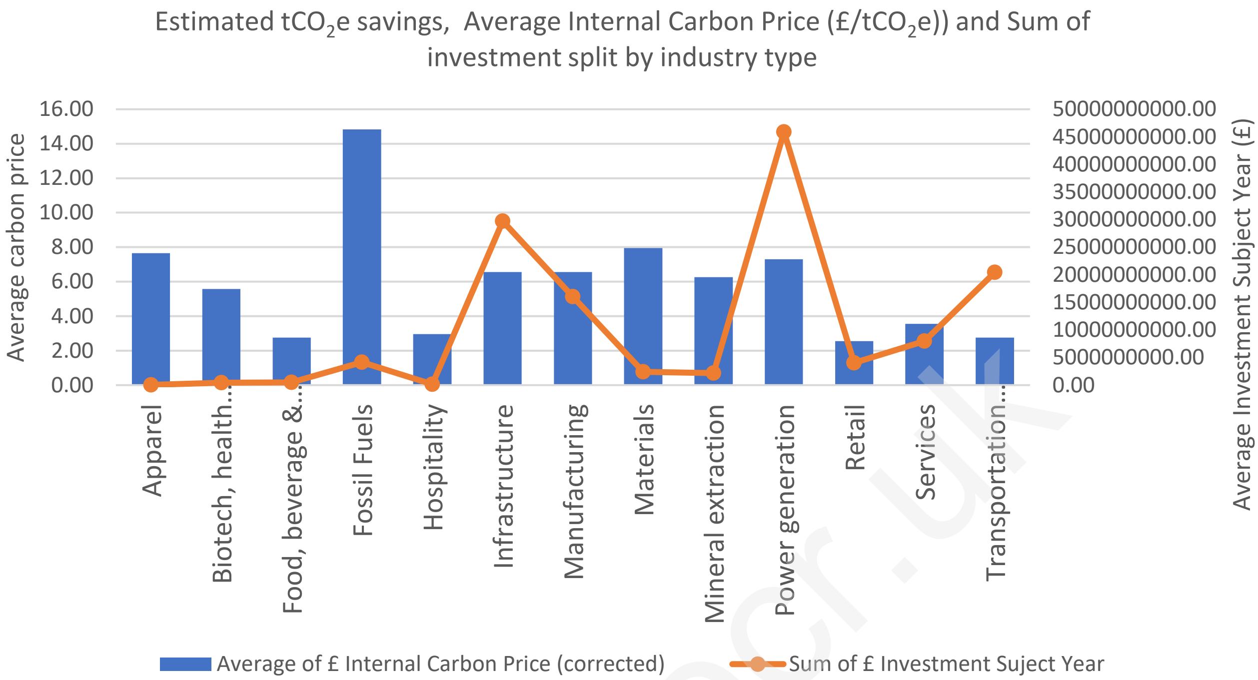


Figure 7. Average carbon price and average sum of investment split by industry type. Source: CPD data 2018

Figure 8 charts total carbon savings and average internal carbon price. It is interesting that less energy intensive industry sectors such ‘Services’ and ‘Hospitality’ showed the highest Total tCO_2e savings even though they had low internal carbon prices. This finding stayed true when carbon offset credits were removed from the total carbon saving but at a much lower level. This likely explains the relatively weak regression analysis between ‘Internal Carbon Price’ and ‘Total CO_2e savings’. It is also interesting that these industries are by far the largest purchasers of Carbon Offsets. It is hypothesised that as these industries are customer facing, public opinion and investor requirements are the significant motivators in achieving greater carbon savings. Internal carbon pricing is likely to be a tool used by some but not all of these organisations.

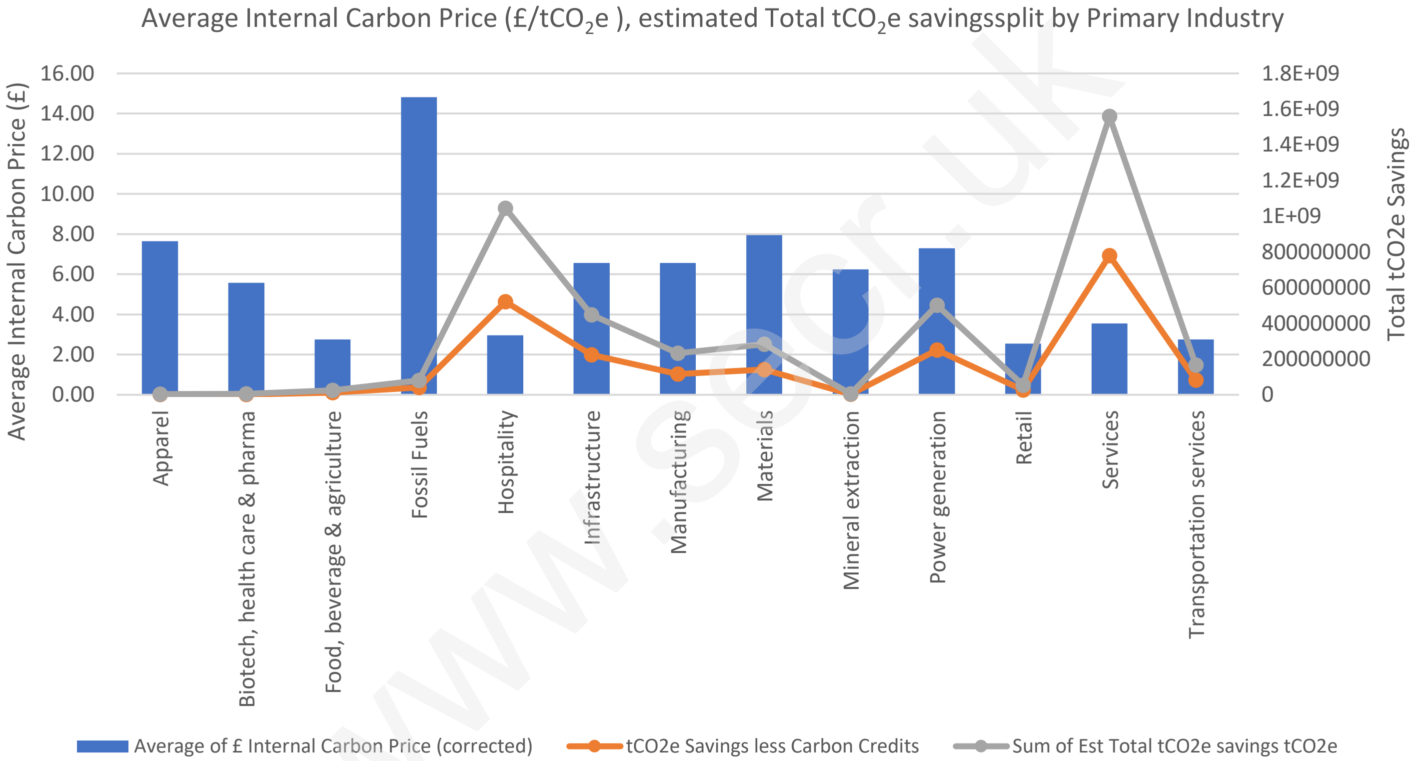


Figure 8. Total carbon savings, average Internal Carbon Price split by industry type

Table 10 present regression analysis where offsets were removed from the total carbon savings. It is interesting that the unstandardized Beta (B) increases but strength of monotonic relationship (Rs) decreases.

Table 10. Regression analysis where offsets were removed from the total carbon savings

Independent Variable	Dependant Variable	(B) Liner Regression Outliers Removed	R^2	Rs	(B) Liner Regression Outliers Removed & Carbon Credits Removed	R^2	Rs
Internal Carbon Price	Total tCO2e Savings	30643.14	0.00	0.33	269141.58	0.01	0.18

Table 11 details the results of Spearmans correlation tests analysing the strength of monotonic relationship between 'Internal Carbon Price' and 'Total tCO_2e Savings' on data split by nominal variables 'Board level oversight' and 'Incentives for management on climate related issues'. The data shows that there is a stronger correlation between the two variables for companies that have selected 'yes' to each question. This indicates that board level oversight and incentives for management increase the strength of relationship between 'Internal Carbon Price' and 'Total tCO_2e' Savings. It is likely that total carbon (CO_2e) reduction is influenced by several interconnected factors and actions driven by high level decision makers who are motivated to reduce carbon emissions and use an internal carbon price as a tool/mechanism to target and reduce annual emissions.

Table 11. Spearmans correlation between nominal variables and Total tCO_2e Savings

Variable	Rs	P
Board Level Oversight - Yes	0.32	$p < .001$, 95% CI [0.28, 0.37]
Board Level Oversight - No	0.21	$p = .021$, 95% CI [0.03, 0.38]
Incentive - Yes	0.31	$p < .001$, 95% CI [0.26, 0.35]
Incentive - No	0.12	$p = .045$, 95% CI [0.00, 0.24]

[=]small effect on size

[=] moderate size effect

To assess the influence of external carbon pricing mechanisms on the strength monotonic relationship (Rs) between 'Internal Carbon Price' and 'Total tCO_2e savings', the data was split into countries that in 2018 had set a price on carbon emissions. The results are presented in Table 12 below. The UK is included in the table due to its inclusion in the EU ETS and Carbon Reduction Commitment scheme which was still in place in 2018. Since 1991, Sweden has levied the highest carbon tax rate in the world (Jonsson, Ydstedt and Asen, 2020). It was assumed that companies would likely set the level of internal carbon price to account for the carbon tax they have to pay. The results suggest that the strength of relationship between 'Internal Carbon Price' and 'Total tCO_2e savings' increases as carbon tax rate increases. The exception to this is France which shows only a small effect on size. Norway's 'not significant' result is likely due to the limited responses received from the country.

Table 12. Strength of monotonic relationship between Internal Carbon Price and Total tCO_2e split by country.

Country	Carbon Tax £	Rs	P
UK*	18.7	0.40	p =< .001, 95% CI [0.26, 0.51]
France	41	0.26	p = .029, 95% CI [0.03, 0.47]
Norway	48	0.32	p = .070, 95% CI [-0.03, 0.60]
Finland	53	0.44	p = .007, 95% CI [0.13, 0.67]
Sweden	104	0.47	p < .001, 95% CI [0.22, 0.67]
Switzerland	76	0.48	p < .001, 95% CI [0.22, 0.67]
Europe (ETS Zone)	12	0.39	p < .001, 95% CI [0.32, 0.46]
Rest of World (None ETS)**	0	0.28	p < .001, 95% CI [0.22, 0.33]
All companies with Internal Carbon Price		0.08	p< 0.108, 95% CI [-0.02,0.18]
All companies with Internal Carbon Price >10		-0.08	p< .213, 95% CI [-0.20, 0.05]

*UK minimum ETS

**not including South Korea and Switzerland

[=]small effect on size

[=] moderate size effect

[=] large size effect

not significant p> 0.05

Figure 9 presents the information as a bar chart, detailing the average carbon price selected by organisations and carbon tax level of the country where they are incorporated. The chart shows that average internal price does not always correspond with high tax levels, suggesting that in addition to internal carbon price, other variables are influencing the strength of relationship. This is particularly noticeable with Sweden. This inidcates that the assumption that high national carbon tax rates equal high internal carbon pricing mechanisms cannot be relied upon. Anomalies such as Luxembourg's high internal price is likely due to the limited responses from the country.

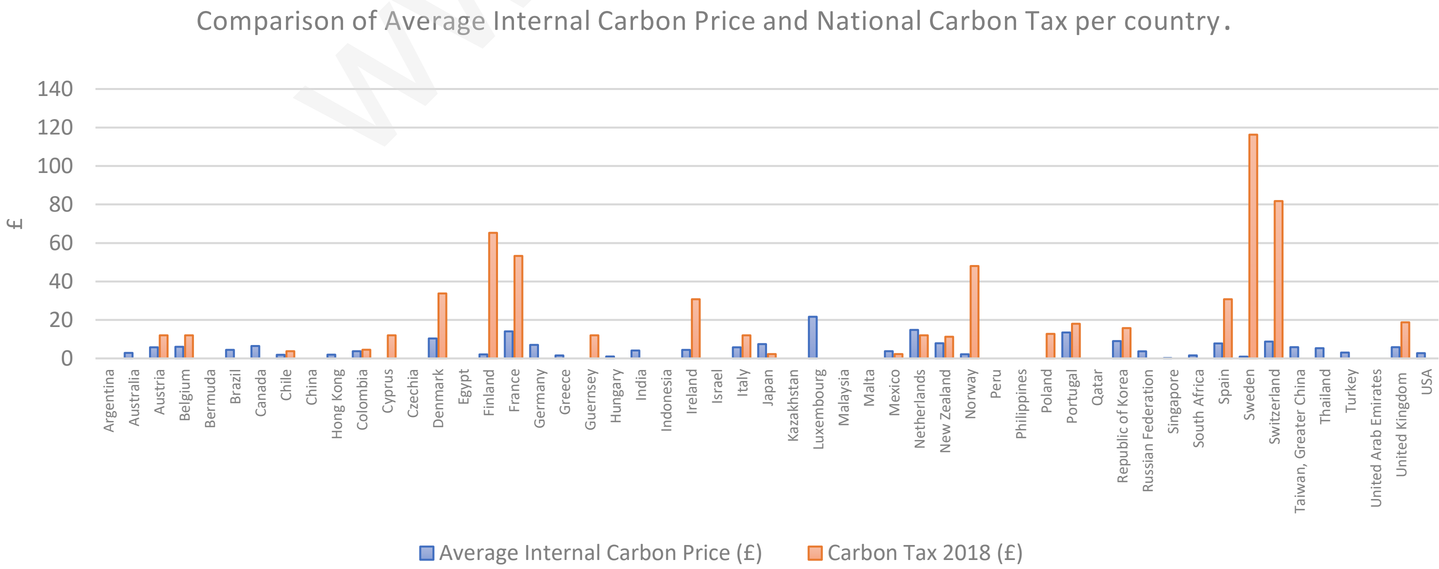


Figure 9. Internal Carbon Price, National carbon tax level. Source: CPD data 2018

The data was grouped according to Internal Carbon Price levels as presented in Table 13. For most pricing levels, there was no noticeable relationship between 'Internal Carbon Price' and 'Total tCO_2e Savings'. The only significant result is when 'Internal Carbon Price' is above £40 for the data set 'outliers removed'. The results indicates that for most price levels the level that internal carbon price is set at has no statistical significance to resulting carbon savings. It is hypothesised that the accuracy of each model was undermined when the data was continually split into smaller data sets. It is conjectured this would magnify the effect of outliers/data anomalies and that more meaningful results would be obtained from repeating the analysis on a larger data set.

Table 13. Regression, Natural Log Regression, Spreamans Rank analysis of Internal Carbon Price on Total tCO_2e Savings grouped by Internal Carbon Price levels

	Regression (log)			Regression			Regression (outliers removed)			Spearmans Rank	
Internal Carbon Price	R2	B	P	R2	B	P	R2	B	P	Rs	P
All	0.08	1	<0.001	0	42081.06	0.133	0.01	30643.1	p < .001	0.33	<0.001
>£10	0.01	-0.46	0.099	0	-6911	0.932	0.01	1868211	p=.253	-0.08	0.213
>£20	0.06	-1.45	0.04	0	-65892.9	0.618	0.01	2018262	p=.191	-0.29	<0.001
>£30	0.09	-1.88	0.04	0.01	-144088	0.436	0.01	2054306	p=.278	-0.34	<0.001
>£40	0.01	-0.62	0.476	0	-302.61	0.785	0.08	249442.3	p=.023	-0.15	0.0241
>£50	0	0.34	0.77	0.01	973.16	0.489	0.03	128609.9	p=.250	0.04	0.809
>£60	0.01	-0.59	0.677	0	575.17	0.75	0.08	190100.9	p=.095	-0.1	0.557
>£75	0.07	-2.21	0.198	0	870.28	0.735	0.09	155442.4	p=.131	-0.26	0.185
>£100	0.04	-3.01	0.04	0	-1419.14	0.81	0.2	242759.7	p=.109	-0.24	0.39

not significant p=>0.05

The analysis detailed in Table 14, between different carbon price types, and carbon savings found that there was no statistically relevant linear regression or Spearman's Rank result.   This is likely due to the removal of responses that had stated multiple types of Internal Carbon Price and those that did not include a carbon price. Where multiple carbon types were identified, these were discounted as an overlap in type would skew the results. 'Carbon Price Type', 'Carbon Tax price', 'CRC price', 'Explicit Price', 'Other, please specify' were discounted due to the low number of responses that included these carbon types as their internal carbon pricing mechanism. The analysis only modelled responses that stated their carbon price type was either: Implicit, Internal Fee/Trading, Offsets, Shadow Price. This reduced the data set to 411 respondents, which was then further split into each of the four groups.

Table 14.Regression analysis of Internal Carbon Price predicting Total tCO_2e Savings split by nominal responses

Independent Variable	Independent Variable	Dependent Variable	B (regression)	Rs (Spearman)
Implicit	Internal Carbon Price	Total tCO2e Savings	-2326.12	0.03
Internal Fee/Trading	Internal Carbon Price	Total tCO2e Savings	640.2	0.15
Offsets	Internal Carbon Price	Total tCO2e Savings	994.7	-0.39
Shadow Price	Internal Carbon Price	Total tCO2e Savings	-10496.96	0.01

Not Significant (p > 0.05)
Significant (p<0.05)

Figure 10 chart the responses of participants to nominal governance questions (C_1). Figure 10 charts the difference between 'Total tCO_2e Savings' when a respondent answered, 'Yes' compared to 'No', and the 'Internal Carbon Price' difference when a respondent answered 'Yes' compared to 'No'. Responses to Q4 & Q5 resulted in negative impacts to 'Total tCO_2e savings' and 'Internal Carbon Price' levels. A notable result that there was a 2091% increase in 'Total tCO_2e Savings' when respondents answered, 'Yes' to 'Q6. Are climate related issues integrated into your business strategy?' which suggests that business strategy has a significant impact on carbon savings. It was not possible to plot percentage increase in 'Internal Carbon Price' for Q6 as there was no carbon price data for 'No' respondents to this question. This is likely due to the low number of 'No' respondents to this question which is also likely to have skewed the percentage increase in carbon saving results.

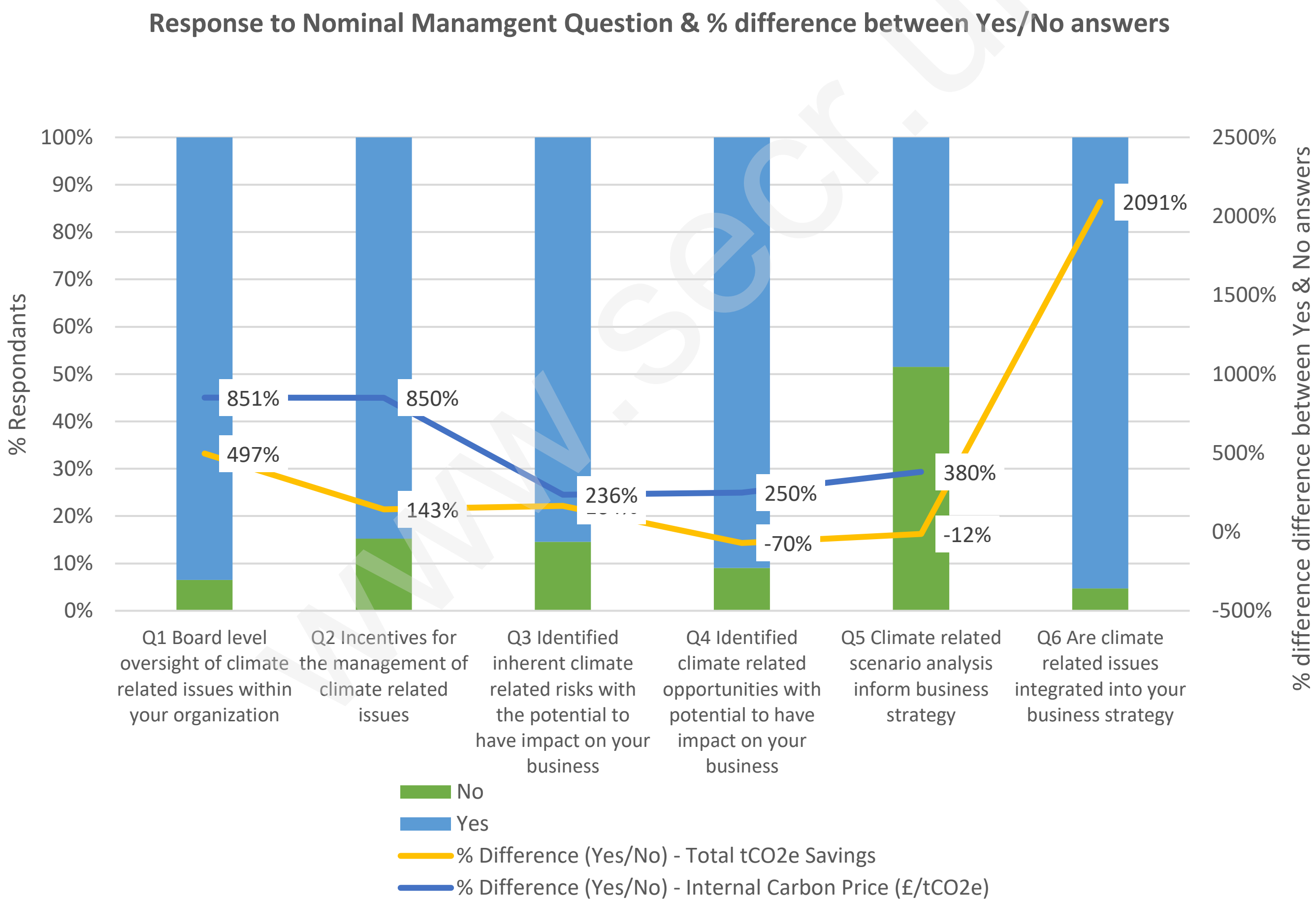


Figure 10. Difference between 'Total tCO_2e Savings' when a respondent answered, 'Yes' compared to 'No', and the 'Internal Carbon Price' difference when a respondent answered, 'Yes' compared to 'No'.

Figure 11 charts the average 'Total tCO_2e Savings' when a respondent answered 'Yes' compared to 'No' for each governance type. For all but one 'No' response, average carbon savings are lower than when respondents answer 'Yes'. Therefore, when respondents responded positively to climate change governance questions carbon savings increased. The exception to this is the response to identifying climate change opportunities. This is likely due to the question and how it relates to business types. Not being able to find a positive in how climate change will affect your business should not be considered a negative.

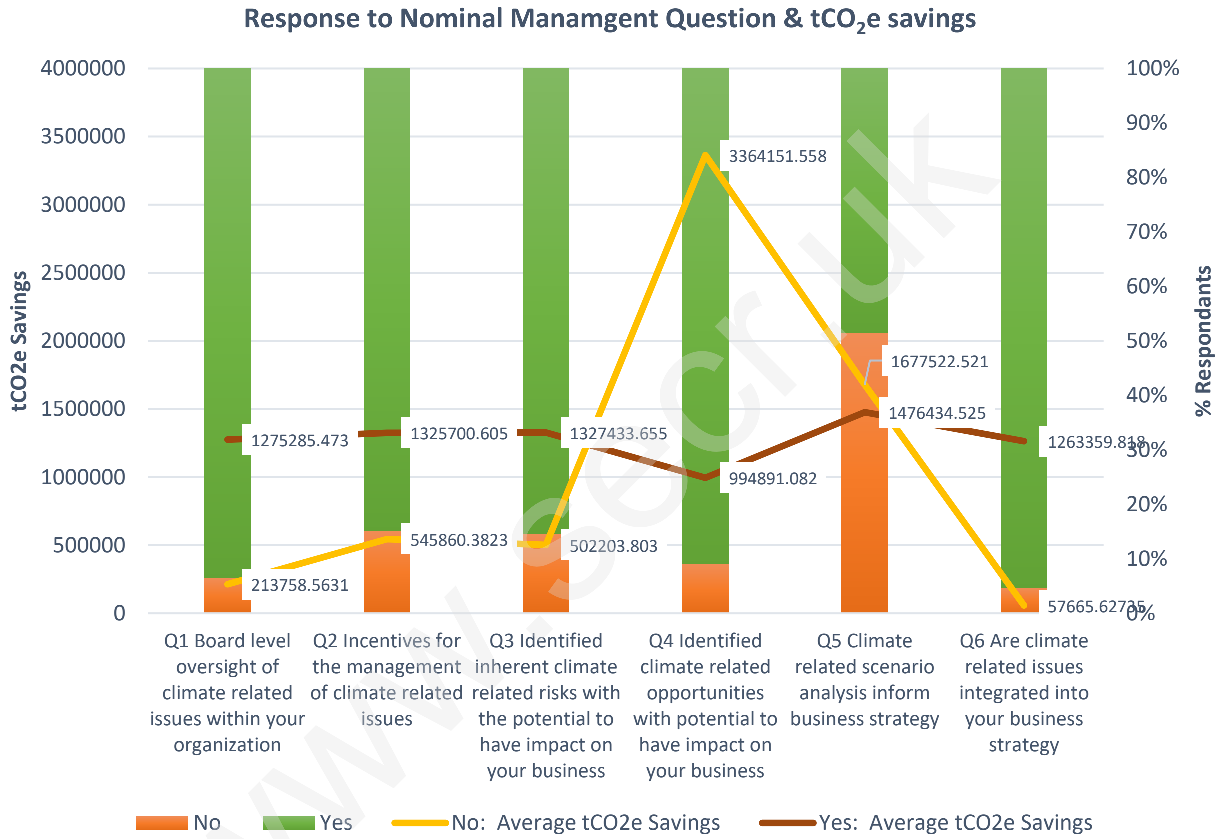


Figure 11. Average 'Total tCO_2e Savings' when a respondent answered 'Yes' compared to 'No' for each governance type

Figure 12 charts the average 'Internal Carbon Price' set by companies when a respondent answered 'Yes' compared to 'No' for each governance type. In all cases, when respondents responded positively to climate change governance questions average 'Internal Carbon Price' set by companies was higher than when respondents answered no.

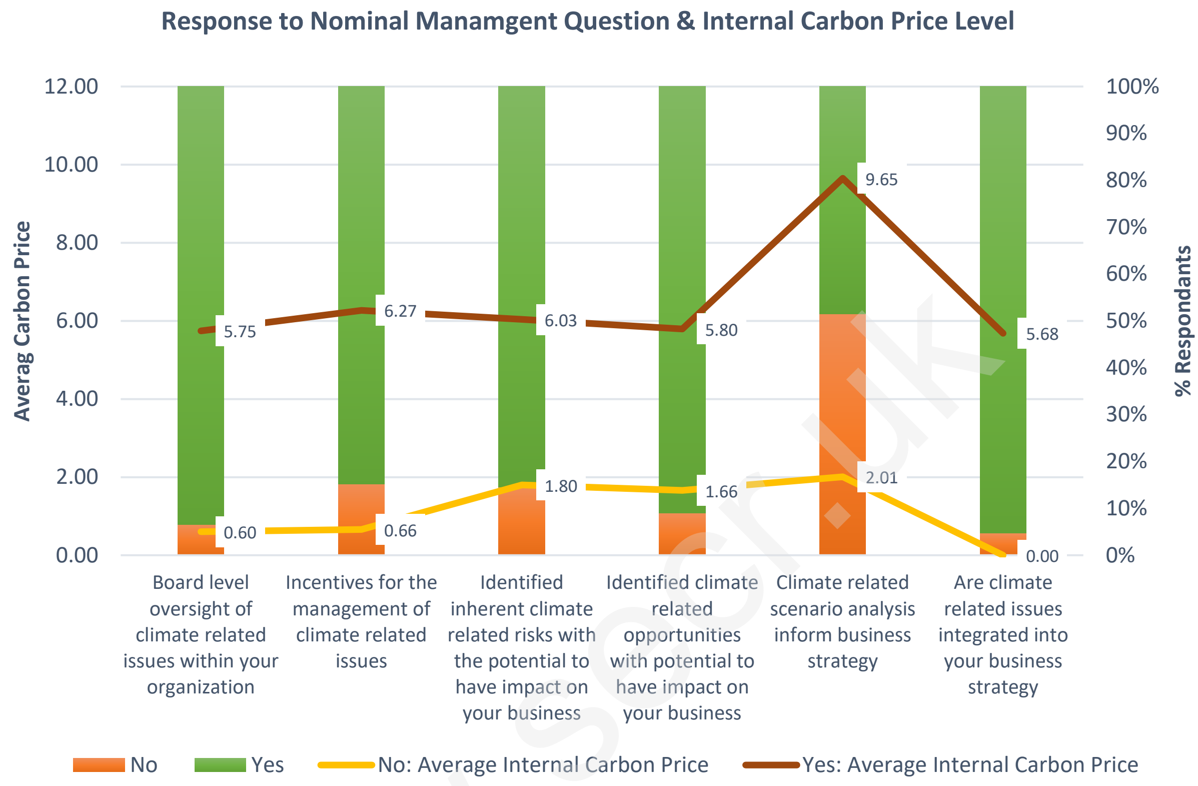


Figure 12. Average 'Internal Carbon Price' set by companies when a respondent answered 'Yes' compared to 'No' for each governance type

Figure 13 charts the average 'Investment' set by companies when a respondent answered 'Yes' compared to 'No' for each governance type. In all cases, when respondents responded positively to climate change governance questions average investment in carbon reduction initiatives increased.

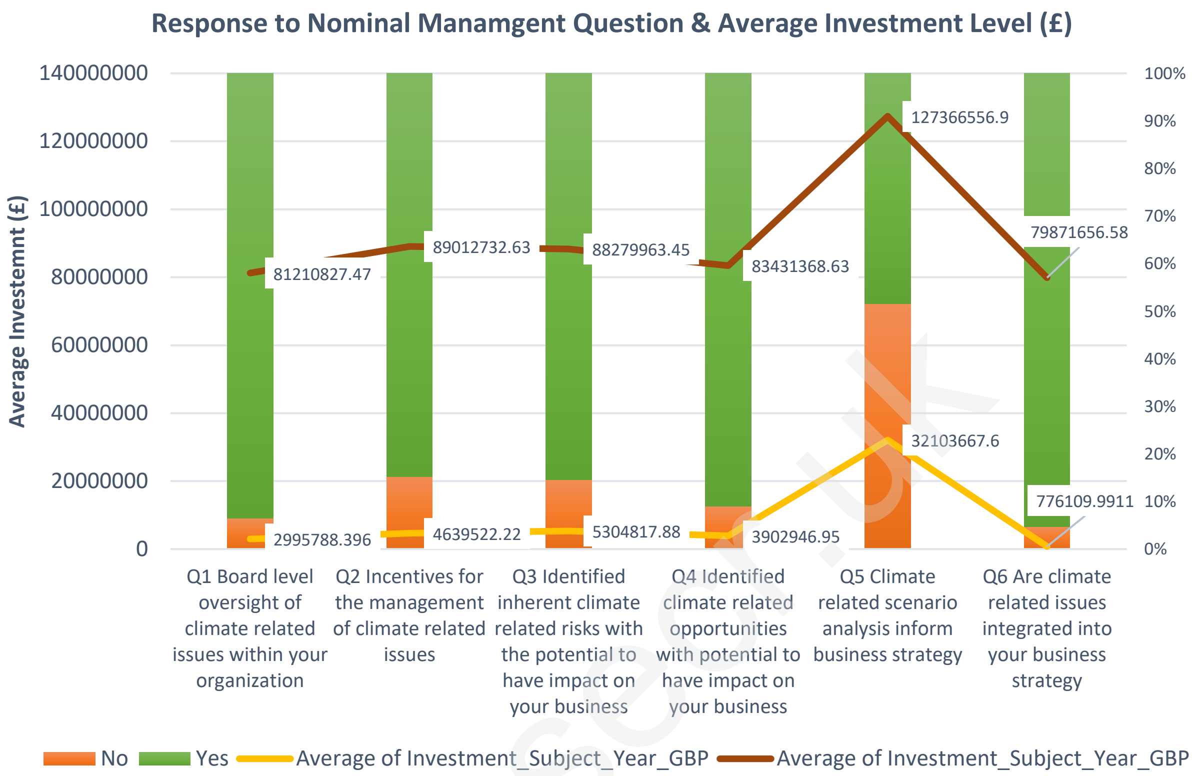


Figure 13. Average 'Investment' set by companies when a respondent answered 'Yes' compared to 'No' for each governance type

Chapter 5. Discussion

The interaction between corporate motivation, external risks and carbon reduction initiatives determines the cumulative carbon savings attained by organisations. The study found that the effect of internal carbon pricing is interconnected with these influences. Consequently, it is not possible to conclusively say that on average, an increase in internal carbon price by X will increase carbon savings and investment in low carbon initiatives by Y. However, the study does show us that there is a positive relationship between companies that have an internal carbon price and increased levels of investment and carbon savings. In addition, the results show that for high energy consuming businesses, internal carbon price has a positive influence on the levels of carbon savings and investment. The strength of relationship between carbon price and carbon savings is more pronounced when split by industry, showing that again, carbon savings are higher for energy intensive industries that employ internal carbon pricing mechanisms. As in previous research conducted by Bento and Gianfrate (2020) the results indicate that greatest carbon savings are achieved when internal carbon price is part of a holistic, companywide approach to tackling climate change.

Companies that included climate change as part of their corporate agenda and include internal carbon pricing mechanism tended to present increased carbon savings. An interesting observation is the strength of correlation between carbon price and carbon savings was lower for serviced based, low energy intensity industries. These companies were shown to have a low internal carbon price but reported high carbon savings. Part of the carbon savings were accounted for by offsetting indicating that a low carbon offset cost (also known as a carbon credit) influences at what price an offset reliant company sets their internal carbon price. In agreement with Goldstein (2016), analysis of 2018 CDP data showed that internal carbon price is low when offsetting is selected as its determinant. This reinforces Bento and Gianfrate (2020) findings that institutional context influences the choice of internal carbon prices. Whilst the low energy intensive industries are likely to have less 'low hanging fruit' carbon reduction initiatives available to them, it is also likely that the low cost and low effort of carbon offsetting is an extremely attractive carbon mitigation action for industries that are influenced by customer and investor opinion. When offsetting was removed for hospitality and services industries, carbon savings decreased by approximately 50%. Therefore, the use of offsets by these industry types potentially skews the results as a low carbon price equated to high carbon savings. The results highlight the risk of potential underinvestment by companies that rely on carbon offsetting as a means of mitigating emissions, the World Bank Group (2020) report in carbon pricing asserted that a low carbon price sends weak market price signals, undervaluing the social cost of carbon and potentially reducing the level of internal carbon reductions investment.

How the findings relate to the UK emissions targets

The disjointed and biased approach of the UK's carbon tax initiatives, projects weak carbon pricing signals and leaves consumers unaware of the social cost of the carbon they are emitting. Experts agree that current carbon reduction policies do not go far enough and at the current emission trajectory, the UK will miss its climate targets (Burke *et al.*, 2019).

The scrapping of the UK's CRC scheme has potentially created a disconnect between tangible costs and emission reductions. CRC required companies to calculate emissions and pay tax on those emissions. The new system requires companies to calculate and report emissions and pay an increased tax on energy consumed. Consumers are less likely to associate their increased energy costs with increased emissions. Analysis of UK company CDP responses to question C11.3a_C5, how in internal carbon price was determined, referenced CRC cost as a primary factor in how companies determined at what level they should set their internal carbon price.

The government in its report 'The future of UK carbon pricing' (HM Government, 2020), recognises that carbon pricing will prove a valuable tool in reaching net zero carbon. Considering the length of time that the concept of carbon pricing has been mooted and the potential revenue it would generate, it is unclear why successive UK governments are yet to implement an effective carbon pricing mechanism. If the Government streamlined its carbon taxation approach and set a carbon price, experts estimate carbon pricing could yield a tax income of £27billion for the UK Government by 2030 (George, 2020).

A possible reason for delay is concern over the impact that such a system would have on the competitiveness of UK's business. To address this concern, this study looked to determine if a mandatory internal carbon fee could be a more palatable alternative to direct carbon taxes.

Potential benefits of a mandatory internal fee.

The benefit of a mandatory internal fee is that it reinvests income generated in low carbon initiatives that benefit the company and its value chain. It is hypothesised that businesses and politicians would find this a more acceptable solution to help the UK meet its climate commitments. Potential benefits of implementing a mandatory internal carbon fee include:

1. It is occurring already on a voluntary basis
2. It would encourage investment in low carbon efficiencies, increasing UK competitiveness and driving innovation.
3. It would accelerate the low carbon market, helping the UK achieve its ambition of being the market leaders in a low carbon world.

4. Money raised would be company controlled enabling more tangiable carbon and cost savings.
5. It would reduce the risk of carbon leakage as annual fees could be increased incrementally. Therefore, as the fee increases, companies are benefiting from the low carbon investments made in previous years.
6. The fee could be a hybrid tax. If internal investment is not finically viable, money raised could be invested in local community offsetting schemes, such as adding photovoltaics to schools.
7. It would increase the importance of climate change planning and risk mitigation strategies on the corporate agenda. This is of import to companies that currently do not assign resources to such activities.
8. Application of mandatory fee at a fixed level would reduce the risk of market led carbon credits devaluing the social cost of carbon emissions.
9. 85% of companies reporting to CDP stated they support carbon pricing policies fully or with just minor exceptions (CDP, 2017)
10. It would be relatively easy to implement.

A potential risk of such a scheme is its verification and enforcement. Currently all large UK companies must report their scope 1 & 2 emissions under SECR legislation and report the actions they have completed during the past financial year to reduce these. Therefore, the mechanisms are already in place for implementing a mandatory internal fee. It is not too much of imposition to require companies reporting under SECR to apply a carbon fee to the emissions they have calculated. The new legislation would then require participants to state how the pot of money generated was invested in low carbon initiatives. SECR legislation applies to companies classed as 'large' under the Companies Act 2006. It is envisaged that to begin with, the application of a mandatory fee would apply to large companies which could be reviewed when greater carbon savings are required.

There is a risk that a fixed internal fee, uniformly applied across industry types could result in unfair burdens for different industry types. Contrary to an external carbon tax unduly effecting energy intensive industries (Bento and Gianfrate, 2020), a fixed internal fee could have more of an impact on low energy users as they have potentially fewer investment and cost saving options. To account for this, further research would be required to determine the optimal internal carbon fee level for each industry type.

Chapter 6. Conclusion

The thesis reviewed current and hypothetical approaches to carbon pricing and analysed responses by companies to Climate Disclosure Project (CDP) 2018 questionnaire. The aim of the study was to determine if internal carbon pricing by companies could help the UK achieve its 2050 net zero climate goals. The analysis focused on the application of internal carbon price mechanisms by companies and if its implementation leads to greater investment in low carbon initiatives and achieved higher carbon savings.

The literature review found that there is a general consensus among experts that carbon pricing is an effective tool in reducing the impact of companies on climate change. Analysis of CDP responses found that there is a significant positive relationship between internal carbon price and carbon reduction initiatives.

When the carbon offset savings were removed from the study, the positive effect of carbon price on investment and projected savings increased significantly. This suggest that carbon offsetting skewed the results. It is recommended that further study on the effect of carbon offsetting on carbon pricing mechanisms and subsequent projected carbon savings would help legislators and companies better understand the impact of such schemes.

Results of analysis of CDP data found weak/very weak effect on variance (R^2) between the independent and dependent variables. To improve this and thus strengthen the findings of the study, it is recommended that a larger data set is analysed. Use of secondary data from external sources is a weak point in the analysis. CDP does not verify information inputted by respondents. Therefore, data entered could be inaccurate, wrong, or deliberately misleading. It was hypothesised that these inaccuracies were responsible for the significant outliers observed in the data. Whilst a bigger data set would reduce the impact of these anomalies it is a suggested that further study requiring interviewing and verification of information would provide more robust data.

As the CDP project is voluntary, the study is acknowledged to be inherently biased towards large companies where climate change is already high up in the corporate agenda. Respondent companies must have the resources available to respond to the questionnaire which suggests they have in-house environmental teams or have employed external experts. It is recommended that future research requiring interviewing and data gathering from a variety of companies of different sizes and industry types. This would produce a more accurate picture of attitudes towards carbon pricing and taxation, and to what degree do the risks posed from climate change register on corporate agendas.

This study looked to answer the question 'would a fixed internal carbon fee help the UK reach net zero emissions by 2050?' Based on the analysis, it is recommended that serious consideration is given to the application of a mandatory internal carbon fee on UK businesses. A fee would not only help the UK meet its 2050 net zero carbon emissions but also increase the competitiveness and resilience of UK businesses in a low carbon world.

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Appendices

Appendix A: CDP Questionnaire Questions

Account number
Organization
Country
Public
Response received date
Primary activity
Primary sector
Primary industry
Primary questionnaire sector
Authority types
Row
RowName
C0.1_Give a general description and introduction to your organization.
C0.4_Select the currency used for all financial information disclosed throughout your response.
C0.5_Select the option that describes the reporting boundary for which climate-related impacts on your business are being reported. Note that this option should align with your consolidation approach to your Scope 1 and Scope 2 greenhouse gas inventory.
C0.2_C1_State the start and end date of the year for which you are reporting data. - Start date
C0.2_C2_State the start and end date of the year for which you are reporting data. - End date
C0.2_C3_State the start and end date of the year for which you are reporting data. - Indicate if you are providing emissions data for past reporting years
C0.2_C4_State the start and end date of the year for which you are reporting data. - Select the number of past reporting years you will be providing emissions data for
C0.3_Select the countries for which you will be supplying data.
C0.3_Select the countries/regions for which you will be supplying data.
C1.1_Is there board-level oversight of climate-related issues within your organization?
C1.2a_Describe where in the organizational structure this/these position(s) and/or committees lie, what their associated responsibilities are, and how climate-related issues are monitored.
C1.3_Do you provide incentives for the management of climate-related issues, including the attainment of targets?
C1.1a_C1_Identify the position(s) of the individual(s) on the board with responsibility for climate-related issues. - Position of individual(s)
C1.1a_C2_Identify the position(s) of the individual(s) on the board with responsibility for climate-related issues. - Please explain
C1.1b_C1_Provide further details on the board's oversight of climate-related issues. - Frequency with which climate-related issues are a scheduled agenda item
C1.1b_C2_Provide further details on the board's oversight of climate-related issues. - Governance mechanisms into which climate-related issues are integrated
C1.1b_C3_Provide further details on the board's oversight of climate-related issues. - Please explain
C1.1c_C1_Why is there no board-level oversight of climate-related issues and what are your plans to change this in the future? - Primary reason
C1.1c_C2_Why is there no board-level oversight of climate-related issues and what are your plans to change this in the future? - Board-level oversight of climate-related issues will be introduced within the next two years
C1.1c_C3_Why is there no board-level oversight of climate-related issues and what are your plans to change this in the future? - Please explain
C1.2_C1_Below board-level, provide the highest-level management position(s) or committee(s) with responsibility for climate-related issues. - Name of the position(s) and/or committee(s)
C1.2_C2_Below board-level, provide the highest-level management position(s) or committee(s) with responsibility for climate-related issues. - Responsibility
C1.2_C3_Below board-level, provide the highest-level management position(s) or committee(s) with responsibility for climate-related issues. - Frequency of reporting to the board on climate-related issues
C1.3a_C1_Provide further details on the incentives provided for the management of climate-related issues. - Who is entitled to benefit from these incentives?
C1.3a_C2_Provide further details on the incentives provided for the management of climate-related issues. - Types of incentives
C1.3a_C3_Provide further details on the incentives provided for the management of climate-related issues. - Activity incentivized
C1.3a_C4_Provide further details on the incentives provided for the management of climate-related issues. - Comment
C2.2b_Provide further details on your organization's process(es) for identifying and assessing climate-related risks.
C2.2d_Describe your process(es) for managing climate-related risks and opportunities.
C2.2_Select the option that best describes how your organization's processes for identifying, assessing, and managing climate-related issues are integrated into your overall risk management.
C2.3_Have you identified any inherent climate-related risks with the potential to have a substantive financial or strategic impact on your business?
C2.4_Have you identified any climate-related opportunities with the potential to have a substantive financial or strategic impact on your business?
C2.1_C1_Describe what your organization considers to be short-, medium- and long-term horizons. - From (years)
C2.1_C2_Describe what your organization considers to be short-, medium- and long-term horizons. - To (years)
C2.1_C3_Describe what your organization considers to be short-, medium- and long-term horizons. - Comment

C2.2a_C1_Select the options that best describe your organization's frequency and time horizon for identifying and assessing climate-related risks. - Frequency of monitoring

C2.2a_C2_Select the options that best describe your organization's frequency and time horizon for identifying and assessing climate-related risks. - How far into the future are risks considered?

C2.2a_C3_Select the options that best describe your organization's frequency and time horizon for identifying and assessing climate-related risks. - Comment

C2.2c_C1_Which of the following risk types are considered in your organization's climate-related risk assessments? - Relevance & inclusion

C2.2c_C2_Which of the following risk types are considered in your organization's climate-related risk assessments? - Please explain

C2.2e_C1_Why does your organization not have a process in place for identifying, assessing, and managing climate-related risks and opportunities, and do you plan to introduce such a process in the future? - Primary reason

C2.2e_C2_Why does your organization not have a process in place for identifying, assessing, and managing climate-related risks and opportunities, and do you plan to introduce such a process in the future? - Please explain

C2.3a_C1_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Identifier

C2.3a_C2_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Where in the value chain does the risk driver occur?

C2.3a_C3_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Risk type

C2.3a_C4_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Primary climate-related risk driver

C2.3a_C5_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Type of financial impact driver

C2.3a_C6_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Company- specific description

C2.3a_C7_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Time horizon

C2.3a_C8_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Likelihood

C2.3a_C9_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Magnitude of impact

C2.3a_C10_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Potential financial impact

C2.3a_C11_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Explanation of financial impact

C2.3a_C12_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Management method

C2.3a_C13_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Cost of management

C2.3a_C14_Provide details of risks identified with the potential to have a substantive financial or strategic impact on your business. - Comment

C2.3b_C1_Why do you not consider your organization to be exposed to climate-related risks with the potential to have a substantive financial or strategic impact on your business? - Primary reason

C2.3b_C2_Why do you not consider your organization to be exposed to climate-related risks with the potential to have a substantive financial or strategic impact on your business? - Please explain

C2.4a_C1_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Identifier

C2.4a_C2_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Where in the value chain does the opportunity occur?

C2.4a_C3_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Opportunity type

C2.4a_C4_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Primary climate-related opportunity driver

C2.4a_C5_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Type of financial impact driver

C2.4a_C6_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Company- specific description

C2.4a_C7_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Time horizon

C2.4a_C8_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Likelihood

C2.4a_C9_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Magnitude of impact

C2.4a_C10_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Potential financial impact

C2.4a_C11_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Explanation of financial impact

C2.4a_C12_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Strategy to realize opportunity

C2.4a_C13_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Cost to realize opportunity

C2.4a_C14_Provide details of opportunities identified with the potential to have a substantive financial or strategic impact on your business. - Comment
C2.4b_C1_Why do you not consider your organization to have climate-related opportunities? - Primary reason
C2.4b_C2_Why do you not consider your organization to have climate-related opportunities? - Please explain
C2.5_C1_Describe where and how the identified risks and opportunities have impacted your business. - Impact
C2.5_C2_Describe where and how the identified risks and opportunities have impacted your business. - Description
C2.6_C1_Describe where and how the identified risks and opportunities have factored into your financial planning process. - Relevance
C2.6_C2_Describe where and how the identified risks and opportunities have factored into your financial planning process. - Description
C3.1a_Does your organization use climate-related scenario analysis to inform your business strategy?
C3.1_Are climate-related issues integrated into your business strategy?
C3.1c_Explain how climate-related issues are integrated into your business objectives and strategy.
C3.1f_Why are climate-related issues not integrated into your business objectives and strategy?
C3.1g_Why does your organization not use climate-related scenario analysis to inform your business strategy?
C3.1d_C1_Provide details of your organization's use of climate-related scenario analysis. - Climate-related scenarios
C3.1d_C2_Provide details of your organization's use of climate-related scenario analysis. - Details
C4.1_Did you have an emissions target that was active in the reporting year?
C4.3_Did you have emissions reduction initiatives that were active within the reporting year? Note that this can include those in the planning and/or implementation phases.
C4.3d_Why did you not have any emissions reduction initiatives active during the reporting year?
C4.5_Do you classify any of your existing goods and/or services as low-carbon products or do they enable a third party to avoid GHG emissions?
C4.1a_C1_Provide details of your absolute emissions target(s) and progress made against those targets. - Target reference number
C4.1a_C2_Provide details of your absolute emissions target(s) and progress made against those targets. - Scope
C4.1a_C3_Provide details of your absolute emissions target(s) and progress made against those targets. - % emissions in Scope
C4.1a_C4_Provide details of your absolute emissions target(s) and progress made against those targets. - % reduction from base year
C4.1a_C5_Provide details of your absolute emissions target(s) and progress made against those targets. - Base year
C4.1a_C6_Provide details of your absolute emissions target(s) and progress made against those targets. - Start year
C4.1a_C7_Provide details of your absolute emissions target(s) and progress made against those targets. - Base year emissions covered by target (metric tons CO2e)
C4.1a_C8_Provide details of your absolute emissions target(s) and progress made against those targets. - Target year
C4.1a_C9_Provide details of your absolute emissions target(s) and progress made against those targets. - Is this a science-based target?
C4.1a_C10_Provide details of your absolute emissions target(s) and progress made against those targets. - % achieved (emissions)
C4.1a_C11_Provide details of your absolute emissions target(s) and progress made against those targets. - Target status
C4.1a_C12_Provide details of your absolute emissions target(s) and progress made against those targets. - Please explain
C4.1b_C1_Provide details of your emissions intensity target(s) and progress made against those target(s). - Target reference number
C4.1b_C2_Provide details of your emissions intensity target(s) and progress made against those target(s). - Scope
C4.1b_C3_Provide details of your emissions intensity target(s) and progress made against those target(s). - % emissions in Scope
C4.1b_C4_Provide details of your emissions intensity target(s) and progress made against those target(s). - % reduction from baseline year
C4.1b_C5_Provide details of your emissions intensity target(s) and progress made against those target(s). - Metric
C4.1b_C6_Provide details of your emissions intensity target(s) and progress made against those target(s). - Base year
C4.1b_C7_Provide details of your emissions intensity target(s) and progress made against those target(s). - Start year
C4.1b_C8_Provide details of your emissions intensity target(s) and progress made against those target(s). - Normalized baseline year emissions covered by target (metric tons CO2e)
C4.1b_C9_Provide details of your emissions intensity target(s) and progress made against those target(s). - Target year
C4.1b_C10_Provide details of your emissions intensity target(s) and progress made against those target(s). - Is this a science-based target?
C4.1b_C11_Provide details of your emissions intensity target(s) and progress made against those target(s). - % achieved (emissions)
C4.1b_C12_Provide details of your emissions intensity target(s) and progress made against those target(s). - Target status
C4.1b_C13_Provide details of your emissions intensity target(s) and progress made against those target(s). - Please explain
C4.1b_C14_Provide details of your emissions intensity target(s) and progress made against those target(s). - % change anticipated in absolute Scope 1+2 emissions
C4.1b_C15_Provide details of your emissions intensity target(s) and progress made against those target(s). - % change anticipated in absolute Scope 3 emissions
C4.1c_C1_Explain why you do not have emissions target and forecast how your emissions will change over the next five years. - Primary reason
C4.1c_C2_Explain why you do not have emissions target and forecast how your emissions will change over the next five years. - Five-year forecast
C4.1c_C3_Explain why you do not have emissions target and forecast how your emissions will change over the next five years. - Please explain
C4.2_C1_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Target
C4.2_C2_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - KPI – Metric numerator
C4.2_C3_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - KPI – Metric denominator (intensity targets only)
C4.2_C4_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Base year
C4.2_C5_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Start year
C4.2_C6_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Target year

C4.2_C7_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - KPI in baseline year
C4.2_C8_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - KPI in target year
C4.2_C9_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - % achieved in reporting year
C4.2_C10_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Target Status
C4.2_C11_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Please explain
C4.2_C12_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Part of emissions target
C4.2_C13_Provide details of other key climate-related targets not already reported in question C4.1/a/b. - Is this target part of an overarching initiative?
C4.3a_C1_Identify the total number of projects at each stage of development, and for those in the implementation stages, the estimated CO2e savings. - Number of projects
C4.3a_C2_Identify the total number of projects at each stage of development, and for those in the implementation stages, the estimated CO2e savings. - Total estimated annual CO2e savings in metric tonnes CO2e (only for rows marked *)
C4.3b_C1_Provide details on the initiatives implemented in the reporting year in the table below. - Activity type
C4.3b_C2_Provide details on the initiatives implemented in the reporting year in the table below. - Description of activity
C4.3b_C3_Provide details on the initiatives implemented in the reporting year in the table below. - Estimated annual CO2e savings (metric tonnes CO2e)
C4.3b_C4_Provide details on the initiatives implemented in the reporting year in the table below. - Scope
C4.3b_C5_Provide details on the initiatives implemented in the reporting year in the table below. - Voluntary/Mandatory
C4.3b_C6_Provide details on the initiatives implemented in the reporting year in the table below. - Annual monetary savings (unit currency – as specified in CC0.4)
C4.3b_C7_Provide details on the initiatives implemented in the reporting year in the table below. - Investment required (unit currency – as specified in CC0.4)
C4.3b_C8_Provide details on the initiatives implemented in the reporting year in the table below. - Payback period
C4.3b_C9_Provide details on the initiatives implemented in the reporting year in the table below. - Estimated lifetime of the initiative
C4.3b_C10_Provide details on the initiatives implemented in the reporting year in the table below. - Comment
C4.3c_C1_What methods do you use to drive investment in emissions reduction activities? - Method
C4.3c_C2_What methods do you use to drive investment in emissions reduction activities? - Comment
C4.5a_C1_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - Level of aggregation
C4.5a_C2_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - Description of product/Group of products
C4.5a_C3_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - Are these low-carbon product(s) or do they enable avoided emissions?
C4.5a_C4_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - Taxonomy, project or methodology used to classify product(s) as low-carbon or to calculate avoided emissions
C4.5a_C5_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - % revenue from low carbon product(s) in the reporting year
C4.5a_C6_Provide details of your products and/or services that you classify as low-carbon products or that enable a third party to avoid GHG emissions. - Comment
C5.2a_Provide details of the standard, protocol, or methodology you have used to collect activity data and calculate Scope 1 and Scope 2 emissions.
C5.2_Select the name of the standard, protocol, or methodology you have used to collect activity data and calculate Scope 1 and Scope 2 emissions.
C5.1_C1_Provide your base year and base year emissions (Scopes 1 and 2). - Base year start
C5.1_C2_Provide your base year and base year emissions (Scopes 1 and 2). - Base year end
C5.1_C3_Provide your base year and base year emissions (Scopes 1 and 2). - Base year emissions (metric tons CO2e)
C5.1_C4_Provide your base year and base year emissions (Scopes 1 and 2). - Comment
C6.4_Are there any sources (e.g. facilities, specific GHGs, activities, geographies, etc.) of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure?
C6.7a_Provide the emissions from biologically sequestered carbon relevant to your organization in metric tons CO2.
C6.7_Are carbon dioxide emissions from biologically sequestered carbon relevant to your organization?
C6.1_C1_What were your organization’s gross global Scope 1 emissions in metric tons CO2e? - Gross global Scope 1 emissions (metric tons CO2e)
C6.1_C2_What were your organization’s gross global Scope 1 emissions in metric tons CO2e? - End-year of reporting period
C6.1_C3_What were your organization’s gross global Scope 1 emissions in metric tons CO2e? - Comment
C6.10_C1_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Intensity figure
C6.10_C2_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Metric numerator (Gross global combined Scope 1 and 2 emissions)
C6.10_C3_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Metric denominator
C6.10_C4_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Metric denominator: Unit total
C6.10_C5_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Scope 2 figure used

C6.10_C6_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - % change from previous year
C6.10_C7_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Direction of change
C6.10_C8_Describe your gross global combined Scope 1 and 2 emissions for the reporting year in metric tons CO2e per unit currency total revenue and provide any additional intensity metrics that are appropriate to your business operations. - Reason for change
C6.2_C1_Describe your organization's approach to reporting Scope 2 emissions. - Scope 2, location-based
C6.2_C2_Describe your organization's approach to reporting Scope 2 emissions. - Scope 2, market-based
C6.2_C3_Describe your organization's approach to reporting Scope 2 emissions. - Comment
C6.3_C1_What were your organization's gross global Scope 2 emissions in metric tons CO2e? - Scope 2, location-based
C6.3_C2_What were your organization's gross global Scope 2 emissions in metric tons CO2e? - Scope 2, market-based (if applicable)
C6.3_C3_What were your organization's gross global Scope 2 emissions in metric tons CO2e? - End-year of reporting period
C6.3_C4_What were your organization's gross global Scope 2 emissions in metric tons CO2e? - Comment
C6.4a_C1_Provide details of the sources of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure. - Source
C6.4a_C2_Provide details of the sources of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure. - Relevance of Scope 1 emissions from this source
C6.4a_C3_Provide details of the sources of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure. - Relevance of location-based Scope 2 emissions from this source
C6.4a_C4_Provide details of the sources of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure. - Relevance of market-based Scope 2 emissions from this source (if applicable)
C6.4a_C5_Provide details of the sources of Scope 1 and Scope 2 emissions that are within your selected reporting boundary which are not included in your disclosure. - Explain why the source is excluded
C6.5_C1_Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions. - Evaluation status
C6.5_C2_Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions. - Metric tonnes CO2e
C6.5_C3_Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions. - Emissions calculation methodology
C6.5_C4_Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions. - Percentage of emissions calculated using data obtained from suppliers or value chain partners
C6.5_C5_Account for your organization's Scope 3 emissions, disclosing and explaining any exclusions. - Explanation
C7.1_Does your organization have greenhouse gas emissions other than carbon dioxide?
C7.3_Indicate which gross global Scope 1 emissions breakdowns you are able to provide.
C7.6_Indicate which gross global Scope 2 emissions breakdowns you are able to provide.
C7.9b_Are your emissions performance calculations in C7.9 and C7.9a based on a location-based Scope 2 emissions figure or a market-based Scope 2 emissions figure?
C7.9_How do your gross global emissions (Scope 1 and 2 combined) for the reporting year compare to those of the previous reporting year?
C7.1a_C1_Break down your total gross global Scope 1 emissions by greenhouse gas type and provide the source of each used greenhouse warming potential (GWP). - Greenhouse gas
C7.1a_C2_Break down your total gross global Scope 1 emissions by greenhouse gas type and provide the source of each used greenhouse warming potential (GWP). - Scope 1 emissions (metric tons of CO2e)
C7.1a_C3_Break down your total gross global Scope 1 emissions by greenhouse gas type and provide the source of each used greenhouse warming potential (GWP). - GWP Reference
C7.2_C1_Break down your total gross global Scope 1 emissions by country/region. - Country/Region
C7.2_C2_Break down your total gross global Scope 1 emissions by country/region. - Scope 1 emissions (metric tons CO2e)
C7.3a_C1_Break down your total gross global Scope 1 emissions by business division. - Business division
C7.3a_C2_Break down your total gross global Scope 1 emissions by business division. - Scope 1 emissions (metric ton CO2e)
C7.3b_C1_Break down your total gross global Scope 1 emissions by business facility. - Facility
C7.3b_C2_Break down your total gross global Scope 1 emissions by business facility. - Scope 1 emissions (metric tons CO2e)
C7.3b_C3_Break down your total gross global Scope 1 emissions by business facility. - Latitude
C7.3b_C4_Break down your total gross global Scope 1 emissions by business facility. - Longitude
C7.3c_C1_Break down your total gross global Scope 1 emissions by business activity. - Activity
C7.3c_C2_Break down your total gross global Scope 1 emissions by business activity. - Scope 1 emissions (metric tons CO2e)
C7.5_C1_Break down your total gross global Scope 2 emissions by country/region. - Country/Region
C7.5_C2_Break down your total gross global Scope 2 emissions by country/region. - Scope 2, location-based (metric tons CO2e)
C7.5_C3_Break down your total gross global Scope 2 emissions by country/region. - Scope 2, market-based (metric tons CO2e)
C7.5_C4_Break down your total gross global Scope 2 emissions by country/region. - Purchased and consumed electricity, heat, steam or cooling (MWh)
C7.5_C5_Break down your total gross global Scope 2 emissions by country/region. - Purchased and consumed low-carbon electricity, heat, steam or cooling accounted in market-based approach (MWh)
C7.6a_C1_Break down your total gross global Scope 2 emissions by business division. - Business division
C7.6a_C2_Break down your total gross global Scope 2 emissions by business division. - Scope 2, location-based emissions (metric tons CO2e)
C7.6a_C3_Break down your total gross global Scope 2 emissions by business division. - Scope 2, market-based emissions (metric tons CO2e)
C7.6b_C1_Break down your total gross global Scope 2 emissions by business facility. - Facility
C7.6b_C2_Break down your total gross global Scope 2 emissions by business facility. - Scope 2 location-based emissions (metric tons CO2e)

C7.6b_C3_Break down your total gross global Scope 2 emissions by business facility. - Scope 2, market-based emissions (metric tons CO2e)

C7.6c_C1_Break down your total gross global Scope 2 emissions by business activity. - Activity

C7.6c_C2_Break down your total gross global Scope 2 emissions by business activity. - Scope 2, location-based emissions (metric tons CO2e)

C7.6c_C3_Break down your total gross global Scope 2 emissions by business activity. - Scope 2, market-based emissions (metric tons CO2e)

C7.9a_C1_Identify the reasons for any change in your gross global emissions (Scope 1 and 2 combined) and for each of them specify how your emissions compare to the previous year. - Change in emissions (metric tons CO2e)

C7.9a_C2_Identify the reasons for any change in your gross global emissions (Scope 1 and 2 combined) and for each of them specify how your emissions compare to the previous year. - Direction of change

C7.9a_C3_Identify the reasons for any change in your gross global emissions (Scope 1 and 2 combined) and for each of them specify how your emissions compare to the previous year. - Emissions value (percentage)

C7.9a_C4_Identify the reasons for any change in your gross global emissions (Scope 1 and 2 combined) and for each of them specify how your emissions compare to the previous year. - Please explain calculation

C8.1_What percentage of your total operational spend in the reporting year was on energy?

C8.2_C1_Select which energy-related activities your organization has undertaken. - Indicate whether your organization undertakes this energy-related activity

C8.2a_C1_Report your organization's energy consumption totals (excluding feedstocks) in MWh. - Heating value

C8.2a_C2_Report your organization's energy consumption totals (excluding feedstocks) in MWh. - MWh from renewable sources

C8.2a_C3_Report your organization's energy consumption totals (excluding feedstocks) in MWh. - MWh from non-renewable sources

C8.2a_C4_Report your organization's energy consumption totals (excluding feedstocks) in MWh. - Total MWh

C8.2b_C1_Select the applications of your organization's consumption of fuel. - Indicate whether your organization undertakes this fuel application

C8.2c_C1_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - Fuels (excluding feedstocks)

C8.2c_C2_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - Heating value

C8.2c_C3_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - Total fuel MWh consumed by the organization

C8.2c_C4_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - MWh fuel consumed for the self-generation of electricity

C8.2c_C5_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - MWh fuel consumed for self-generation of heat

C8.2c_C6_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - MWh fuel consumed for self-generation of steam

C8.2c_C7_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - MWh fuel consumed for self-generation of cooling

C8.2c_C8_State how much fuel in MWh your organization has consumed (excluding feedstocks) by fuel type. - MWh fuel consumed for self- cogeneration or self-trigeneration

C8.2d_C1_List the average emission factors of the fuels reported in C8.2c. - Emission factor

C8.2d_C2_List the average emission factors of the fuels reported in C8.2c. - Unit

C8.2d_C3_List the average emission factors of the fuels reported in C8.2c. - Emission factor source

C8.2d_C4_List the average emission factors of the fuels reported in C8.2c. - Comment

C8.2e_C1_Provide details on the electricity, heat, steam, and cooling your organization has generated and consumed in the reporting year. - Total Gross generation (MWh)

C8.2e_C2_Provide details on the electricity, heat, steam, and cooling your organization has generated and consumed in the reporting year. - Generation that is consumed by the organization (MWh)

C8.2e_C3_Provide details on the electricity, heat, steam, and cooling your organization has generated and consumed in the reporting year. - Gross generation from renewable sources (MWh)

C8.2e_C4_Provide details on the electricity, heat, steam, and cooling your organization has generated and consumed in the reporting year. - Generation from renewable sources that is consumed by the organization (MWh)

C8.2f_C1_Provide details on the electricity, heat, steam and/or cooling amounts that were accounted for at a low-carbon emission factor in the market-based Scope 2 figure reported in C6.3. - Basis for applying a low-carbon emission factor

C8.2f_C2_Provide details on the electricity, heat, steam and/or cooling amounts that were accounted for at a low-carbon emission factor in the market-based Scope 2 figure reported in C6.3. - Low-carbon technology type

C8.2f_C3_Provide details on the electricity, heat, steam and/or cooling amounts that were accounted for at a low-carbon emission factor in the market-based Scope 2 figure reported in C6.3. - MWh consumed associated with low-carbon electricity, heat, steam or cooling

C8.2f_C4_Provide details on the electricity, heat, steam and/or cooling amounts that were accounted for at a low-carbon emission factor in the market-based Scope 2 figure reported in C6.3. - Emission factor (in units of metric tons CO2e per MWh)

C8.2f_C5_Provide details on the electricity, heat, steam and/or cooling amounts that were accounted for at a low-carbon emission factor in the market-based Scope 2 figure reported in C6.3. - Comment

C9.1_C1_Provide any additional climate-related metrics relevant to your business. - Description

C9.1_C2_Provide any additional climate-related metrics relevant to your business. - Metric value

C9.1_C3_Provide any additional climate-related metrics relevant to your business. - Metric numerator

C9.1_C4_Provide any additional climate-related metrics relevant to your business. - Metric denominator (intensity metric only)

C9.1_C5_Provide any additional climate-related metrics relevant to your business. - % change from previous year

C9.1_C6_Provide any additional climate-related metrics relevant to your business. - Direction of change

C9.1_C7_Provide any additional climate-related metrics relevant to your business. - Please explain

C10.1_C1_Indicate the verification/assurance status that applies to your reported emissions. - Verification/assurance status

C10.1a_C1_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Scope
C10.1a_C2_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Verification or assurance cycle in place
C10.1a_C3_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Status in the current reporting year
C10.1a_C4_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Type of verification or assurance
C10.1a_C5_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Attach the statement
C10.1a_C6_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Page/ section reference
C10.1a_C7_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Relevant standard
C10.1a_C8_Provide further details of the verification/assurance undertaken for your Scope 1 and/or Scope 2 emissions and attach the relevant statements. - Proportion of reported emissions verified (%)
C10.1b_C1_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Scope
C10.1b_C2_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Verification or assurance cycle in place
C10.1b_C3_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Status in the current reporting year
C10.1b_C4_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Attach the statement
C10.1b_C5_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Page/section reference
C10.1b_C6_Provide further details of the verification/assurance undertaken for your Scope 3 emissions and attach the relevant statements. - Relevant standard
C10.2_Do you verify any climate-related information reported in your CDP disclosure other than the emissions figures reported in C6.1, C6.3, and C6.5?
C10.2a_C1_Which data points within your CDP disclosure have been verified, and which verification standards were used? - Disclosure module verification relates to
C10.2a_C2_Which data points within your CDP disclosure have been verified, and which verification standards were used? - Data verified
C10.2a_C3_Which data points within your CDP disclosure have been verified, and which verification standards were used? - Verification standard
C10.2a_C4_Which data points within your CDP disclosure have been verified, and which verification standards were used? - Please explain
C11.1_Are any of your operations or activities regulated by a carbon pricing system (i.e. ETS, Cap & Trade or Carbon Tax)?
C11.1a_Select the carbon pricing regulation(s) which impacts your operations.
C11.1d_What is your strategy for complying with the systems in which you participate or anticipate participating?
C11.2_Has your organization originated or purchased any project-based carbon credits within the reporting period?
C11.3_Does your organization use an internal price on carbon?
C11.1b_C1_Complete the following table for each of the emissions trading systems in which you participate. - % of Scope 1 emissions covered by the ETS
C11.1b_C2_Complete the following table for each of the emissions trading systems in which you participate. - Period start date
C11.1b_C3_Complete the following table for each of the emissions trading systems in which you participate. - Period end date
C11.1b_C4_Complete the following table for each of the emissions trading systems in which you participate. - Allowances allocated
C11.1b_C5_Complete the following table for each of the emissions trading systems in which you participate. - Allowances purchased
C11.1b_C6_Complete the following table for each of the emissions trading systems in which you participate. - Verified emissions in metric tons CO2e
C11.1b_C7_Complete the following table for each of the emissions trading systems in which you participate. - Details of ownership
C11.1b_C8_Complete the following table for each of the emissions trading systems in which you participate. - Comment
C11.1c_C1_Complete the following table for each of the tax systems in which you participate. - Period start date
C11.1c_C2_Complete the following table for each of the tax systems in which you participate. - Period end date
C11.1c_C3_Complete the following table for each of the tax systems in which you participate. - % of emissions covered by tax
C11.1c_C4_Complete the following table for each of the tax systems in which you participate. - Total cost of tax paid
C11.1c_C5_Complete the following table for each of the tax systems in which you participate. - Comment
C11.2a_C1_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Credit origination or credit purchase
C11.2a_C2_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Project type
C11.2a_C3_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Project identification
C11.2a_C4_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Verified to which standard
C11.2a_C5_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Number of credits (metric tonnes CO2e)
C11.2a_C6_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Number of credits (metric tonnes CO2e): Risk adjusted volume

C11.2a_C7_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Credits cancelled

C11.2a_C8_Provide details of the project-based carbon credits originated or purchased by your organization in the reporting period. - Purpose, e.g. compliance

C11.3a_C1_Provide details of how your organization uses an internal price on carbon. - Objective for implementing an internal carbon price

C11.3a_C2_Provide details of how your organization uses an internal price on carbon. - GHG Scope

C11.3a_C3_Provide details of how your organization uses an internal price on carbon. - Application

C11.3a_C4_Provide details of how your organization uses an internal price on carbon. - Actual price(s) used (Currency /metric ton)

C11.3a_C5_Provide details of how your organization uses an internal price on carbon. - Variance of price(s) used

C11.3a_C6_Provide details of how your organization uses an internal price on carbon. - Type of internal carbon price

C11.3a_C7_Provide details of how your organization uses an internal price on carbon. - Impact & implication

C12.1c_Give details of your climate-related engagement strategy with other partners in the value chain.

C12.1_Do you engage with your value chain on climate-related issues?

C12.1d_Why do you not engage with any elements of your value chain on climate-related issues, and what are your plans to do so in the future?

C12.3b_Are you on the board of any trade associations or do you provide funding beyond membership?

C12.3d_Do you publicly disclose a list of all research organizations that you fund?

C12.3_Do you engage in activities that could either directly or indirectly influence public policy on climate-related issues through any of the following?

C12.3e_Provide details of the other engagement activities that you undertake.

C12.3f_What processes do you have in place to ensure that all of your direct and indirect activities that influence policy are consistent with your overall climate change strategy?

C12.3g_Why do you not engage with policy makers on climate-related issues?

C12.1a_C1_Provide details of your climate-related supplier engagement strategy. - Type of engagement

C12.1a_C2_Provide details of your climate-related supplier engagement strategy. - Details of engagement

C12.1a_C3_Provide details of your climate-related supplier engagement strategy. - % of suppliers by number

C12.1a_C4_Provide details of your climate-related supplier engagement strategy. - % total procurement spend (direct and indirect)

C12.1a_C5_Provide details of your climate-related supplier engagement strategy. - % Scope 3 emissions as reported in C6.5

C12.1a_C6_Provide details of your climate-related supplier engagement strategy. - Rationale for the coverage of your engagement

C12.1a_C7_Provide details of your climate-related supplier engagement strategy. - Impact of engagement, including measures of success

C12.1a_C8_Provide details of your climate-related supplier engagement strategy. - Comment

C12.1b_C1_Give details of your climate-related engagement strategy with your customers. - Type of engagement

C12.1b_C2_Give details of your climate-related engagement strategy with your customers. - Details of engagement

C12.1b_C3_Give details of your climate-related engagement strategy with your customers. - Size of engagement

C12.1b_C4_Give details of your climate-related engagement strategy with your customers. - % Scope 3 emissions as reported in C6.5

C12.1b_C5_Give details of your climate-related engagement strategy with your customers. - Please explain the rationale for selecting this group of customers and scope of engagement

C12.1b_C6_Give details of your climate-related engagement strategy with your customers. - Impact of engagement, including measures of success

C12.3a_C1_On what issues have you been engaging directly with policy makers? - Focus of legislation

C12.3a_C2_On what issues have you been engaging directly with policy makers? - Corporate position

C12.3a_C3_On what issues have you been engaging directly with policy makers? - Details of engagement

C12.3a_C4_On what issues have you been engaging directly with policy makers? - Proposed legislative solution

C12.3c_C1_Enter the details of those trade associations that are likely to take a position on climate change legislation. - Trade association

C12.3c_C2_Enter the details of those trade associations that are likely to take a position on climate change legislation. - Is your position on climate change consistent with theirs?

C12.3c_C3_Enter the details of those trade associations that are likely to take a position on climate change legislation. - Please explain the trade association's position

C12.3c_C4_Enter the details of those trade associations that are likely to take a position on climate change legislation. - How have you, or are you attempting to, influence the position?

C12.4_C1_Have you published information about your organization's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s). - Publication

C12.4_C2_Have you published information about your organization's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s). - Status

C12.4_C3_Have you published information about your organization's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s). - Attach the document

C12.4_C4_Have you published information about your organization's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s). - Content elements

C14.1_C1_Provide details for the person that has signed off (approved) your CDP climate change response. - Job title

C14.1_C2_Provide details for the person that has signed off (approved) your CDP climate change response. - Corresponding job category

Appendix B: Baron Kenny Mediation Analysis Results (Full)

Not Significant
Significant
independent variable has a significant effect on the dependant variable

Mediation Results for est Total tCO2e Corrected predicting Percentage spend on energy mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Total tCO2e Savings	Percentage Revenue spend on energy	71617.34	8651.75	8.28	< .001
Regression 2:					
Internal Carbon Price	Percentage Revenue spend on energy	0.07	0.06	1.18	0.239
Regression 3:					
Total tCO2e Savings	Percentage Revenue spend on energy	71265.7	8652.66	8.24	< .001
	Internal Carbon Price	5330.93	3741.92	1.42	0.154
Mediation Not Supported					

Mediation Results for Est Total tCO2e savings tCO2e predicting Total MWh mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Total tCO2e Savings	Total MWh	0.02	0.01	3.54	< .001
Regression 2:					
Internal Carbon Price	Total MWh	0	0	6.06	< .001
Regression 3:					
Total tCO2e Savings	Total MWh	0.02	0.01	3.11	0.002
	Internal Carbon Price	148328.97	53409.15	2.78	0.006
Partial Mediation Supported					

Mediation Results for est Total tCO2e Corrected predicting Combined Scope 1 and 2 tCO2e .1 mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Total tCO2e Savings	Combined Scope 1 and 2 tCO2e	0	0	0.61	0.545
Regression 2:					
Internal Carbon Price	Combined Scope 1 and 2 tCO2e	0	0	-0.18	0.855
Regression 3:					

Total tCO2e Savings	Combined Scope 1 and 2 tCO2e	0	0	0.63	0.53
	Internal Carbon Price	32479.44	8214.52	3.95	<.001
Mediation Not Supported					

Mediation Results for est Total tCO2e Corrected predicting Investment Subject Year .1 mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
est Total tCO2e Corrected	Investment Subject Year GBP	0	0	10.86	<.001
Regression 2:					
Internal Carbon Price GBP	Investment Subject Year GBP	0	0	4.28	<.001
Regression 3:					
est Total tCO2e Corrected	Investment Subject Year GBP	0	0	10.49	<.001
	Internal Carbon Price GBP	19896.03	5971.15	3.33	<.001
Partial Mediation Supported					

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Investment Subject Year	Percentage spend on energy	2717403.95	606196.81	4.48	<.001
Regression 2:					
Internal Carbon Price	Percentage spend on energy	0.12	0.03	3.92	<.001
Regression 3:					
Investment Subject Year	Percentage spend on energy	2515731.76	606968.1	4.14	<.001
	Internal Carbon Price	1734482.75	498721.1	3.48	<.001
Partial Mediation Supported					

Mediation Results for Investment Subject Year predicting Total MWh mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Investment Subject Year	Total MWh	0.55	0.06	8.43	<.001
Regression 2:					

Internal Carbon Price	Total MWh	0	0	5.81	< .001
Regression 3:					
Investment Subject Year	Total MWh	0.52	0.07	7.92	< .001
	Internal Carbon Price	1653011.21	504218.2	3.28	0.001
Partial Mediation Supported					

Mediation Results for Investment Subject Year predicting Combined Scope 1 and 2 tCO2e mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Investment Subject Year	Combined Scope 1 and 2 tCO2e	0	0.02	0.21	0.836
Regression 2:					
Internal Carbon Price	Combined Scope 1 and 2 tCO2e	0	0	-0.19	0.846
Regression 3:					
Investment Subject Year	Combined Scope 1 and 2 tCO2e	0.01	0.02	0.23	0.818
	Internal Carbon Price	2425629.05	584947.39	4.15	< .001
Mediation Not Supported					

Mediation Results for Investment Subject Year predicting Annual Saving through Investment in Subject Year mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Investment Subject Year GBP	Annual Saving through Investment in Subject Year GBP	2	0.16	12.72	< .001
Regression 2:					
Internal Carbon Price GBP	Annual Saving through Investment in Subject Year GBP	0	0	4.76	< .001
Regression 3:					
Investment Subject Year GBP	Annual Saving through Investment in Subject Year GBP	1.94	0.16	12.32	< .001
	Internal Carbon Price GBP	1487854.35	494957.39	3.01	0.003

Mediation Results for Total tCO2e Savings predicting Percentage spend on energy mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Total tCO2e Savings	Percentage spend on energy	71626.43	8764.73	8.17	< .001
Regression 2:					

Internal Carbon Price	Percentage spend on energy	0.12	0.03	4.07	< .001
Regression 3:					
Total tCO2e Savings	Percentage spend on energy	68883.28	8784.6	7.84	< .001
	Internal Carbon Price	22718.83	7208.75	3.15	0.002

Mediation Results for Annual Saving through Investment predicting Total MWh mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Annual Saving through Investment	Total MWh	0.09	0.01	9.52	< .001
Regression 2:					
Internal Carbon Price	Total MWh	0	0	5.86	< .001
Regression 3:					
Annual Saving through Investment	Total MWh	0.08	0.01	8.96	< .001
	Internal Carbon Price	264160.9	74374.01	3.55	< .001

Mediation Results for Annual Saving through Investment predicting Investment Subject Year mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					
Annual Saving through Investment	Investment Subject Year	0.04	0	12.72	< .001
Regression 2:					
Internal Carbon Price	Investment Subject Year	0	0	4.26	< .001
Regression 3:					
Annual Saving through Investment	Investment Subject Year	0.04	0	12.32	< .001
	Internal Carbon Price	267298.92	72675.2	3.68	< .001

Mediation Results for Annual Saving through Investment predicting Combined Scope 1 & 2 emissions mediated by Internal Carbon Price

Dependent	Independent	*B*	*SE*	*t*	*p*
Regression 1:					

Annual Saving through Investment	Combined Scope 1 & 2 emissions (tCO2e)	0	0	-0.01	0.996
Regression 2:					
Internal Carbon Price	Combined Scope 1 & 2 emissions (tCO2e)	0	0	2.87	0.004
Regression 3:					
Annual Saving through Investment	Combined Scope 1 & 2 emissions (tCO2e)	0	0	-0.14	0.888
	Internal Carbon Price	75976.51	42544.65	1.79	0.074