The Future of Carbon Pricing

Policy Exchange

Implementing an independent carbon tax with dividends in the UK

Matt Rooney, Josh Burke, Michael Taylor and Warwick Lightfoot

Foreword by Alistair Darling and William Hague

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Policy Exchange

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Contents

Foreword	6
Executive Summary	7
Background to the Project	16
The Justification for a New Approach	18
A Review of Current Approaches to Carbon Pricing	34
The Potential for an Independent UK Carbon Tax	57
Postscript: The Future of Carbon Pricing	74
Afterword	75
Appendix: Border Carbon Adjustments and Trade Policy	77
Glossary of Key Terms	81

Foreword

By Rt Hon Lord Hague of Richmond PC Rt Hon the Lord Darling of Roulanish PC

The UK has consistently led the world in responding to the threat of dangerous global warming. By signing into law the Climate Change Act in 2008, with cross-party support, we were the first country to set legally binding targets for reductions in greenhouse gas emissions.

Subsequently, the UK Government showed leadership by introducing a minimum carbon price in the UK. This policy has helped incentivise cleaner technologies in the power sector and this year for the first time in over a century Britain went a full day without relying on coal for electricity generation. The UK continues to lead the world in this area through the Powering Past Coal initiative.

That these initiatives have continued through Labour, Coalition and Conservative Governments shows that clean energy has genuine cross-party support – the threat of climate change is too great for party politics to get in the way.

However, as this report by Policy Exchange shows, many challenges remain, most notably that of carbon leakage whereby energy intensive industries move abroad to avoid environmental taxes. Cleaning up our own energy system will mean little if we simply outsource our emissions. In the absence of a unified global carbon tax, border carbon adjustments are essential to ensure that British businesses are operating on a level playing field with those that are foreign-based. The authors outline a clear plan for how this would work in practice and we commend them for it.

In our drive to decarbonise the economy, it is important that we take people with us. If carbon taxes are seen to unduly punish that average citizen, they will fail. That is why Policy Exchange's idea of recycling the revenue from carbon taxation back to the people in the form of a 'carbon dividend' is worth exploring. It would make a carbon tax both progressive and popular.

Recent research suggests that global greenhouse gas emissions rose in 2017 after falling for three years in a row. This emphasises the need for action now. There is wide agreement that a strong carbon price is a key plank of any plan to decarbonise our energy system and the UK is well placed to lead the world once again by implementing new and innovative environmental polices that are efficient, fair and equitable.

Executive Summary

The prospect of leaving the EU Emissions Trading System as a result of leaving the EU presents the UK with an opportunity for innovation in the field of carbon pricing. A better approach could reduce the cost of decarbonisation and prevent the offshoring of emissions. Also, by redistributing the proceeds of an economy-wide carbon tax directly to citizens through a 'dividend' we can ensure more inclusive economic growth and make carbon pricing popular. The UK is already leading a coalition of nations in 'powering past coal'; we should seek to build on this climate diplomacy and implement a system of carbon pricing that really works, overcoming a market failure that does great harm to the environment.

The concept of pricing carbon has become synonymous with climate change mitigation. It is considered to be one of the most important tools in reducing and capturing the external costs of greenhouse gas emissions. Yet globally 85% of emissions are still not covered by carbon pricing and carbon prices are significantly lower than values the Stern-Stiglitz High-Level Commission on Carbon Prices found to be consistent with the temperature goal of the Paris Agreement.[1] Indeed, about 75% of emissions covered by a carbon price are below $10 per tonne of CO_2.

Worryingly, a recent stall in emissions reductions has occurred: global energy-related carbon dioxide emissions increased by 1.4% in 2017 after three years of remaining flat[2], while EU Emissions Trading Scheme (EU ETS) emissions rose by 0.3% in 2017 – the first rise in 7 years[3] and non-ETS covered emissions rose for the second consecutive year (2014-2016). If the world is committed to limiting average temperatures at less than 2 °C above pre-industrial levels, a well-designed economy-wide carbon price is an indispensable part of a strategy for efficiently reducing greenhouse gas emissions while also fostering growth.[4]

Although the UK Government is committed in principle to carbon pricing as a mechanism to bring down emissions, what such a system will look like after we leave the EU is unclear. Remaining full participants of the EU ETS seems unlikely at this stage given that this would involve the UK continuing to abide by energy market and other rules set by the EU, while having little say over new rules as they are implemented, accepting the jurisdiction of the European Court of Justice as the arena for dispute resolution and perhaps even compromising over the free movement of people. If the UK leaves, this presents an opportunity to make a carbon pricing system fit for purpose. There are various options for UK carbon pricing outside the EU ETS and one

1 Carbon Pricing Leadership Coalition (2017). *Report of the High-Level Commission on Carbon Prices*. https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices/

2 IEA (2018). 'Global energy demand grew by 2.1% in 2017, and carbon emissions rose for the first time since 2014'. https://www.iea.org/newsroom/news/2018/march/global-energy-demand-grew-by-21-in-2017-and-carbon-emissions-rose-for-the-firs.html

3 Sandbag (2018). 'EU ETS emissions rise for first time in 7 years'. https://sandbag.org.uk/project/eu-emissions-rise-for-first-time-in-7-years/

4 World Bank (2017). 'More Countries Are Putting a Price on Carbon But Stronger Action Is Needed to Meet Paris Targets'. http://www.worldbank.org/en/news/press-release/2017/11/01/more-countries-are-putting-a-price-on-carbon-but-stronger-action-is-needed-to-meet-paris-targets-new-world-bank-report

is to implement an independent carbon tax. This is the option put forward in this report. Such a plan would consist of:

- **A steadily rising, economy-wide carbon tax** – after leaving the EU ETS at the end of the third trading period in 2021, this would initially continue at the level of the UK's Total Carbon Price[5] at that time to provide continuity for business, but would steadily increase year-by-year, with future rises signposted in advance by the Government. Price certainty can only be ensured if there is institutional certainty and so an independent expert body – such as the Committee on Climate Change (CCC) – would set the level and trajectory of taxation consistent with meeting decarbonisation targets in order to insulate the issue from the day-to-day volatility of party politics and give more certainty to investors. Any deviation from the trajectory recommended by the CCC would require a vote in Parliament and a Public statement by the Chancellor. The tax would be progressively expanded to cover all sectors of the economy.
- **Border carbon adjustments** – to create a level playing field between domestic and foreign industry a system will be set up to ensure that companies that export carbon intensive products into the UK will be subject to the same level of carbon taxation as domestic industries. UK exporters of such goods will be rebated their tax at the border. This will prevent carbon leakage whereby energy intensive industries direct new investment overseas or leave the country to avoid emissions levies.
- **Rationalisation of environmental regulations** – the UK currently has a complicated set of environmental taxes and exemptions that often overlap or work against one another. With the gradual implementation of an economy-wide carbon tax many policies will become redundant and could be phased out thus reducing the regulatory burden on business. This will in no way reduce environmental protection and where regulation is still required to correct market failures (e.g. product standards) it will be retained.

An economy-wide carbon tax would generate significant revenues, but alone could simply be a regressive and unpopular tax that penalises consumers. This flaw can be corrected by redirecting the proceeds of carbon pricing directly back into the pockets of the people:

- **We recommend that the revenue from carbon taxation should be directly returned to the populace in the form of a *carbon dividend*** in order to give voters an immediate interest in the fight against climate change and lock in carbon taxation as a political imperative. **This would turn an otherwise regressive and unpopular carbon tax into a popular and even populist policy that promotes more inclusive economic growth and enables the vast majority of UK citizens to benefit financially from this new climate solution**.

5 The UK Total Carbon Price equals the EU ETS permit price plus the additional Carbon Price Support top-up (currently an additional £18 per tonne on top of the EU ETS permit price).

Carbon taxes

A steadily rising, economy-wide carbon tax is widely regarded as a crucial mechanism for decarbonisation by economists. It ensures that the least cost options for reducing emissions are pursued first, with more expensive mitigation technologies only being invested in when the carbon tax has increased to a level high enough to provide the necessary incentive for business to switch from the old carbon intensive technologies to cleaner alternatives.

However, in the latest release of their series of reports on Taxing Energy Use, the OECD analysed carbon prices in 42 countries and found that they are 'falling well short of their potential to improve environmental and climate outcomes'.[6] Although carbon taxes and emissions trading schemes are proliferating around the world, for various reasons countries are reluctant to apply the taxes widely enough or raise their carbon taxes to a level high enough to make a real difference.

The UK has already shown that a carbon tax can make a difference. A major success in our decarbonisation drive has been in the power sector where, thanks to the successful deployment of renewables, most notably wind, and switching from coal to gas, emissions have fallen by more than 62% since 1990 despite increasing demand.[7] The UK Total Carbon Price of ~£25 per tonne was enough to tip the balance in favour of natural gas, meaning that coal power has almost disappeared completely, with one estimate suggesting that UK Carbon Price Support policy alone caused 73% of the reduction in coal generation from 2012 to 2016.[8]

Overall, greenhouse gas emissions in the UK appear to be falling, but this does not tell the whole story. Our transition to a service-based economy has meant that we import more goods than we export and a large proportion of our national carbon footprint has been offshored to developing economies where labour, and often energy, is cheaper – a process know as *carbon leakage*. A true economy-wide decarbonisation solution must thoughtfully address the outsourcing of emissions through carbon leakage.

Accordingly, the UK needs to build on its early success with carbon taxation in two important ways: a) by expanding the carbon tax to cover all other sectors of the UK economy which have made less progress with decarbonisation; and b) by developing new trade mechanisms that prevent carbon leakage and counter-act incentives for one nation to free-ride off the emissions reduction efforts of others.

Preventing carbon leakage

We have already seen directly what can happen when there are differential carbon taxes between neighbouring countries. The UK trades electricity with neighbouring countries through interconnectors – transmission cables between countries – but because other nations are not subject to the carbon tax top-up that domestic British companies pay, our European neighbours have a competitive advantage. The carbon intensity of French imports is approximately 53 g/kWh, Dutch imports are 474 (g/kWh)

6 OECD (2018). Taxing Energy Use 2018. http://www.oecd.org/ctp/taxing-energy-use-2018-9789264289635-en.htm

7 BEIS (2016). '2016 UK Greenhouse Gas Emissions'. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/604408/2016_Provisional_Emissions_statistics.pdf

8 Aurora Energy Research (2017). *The carbon price thaw: Post-freeze future of the GB carbon price*.

and Irish imports are 458 (g/kWh)[9], yet despite the increasing share of imported electricity, it is treated as zero carbon when calculating national emissions inventories.[10]

Though the UK's existing carbon tax has been successful in reducing domestic power sector emissions, the existence of interconnectors has favoured imports from parts of the EU where power stations are on average older and less efficient than the UK. Perversely this means that although our own carbon tax has decreased UK emissions, it may have increased EU-wide emissions because of carbon leakage.[11] This could be exacerbated further by planned interconnector projects from regions with carbon intensive electricity, such as the NeuConnect interconnector with Germany. Importing power derived from German lignite is incongruous with UK climate policy. Whilst interconnectors have many benefits – such as reducing UK wholesale prices, reducing the cost of integrating renewables and enhancing UK industrial access to low cost generators on the continent[12] – the price divergence and carbon accounting principles also serves to dilute UK emissions reductions and falsely bolster decarbonisation targets.

Our analysis suggests that carbon leakage due to carbon pricing has not happened at significant levels in the most at risk energy intensive industries yet, but only because the Government has created a complicated system of exemptions for these industries to ensure that they do not move production elsewhere. We are prevented from properly cleaning up our whole economy by the risk of carbon leakage. In the absence of a worldwide harmonised carbon tax the only solution to this problem is border carbon adjustments (BCAs). In this report ways to design border adjustments that are compatible with the World Trade Organisation (WTO) are put forward.

To prevent carbon leakage companies that wish to export electricity or carbon-intensive goods into the UK should have to pay the level of carbon tax that our domestic companies do in order to facilitate a level playing field and ensure that carbon emissions are not offshored. BCAs – and taxing consumption rather than production – is powerfully supported by arguments of both efficiency and equity[13], but not protectionism. All products in their destination markets should reflect domestic emissions. This is the same arithmetic that informs excise duty adjustments at the point of import and export and should therefore be viewed no differently.

Simplifying a duplicative policy landscape

UK and EU climate and energy regulation is at present a combination of inconsistent and overlapping regulations and exemptions. Figure ES1 below gives and overview of the policies in place or that are still being paid for.

We believe that many of these policies will become redundant after the implementation of an economy-wide carbon tax, but with a guiding principle of defining such redundancy that there will be no weakening of environmental standards. For example, we recommend that many building regulations, product standards and policies to promote energy efficiency should be kept and even strengthened. There are a range of financial, non-

9 BEIS (2016). '2016 UK Greenhouse Gas Emissions'. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/604408/2016_Provisional_Emissions_statistics.pdf

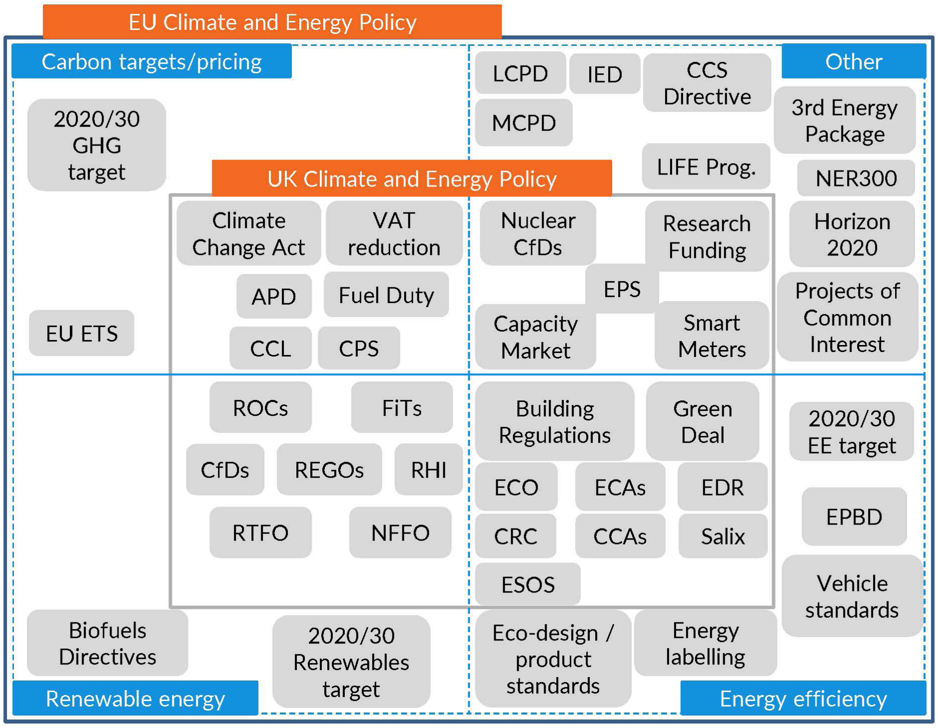
10 Staffell, I. (2017). 'Measuring the progress and impacts of decarbonising British electricity', *Energy Policy*, Vol. 102, Pages 463-475.

11 Howard, R. (2016). *Next Steps for the Carbon Price Floor*, Policy Exchange.

12 Grubb, M. and Drummond, P. (2018). *Industrial Electricity Prices: Competitiveness in a low carbon world*, Institute for Sustainable Resources, University College London.

13 Dieter Helm (2010). *Greener, Cheaper (Section Two: the Case for a Carbon Tax)*, Policy Exchange. https://www.policyexchange.org.uk/wp-content/uploads/2016/09/greener-cheaper-jul-10.pdf

Figure ES1: Overview of the main EU and UK climate and energy policies[14]



financial and behavioural factors which may inhibit investment in energy efficiency which can't be dealt with by a carbon tax alone and therefore reinforces the case for Government intervention.

We also believe that consumers should be correctly informed as to the efficiency of the products they buy, especially road vehicles. Finally, the Industrial Emissions Directive focuses on reducing emissions of pollutants that are directly harmful to human health, not greenhouse gases, therefore it should be kept.

There will be no bonfire of environmental regulations after implementation of this plan, only a gradual withdrawal of policies that become redundant or that were counterproductive in the first place.

Dividends: making carbon pricing popular and sustainable

Although carbon taxes have many advantages compared with emissions trading schemes, the main downside is that they are subject to the whims of the government of the day. Alone, carbon taxes give price certainty but regulatory uncertainty. Business needs to believe that the carbon tax will stick and that it will rise in line with expectations.

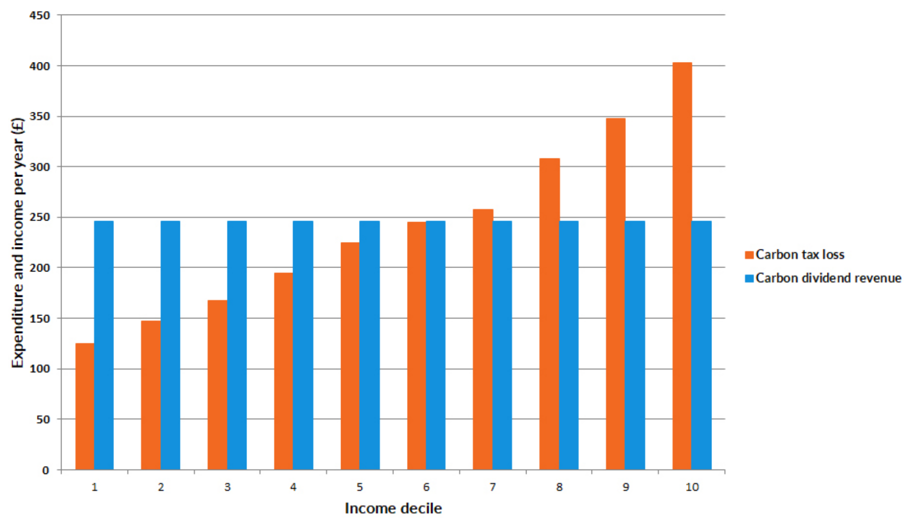
Along with an independent body setting the level of the tax, carbon dividends are a solution. The Winter Fuel Payment, cash payments given to people aged 65 and over to help heat their homes, is an example of a policy that has now become a third rail of British politics – something that cannot be reformed or withdrawn without the Government of the day suffering at the ballot box. Similarly, by linking the carbon tax directly to payments to individual citizens it will both win support for action on

14 APD (Air Passenger Duty); CCA (Climate Change Agreement); CCL (Climate Change Levy); CCS (Carbon Capture and Storage); CfDs (Contracts for Difference); CPS (Carbon Price Support); CRC (Carbon Reduction Commitment); ECA (Enhanced Capital Allowance); ECO (Energy Company Obligation) EPS (Emissions Performance Standard); EDR (Electricity Demand Reduction); ESOS (Energy Savings Opportunity Scheme); ETS (Emissions Trading Scheme); IED (Industrial Emissions Directive); FiTs (Feed-in Tariffs); LCPD (Large Combustion Plant Directive); MCPD (Medium Combustion Plant Directive); NFFO (Non Fossil Fuel Obligation); REGOs (Renewable Energy Guarantees of Origin); RHI (Renewable Heat Incentive); ROCs (Renewable Obligation Certificates); RTFO (Renewable Transport Fuel Obligation).

climate change and ensure that the carbon tax is bankable. This is favoured among behavioural and political studies that emphasise the importance of distributional fairness, revenue salience, political trust, and policy stability amid partisan changes in government.[15]

Therefore, we recommend redirecting the proceeds on carbon taxation directly back to citizens in order to give voters a direct and visible stake in fighting climate change and increase the acceptability of carbon taxes. In the absence of such payments, carbon taxes can be a regressive policy in which the poor pay a higher share of their income on such taxes than the rich, but dividends correct this problem.

Figure ES2: The redistributive effect of a carbon tax with dividends



In general, the richer you are the higher your carbon footprint. You are more likely to have a bigger house, to own a car (or two) and to travel more. Analysis by the Joseph Rowntree Foundation in 2013 found that the carbon footprint of the top income decile of households was three times higher than that of the lowest. This means if the UK was to apply an economy-wide carbon tax the richest would pay higher carbon taxes, but not as high as the ratio of incomes between these income deciles. With carbon taxes alone, the poorest would lose a higher percentage of their income than the richest. However, recycling the revenue in the form of a dividend to citizens corrects this. If everyone receives the same amount back, then the lowest income households are the biggest winners, as shown in Figure ES2 below. This is one illustrative graph, and the exact distributive nature depends on the input assumptions and year of data collection, but one thing is always very clear: a carbon tax with dividends is a progressive policy. This is important because for carbon taxes to be accepted, they need to be seen as fair.

15 Klenert, D. et al (2017). Making Carbon Pricing Work, Working Paper no. 2017-11, Oxford Institute for New Economic Thinking. https://www.inet.ox.ac.uk/files/Making_INET_Klenert_et_al.pdf

Policy recommendations

Policy Exchange does not believe that this transition can happen overnight and a gradual transition will remove the risk of any shock to our economy. In setting up a new independent system of carbon pricing, we have a once in a generation chance to improve energy and environmental policy that will help British businesses and consumers, whilst meeting our decarbonisation targets in the most efficient and equitable manner possible. To that end, we make a number of specific policy recommendations in this report that will enable implementation of this plan, the most important of which follow.

On carbon taxation and the EU ETS:

- **Continued membership of EU ETS and internal energy market during Brexit transition period.** This will remove any risk of an imminent cliff edge for trading businesses and for the import and export of electricity through international interconnectors and will allow for continued participation in the EU ETS during the transition period.
- **Exit the EU ETS in 2021.** The third trading period of the EU ETS (phase 3) will come to an end at the beginning of 2021. This is the most suitable time to leave the scheme and begin the implementation of a new independent British carbon tax with border carbon adjustments.
- **Create a new independent UK carbon tax.** The level of the tax will initially be set at the existing Total Carbon Tax at the beginning of 2021 to minimise disruption during the transfer period. Revenues will be collected by the Treasury, but the level of the tax and its future trajectory will be defined by an independent body – such as the Committee on Climate Change – that will set the rate of increase for the following five years.
- **After the Brexit transition, mirror the technical and safety requirements of the internal energy market to allow trade in fuel and electricity to continue. Continued linkage in some form beyond the transition date may be desirable, but should only be agreed to if compatible with border carbon adjustments.** If the UK leaves the internal energy market, it should take observer status (like Norway) in the European Energy Community and seek to create bilateral agreements relating to the import and export of electricity through the interconnectors.

On preventing carbon leakage:

- **Interconnectors should be classified as quasi-domestic generators and the implementation of border carbon adjustments on electricity imports and exports should begin. Seek bilateral agreements with neighbouring countries** with the condition that electricity will be traded based on the UK carbon tax. Given the complexity in identifying the specific generation sources that serve interconnectors, owners of the interconnectors will be subject to the carbon tax. Payment could be based on the interconnectors' average quarterly emissions intensity[16] multiplied by gross export over the period.

- **Create a new cross-department body to design the implementation of border carbon adjustments beyond electricity.** Implementation of border carbon adjustment of electricity traded through interconnectors would be the logical place to start, followed by imports of carbon intensive commodities such as cement, steel, and aluminium production, which are responsible for approximately 30% of global CO_2 emissions.[17] A continuum of potential methods for applying consumption based pricing is proposed, ranging from a single benchmark consumption based charge – which is easier to administer – to an actual carbon consumption based charge which is more complex but encompasses greater environmental efficacy. We recommend that consumption based pricing compromises between the basic and the complex charging methodologies, beginning with an undifferentiated approach and evolving to become more accurate over time.
- **Retain the Climate Change Act.** The associated targets for reducing greenhouse gas emissions should be retained and strengthened to measure emissions on a consumption as well as production basis. Extra targets should be set for reducing emissions on a consumption basis in parallel to the existing production-based targets, and the Committee on Climate Change should recommend ways to meet these targets.

On simplifying environmental regulations:

- **Progressively repeal all other direct and indirect forms of carbon taxation as those sectors become covered by the new UK carbon tax**. In the report we assess which policies have worked and which have not, which have to be kept and which do not.

On locking in political and public support for carbon taxation:

- **Create a system of payments to citizens, a carbon dividend, payable quarterly or yearly, funded by expanding the scope of carbon taxation to cover the whole economy.** Every adult will receive the same amount and those with children will receive an additional payment to reflect the fact that parents will have to pay for the carbon footprint of their children.
- **Investigate inventive ways of paying the dividend to ensure that the most vulnerable receive it.** Linking the dividend to national insurance numbers would be one a way to pay the dividend, but this may mean that the most vulnerable miss out. The Government

16 The average carbon intensity of imported electricity can be calculated using monthly generation mix data, and the estimated carbon intensities of fossil plants. See: http://electricinsights.co.uk/#/reports/methodology?period=1-year&start=2016-02-07&_k=iy91km

17 Carbon Pricing Leadership Coalition (2018). *Executive Briefing: How can consumption-based carbon pricing address carbon leakage and competitiveness concerns?*

should investigate whether new technology can be used to pay the dividend securely through a mobile app to ensure as many eligible people as possible receive it.

- **Allow citizens to borrow against their future dividend payments for investments in energy efficiency.** Government incentives for home energy efficiency have largely failed to meet their targets, which means the country has not been taking advantage of one of the most cost-effective paths to decarbonisation. As the Committee on Climate Change set out in 2017, low-carbon policies added just over £100 to household bills in 2016, but this was more than offset by improvements in energy efficiency which have saved the typical household around £290 per year since 2008. The total borrowing against future dividends will be capped in order to control costs whilst evaluating the effectiveness of this policy. The Government should also ensure schemes are in place to help the small number of low income people who may be disproportionately affected by carbon taxes and less likely to insulate their homes.

On promoting innovation and helping new technologies:

- **Invest in large-scale energy research and development.** Carbon taxes are necessary but not sufficient to spur the innovation of certain large-scale low carbon technologies, for example, carbon capture and storage. The Government should invest directly in energy infrastructure and in some cases large-scale demonstration programmes that, due to investment risk and regulatory hurdles, cannot reach the market without Government involvement. Indeed, in dealing with industries with such long-term liabilities, like nuclear power and carbon capture and storage (CCS), the Government will still need to play a key role, though direct subsidies once past the demonstration phase should be avoided as this would negate the efficient and technology neutral approach of the carbon tax.

Background to the Project

Many energy and climate policies have been implemented at both a UK and EU level with the intended purpose of reducing emissions. This has resulted in a complicated, often duplicative and costly system of overlapping initiatives that in many cases either do not work or vitiate their intended purpose. Electricity consumers pay for the EU Emissions Trading Scheme (EU ETS), the Carbon Price Support, the Renewable Obligation, Feed-in Tariffs and Contracts for Difference, while businesses also pay for Climate Change Levy and CRC Energy Efficiency Scheme (although the CRC is soon to be abolished). Amid such a complicated system, there is a strong case to be made for the implementation of a carbon tax that covers the whole economy.

Such a case was made in a report for Policy Exchange in 2010 by Oxford University's Professor Dieter Helm. In *The Case for a Carbon Tax*,[18] he concluded that emissions trading schemes are inferior to a carbon tax for two main reasons. Firstly, as has been shown in the EU, it is very easy to get the number of permits wrong, thus undermining the whole system. The EU ETS price has been consistently too low to have a significant impact on emissions due to a surplus of permits. Reforms have begun to try to fix this, but there is also a risk in the opposite direction of a deficit resulting in sharply rising prices. This volatility creates uncertainty for business. Secondly, the complexity of trading schemes leaves the process of permit trading open to exploitation by rent-seeking 'vultures' and undermines the market underpinning the entire policy .

Professor Helm recommended combining a UK carbon tax paid upstream on fossil fuels combined with border adjustments on imported fuel and goods to prevent carbon leakage. He reiterated this proposal in the 2017 Cost of Energy Review commissioned by the UK Government.[19]

The Climate Leadership Council[20] (CLC) is an organisation devoted to promoting carbon pricing as the most cost-effective way to address climate change. Similarly to Professor Helm, they advocate an economy-wide carbon tax with border carbon adjustments, but also have an innovative proposal to rebate the carbon tax proceeds back to the population in the form of 'carbon dividends'.

Due to a similar interest in this area, in 2017 Policy Exchange became a strategic partner of the Climate Leadership Council and launched a study into if and how a similar plan could work in the context of the UK and EU. This report is the result of that study.

The UK's exit from the EU and the likely exit from the EU Emissions

18 Helm, D. (2010). *Greener, Cheaper (Section Two: the Case for a Carbon Tax)*, Policy Exchange.

19 Helm, D. (2017). *Cost of Energy: Independent Review*, BEIS.

20 https://www.clcouncil.org/

Trading Scheme offer a chance for major reform of carbon taxation. The UK is in a better position than most countries for the implementation of an independent carbon tax as there is already broad cross-party support for strong action on decarbonisation. The Climate Change Act is also supported by every major political party in Britain and the UK already has a form of carbon tax, the Carbon Price Support policy.

This report analyses carbon taxation in the context of the UK at the crucial moment in its history of leaving the European Union. It is divided into three sections. The report can be read front to back, but each of the three central chapters (below) also stand alone as individual readable documents:

- An overview of current UK and EU energy and climate policies.
- Analysis of carbon pricing in the UK and internationally.
- Specific proposals for a new system of carbon pricing when we leave the EU ETS.

The Justification for a New Approach

A recent history of UK energy and climate policy

The concept of anthropogenic climate change began to enter the political discourse in the 1980s. The Inter-Governmental Panel on Climate Change was created in 1988 and shortly afterwards the Prime Minister Margaret Thatcher gave a speech to the Royal Society and subsequently to the UN stating that 'the problem of global climate change is one that affects us all and action will only be effective if it is taken at the international level'.[21] It took another decade before nation states seriously started implementing policies aimed at reducing greenhouse gas (GHG) emissions. Although the United Nations Framework Convention on Climate Change[22] of 1992 brought the countries of the world together to agree that something must be done to stabilise global temperatures, it was not until the 1997 Kyoto Protocol[23] that international targets were set.

By the early part of the 2000s, climate change was firmly part of the political debate in the UK and legislation on reducing carbon emissions, improving energy efficiency and promoting renewable energy came thick and fast. At a high level this began in 2000 with the Royal Commission on Environment and Pollution report *Energy – The Changing Climate*, which recommended a 60% reduction in domestic greenhouse gas emissions by 2050. This was followed by the *Energy Review*[24] in 2002 and a subsequent White Paper in 2003 entitled *Our energy future – creating a low carbon economy*[25]. This was a time of high and rising oil prices and there were still concerns about 'peak oil'. High energy prices also made 'fuel poverty' an increasingly controversial political issue.

The Department for Energy and Climate Change (DECC) was also set up in 2008 with Ed Miliband being the first Secretary of State to lead it. The UK also passed the Climate Change Act[26], which made it a legal requirement for the UK to reduce greenhouse gas emissions by 80% by 2050 (from 1990 levels), and created the Committee on Climate Change (CCC) which would be responsible for setting five-year 'carbon budgets' (legal limits on the amount of GHG the UK could emit during this period) and advising the Government on how to meet them.

The focus of energy policy in the UK was now what was referred to as the energy trilemma: security of supply; affordability; low carbon. Technology-wise the main candidates to meet the energy trilemma were nuclear power, carbon capture and storage (CCS) and various renewable energy technologies.

21 Margaret Thatcher (1989). 'Speech to United Nations General Assembly'. http://www.margaretthatcher.org/document/107817

22 UN (1992). *United Nations Convention Framework on Climate Change*. https://unfccc.int/resource/docs/convkp/conveng.pdf

23 UN (1998). *Kyoto Protocol to the United Nations Convention on Climate Change*. http://unfccc.int/kyoto_protocol/items/2830.php

24 Cabinet Office (1992). *The Energy Review*. http://www.gci.org.uk/Documents/TheEnergyReview.pdf

25 DTI (2003). *Our energy future - creating a low carbon economy*.

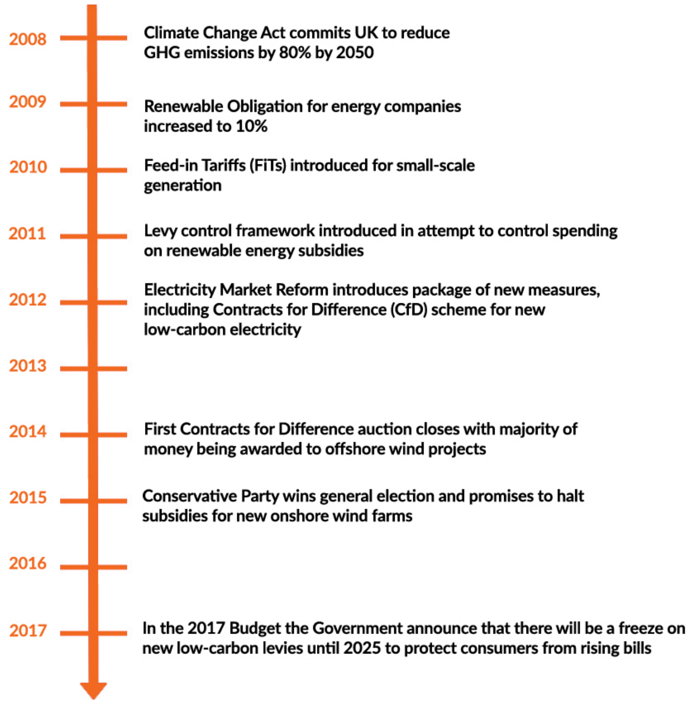
26 Climate Change Act 2008, UK. http://www.legislation.gov.uk/ukpga/2008/27/contents

Almost zero progress on nuclear power and CCS was made over the decade that followed, but a raft of new policies and subsidies (Non Fossil Fuel Obligation, Renewable Obligation, Feed-in Tariffs, etc.) meant that there was a renewables boom, albeit from a very low starting point, particularly in solar and wind. Much of this new renewable energy deployment was small-scale and distributed as homeowners and businesses took advantage of the various generous subsidy schemes available, in particular the Feed-in Tariff for roof-top solar power. A hands-off approach by Government in the 1990s delivered the dash-for-gas, but by the late 2000s it was clear that major Government intervention in the energy market was becoming the norm again.

A cross-party consensus on the requirement to act on climate change had emerged by this stage and the newly elected Conservative and Liberal Democrat coalition Government in 2010 broadly continued the Miliband approach to energy policy, with a firm commitment to the energy trilemma. Energy White Paper in 2011 led to the Green Deal (support for homeowners to insulate their home/enhance domestic energy efficiency), the Green Investment Bank (a Government-backed scheme for financing green infrastructure) and Electricity Market Reform, including Carbon Price Support. Figure 2.1 shows a broad overview of the timeline of renewable electricity subsidies in the UK from the passing of the Climate Change Act in 2008 to the present day.

In parallel to this process has been the increasing collaboration across Europe on energy market integration. The UK has been a leader in encouraging the development of the European Internal Energy Market, which is the process to harmonise the trading rules and technical

Figure 2.1: Timeline of significant UK renewable energy subsidies[27]



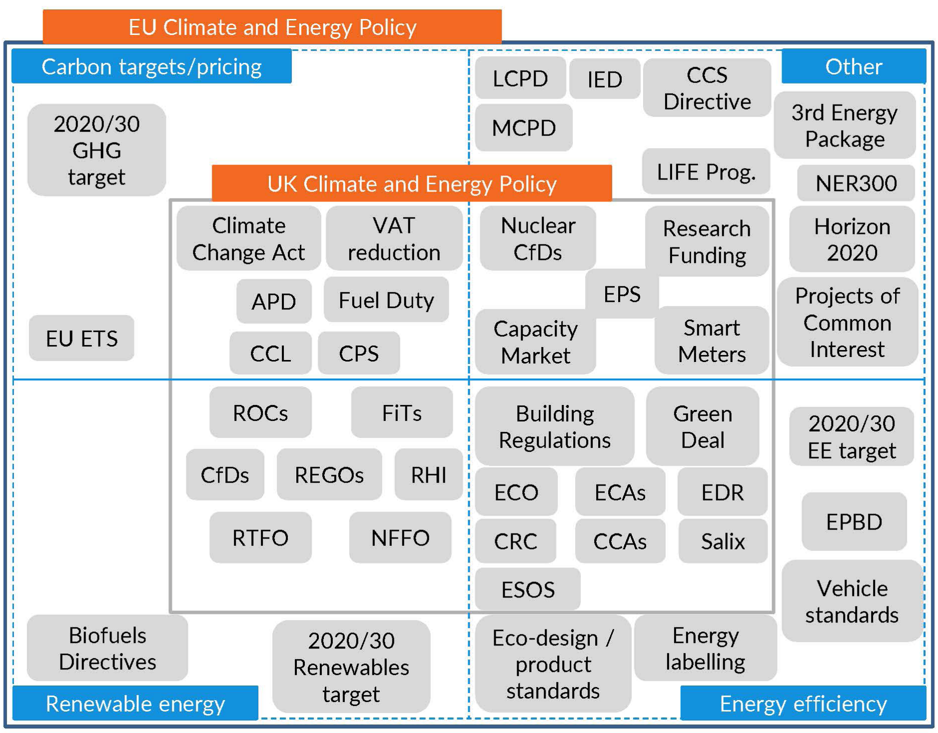
27 House of Lords (2017). *The Price of Power: Reforming the Electricity Market*, Select Committee on Economic Affairs, 2nd Report of Session 2016–17. https://publications.parliament.uk/pa/ld201617/ldselect/ldeconaf/113/113.pdf

standards across the continent to enable the frictionless flow of energy across borders, mainly in the form of gas and electricity. The UK has also been a participant in the EU Emissions Trading Scheme since its launch in 2005, which will be examined in more detail later in the report.

Overview of EU and UK climate and energy policies

The decade-long procession of new policy after policy has led to a complicated and messy patchwork of subsidies and penalties that make up the UK energy market today. On top of this, the EU approach to climate and energy is largely derived from the 2020 Climate & Energy Package, which is framed around a set of targets for greenhouse gas emissions reduction and renewable energy. From this stems a number of EU Directives and associated policies and regulations, which each member state is obligated to implement at a local level. There has been a lack of technology neutrality in decision-making meaning that the industries most effective at lobbying governments have been most effective in capturing support, which often works against the principle of finding the lowest cost path to emissions reduction. Figure 2.2 provides a summary of the resulting EU and UK climate and energy policy landscape.

Figure 2.2: Overview of the main EU and UK climate and energy policies[28]



To make matters more confused, the various policies are applied in different ways to different sectors of the economy, as shown in Table 2.1.

The next sections of this report look at the previous and current policies implemented at UK and EU levels and discuss the positive and negative aspects of the main initiatives, and the lessons that can be learned. The

28 APD (Air Passenger Duty); CCA (Climate Change Agreement); CCL (Climate Change Levy); CCS (Carbon Capture and Storage); CfDs (Contracts for Difference); CPS (Carbon Price Support); CRC (Carbon Reduction Commitment); ECA (Enhanced Capital Allowance); ECO (Energy Company Obligation) EPS (Emissions Performance Standard); EDR (Electricity Demand Reduction); ESOS (Energy Savings Opportunity Scheme); ETS (Emissions Trading Scheme); IED (Industrial Emissions Directive); FiTs (Feed-in Tariffs); LCPD (Large Combustion Plant Directive); MCPD (Medium Combustion Plant Directive); NFFO (Non Fossil Fuel Obligation); REGOs (Renewable Energy Guarantees of Origin); RHI (Renewable Heat Incentive); ROCs (Renewable Obligation Certificates); RTFO (Renewable Transport Fuel Obligation)

Table 2.1: The main climate policies and the sectors to which they apply[29]

	Households	Small business	Medium business	Large energy-intensive business
Electricity	EU ETS Carbon Price Support (CPS) Renewable Obligation (RO) Feed-in Tariffs (FiT) Energy Company Obligation VAT subsidy	EU ETS CPS RO FiTs Climate Change Levy (CCL)	EU ETS CPS RO FiTs CCL	EU ETS CPS RO FiTs Climate Change Agreements (CCA)
Gas	Warm Homes Discount ECO VAT subsidy	CCL	CCL	EU ETS CCAs

policies analysed are divided into three categories:

- Emissions reduction targets
- Renewable energy targets and subsidies
- Energy efficiency

EU emissions targets

The EU's targets in the current 2020 Climate & Energy Package are slightly arbitrary, in that they seem to have been set such that they all reach the number 20 in 2020 rather than being based on any scientific criteria. The package aims that by 2020, the EU should achieve a 20% cut in greenhouse gas emissions (from 1990 levels), 20% of all energy from renewables, and a 20% improvement in energy efficiency. Looking further ahead, the EU's 2030 climate and energy framework aims to achieve at least 40% cuts in greenhouse gas emissions, at least 27% share for renewable energy and at least 27% improvement in energy efficiency from the same baselines as the 2020 framework. Our report looks at renewable energy and efficiency in later sections. This section analyses UK and EU emissions targets only, which in setting climate change policy are ultimately the numbers that really matter.

The EU has made significant progress in reducing GHG emissions, achieving a 20% reduction in emissions in 2014 – six years ahead of the 2020 target. GHG emissions were broadly static throughout the latter part of the 1990s and the early 2000s, but fell dramatically in 2009 following the Great Recession. Projections show that the EU is on course to achieve a 25% reduction in GHG emissions by 2020, and 29% by 2030. On this basis the 2020 emissions target would be met, but without further policies or a significant reduction in economic growth, the 2030 target would be missed by a significant margin.[30]

29 Source: https://www.ifs.org.uk/docs/PE%20slides_Environmental.pdf

30 European Environment Agency (2017). *Trends and projections in Europe 2017*. https://www.eea.europa.eu/themes/climate/trends-and-projections-in-europe/executive-summary-1

UK emissions targets

The UK has set targets to reduce greenhouse gas emissions under the Climate Change Act of 2008, which aimed to reduce them by at least 80% by 2050, compared to the 1990 baseline.[31] A key provision of the Climate Change Act was the creation of the Committee on Climate Change (CCC), to act as an adviser to the Government, measure progress and set interim targets to 2050. The Climate Change Act sets a high-level framework in legislation, and then the CCC forces action through the use of 'carbon budgets', which set a cap on greenhouse gas emissions in five-year periods.

The CCC advises the Government on the various ways in which carbon budgets *could* be met, but rightly stops short of prescribing exactly how emissions reductions should be achieved in terms of technologies or policies. The latest progress report by the CCC praises the significant progress which has already been made to decarbonise the power and waste sectors, but also says better progress will be required in other areas, particularly in buildings and transport, in order to meet future carbon budgets.[32]

Over the longer term, the UK has made substantial progress in reducing greenhouse gas emissions. Total GHG emissions have fallen by 42% since 1990, whilst at the same time GDP has risen by more than 60%.[33] Significant progress has been made to decarbonise the power sector, industry and the waste sector. The UK is already on course to meet the second and third carbon budgets (covering the periods 2013-17 and 2018-22 respectively).

However, modelling shows that based on current policies alone, the UK is likely to miss the fourth and fifth carbon budgets (covering the periods 2023-27 and 2028-32). The UK Government have set out how the fourth and fifth carbon budgets will be delivered in the recently published *Clean Growth Strategy*.[34] This included various additional actions to address GHG emissions from buildings and transport, where progress to date has been slow.

Different methods of carbon accounting and why this matters

On the evidence above, it seems the UK's record in reducing GHG emissions is strong. Figure 2.3 shows that UK territorial carbon emissions (given in tonnes of CO_2 per terajoule (TJ)) have been reducing steadily since 1990.

However, the carbon accounting method used by the CCC (and similarly by the EU and other international bodies) to assess carbon emissions only considers the greenhouse gases emitted within each country, rather than those associated with the products we consume. This does not take into account what is known as carbon leakage. As we have moved to a more service-based economy much of our manufacturing has moved to countries where, for various reasons, production is less expensive, thus reducing the UK's production emissions, but not necessarily global emissions.

A number of different methods exist for carbon accounting. The UK Government publishes emissions statistics using three different approaches:

1. Emissions based only on greenhouse gases that occur within UK border. This forms the basis of reporting to the European

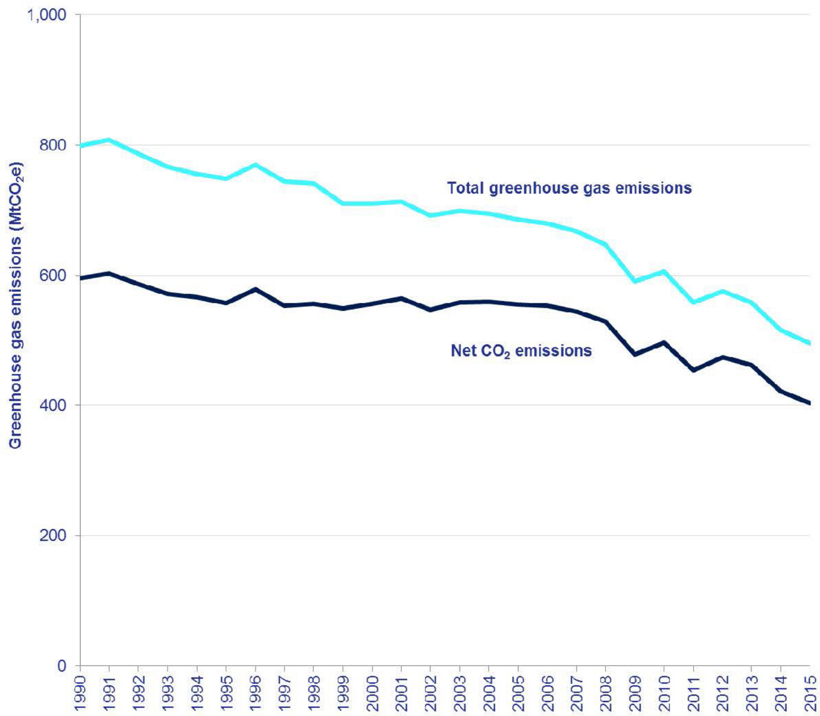
31 Climate Change Act 2008, UK. http://www.legislation.gov.uk/ukpga/2008/27/contents

32 CCC (2017) *Reducing emissions and preparing for climate change: Summary and recommendations*, Committee on Climate Change. https://www.theccc.org.uk/wp-content/uploads/2017/06/Reducing-emissions-and-preparing-for-climate-change-2017-Report-to-Parliament-Summary-and-recommendations.pdf

33 Ibid.

34 BEIS (2018). *Clean Growth Strategy: Leading the way to a low carbon future*, HM Government. https://www.gov.uk/government/publications/clean-growth-strategy

Figure 2.3: UK greenhouse gas emissions on a production basis[35]



Commission (EC), United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. It is this data that is used for reporting on progress towards the UK's domestic and international emissions reduction targets.

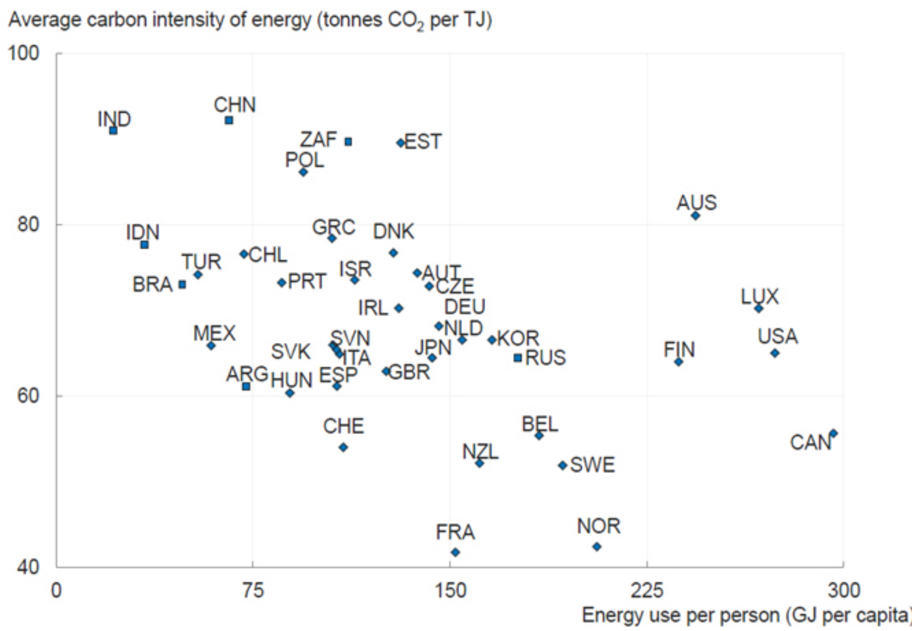
2. Measurement of GHG Emissions on what is referred to as a 'residents' basis. This means measuring only emissions caused by UK residents and industry whether in the UK or abroad.
3. Embedded emissions which measure the emissions embedded within the manufactured goods and services which the UK imports and exports. This methodology is not used for reporting to the EC, UNFCC or as part of domestic targets.[36]

Under the first methodology the UK is doing well, though the third tells a different story. The third method is really a more suitable measure of emissions by country, and it is referred to as carbon consumption accounting. Using this methodology, carbon emissions embodied within the products and services consumed in the UK would be allocated to our emissions, no matter where those products and services were produced. For example, the emissions from steel produced in China but used in a building in the UK would be allocated to the UK. This method captures the effects of offshoring economic activities. As the emissions intensity of the Chinese energy sector is much higher than in the UK (see Figure 2.4), and because there is extra energy involved in the transportation of goods, this carbon leakage can have the counterproductive effect of actually *increasing* emissions at a global level.

35 Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/604350/2015_Final_Emissions_statistics.pdf

36 DECC (2015). *Alternative approaches to reporting UK Greenhouse Gas Emissions*. https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-explanatory-notes

Figure 2.4: Energy use per capita and carbon intensity across selected countries[37]



On the basis of this carbon consumption accounting method, the UK and many other advanced economies fare less well than is often assumed. Policy Exchange analysed the discrepancy between carbon production and carbon consumption as far back as 2010. Our report Carbon Omissions found that 'EU consumption emissions have risen by an astonishing 47% since 1990 [to 2010], and UK consumption emissions have risen by 30%.'[38]

More recently, the Sustainability Research Unit at the University of Leeds have developed a model that allocates emissions from the production of products to their final consumer.[39] Using this carbon consumption methodology, as illustrated in Figure 2.5, UK emissions actually rose steadily from 1993 until 2007, and then fell primarily due to the Great Recession. UK climate and energy policy has been much less successful than it seems then, with the majority of the emissions reductions achieved by offshoring production and emissions to other countries.

The carbon production numbers commonly used and presented for the EU and UK are not completely irrelevant – they still make up the majority of emissions – but when viewing these statistics we should always keep in mind that it is global emissions that matter and if EU emissions are simply being offshored, then this represents a major flaw in our climate policies. As overseas production to serve UK demand is almost twice as emissions intensive as domestic production[40], this presents a global problem which simply becomes moved rather than solved.

A more globalised world, with greater flows of trade means the resulting emissions need to be calculated. A global problem needs a global solution.

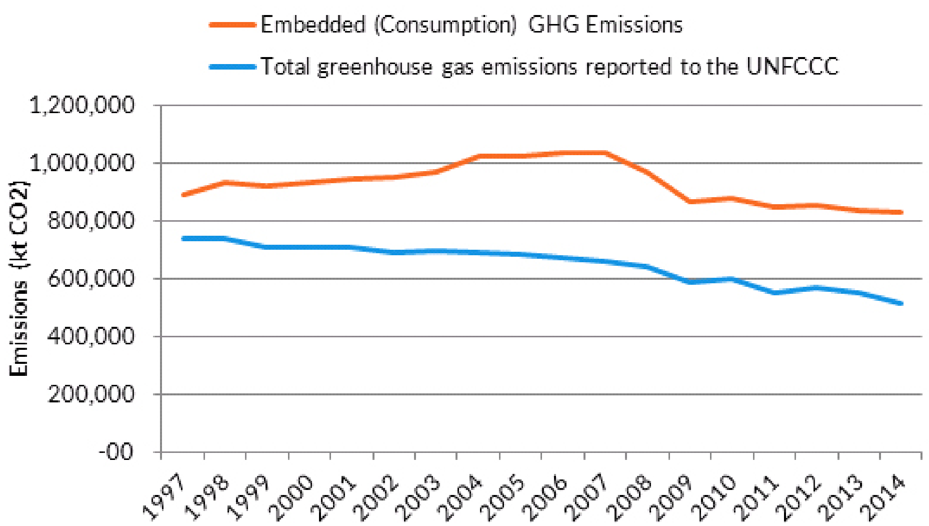
37 OECD (2015). *Taxing Energy Use 2015: OECD and Selected Partner Economies.*

38 Brinkley, A. and Less, S. (2010) *Carbon Omissions*, Policy Exchange.

39 http://www.emissions.leeds.ac.uk/index.html

40 Deloitte (2015). Consumption-based carbon emissions. https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-carbon-analytics-consumption-based-carbon-emissions-050815.pdf

Figure 2.5: UK greenhouse gas emissions on a consumption basis[41, 42]



Renewable energy targets and subsidies

The **Renewable Energy Directive** (RED) requires the EU to meet 20% of its total energy needs from renewable sources by 2020, and 27% by 2030. It also set a 10% target for renewable transport fuels by 2020. Each country has its own individual target based on its starting point and its renewable energy potential. The UK's 2020 targets under the RED are:

- 30% renewable electricity
- 12% renewable heat
- 10% renewable transport[43]

Again, good progress has been made in the power sector and the 30% target is likely to be met, but this is unlikely to compensate for poor performance on meeting the heating and transport targets.

The Renewable Electricity Directive is technology neutral to a certain extent in that it does not mandate which particular renewable technologies each country should deploy. It allows each member state to make the best use of their natural resources and the neutrality should in theory allow the market to determine which renewable technologies are most cost effective.

However, one of the main problems with the RED and the UK's implementation is in its interaction with the EU ETS, which is discussed in more detail later in the report. Under the EU ETS, total emissions are capped and then market forces should determine the most cost-effective path to meeting the cap. When the RED is superimposed on top of this policy, it achieves zero extra emissions reduction, and with Government ministers favouring immature renewable technologies it does ensure that some of the most expensive technologies are chosen, thus working directly against the whole point of the ETS and wasting resources that could have achieved greater emissions savings elsewhere.

Setting targets is not always a problem, but certain targets can create perverse incentives and having multiple targets that do not necessarily pull

41 Defra (2017). *UK's Carbon Footprint 1997-2014*. https://www.gov.uk/government/statistics/uks-carbon-footprint

42 BEIS (2018). *Final UK greenhouse gas emissions national statistics: 1990-2016*. https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-2016

43 www.parliament.uk (2017). *2020 renewable heat and transport targets*. https://www.publications.parliament.uk/pa/cm201617/cmselect/cmenergy/173/17305.htm

in the same direction can result sub-optimal outcomes. The Government's main policies to meet targets set out in the RED forced the UK to pursue a policy involving mass deployment of renewables before they were cost competitive. This points to the main flaw with renewable energy targets: overall emissions reductions targets are designed to find the lowest cost path to decarbonisation. Prioritising renewable technologies can work against this aim and result in very high costs.

As outlined in previous Policy Exchange reports, *Greener, Cheaper (Section 1: Cutting the Cost of Cutting Carbon)*[44] and *The Customer is Always Right*[45], the particular British policy levers for meeting these targets, primarily the Renewables Obligation (RO) and the Feed-in Tariff (FiT), were extremely expensive from a decarbonisation point of view, 'an order of magnitude more expensive per tonne of carbon saved' than some other options. Government support for emerging technologies in order to assist them in bridging the 'valley of death' between development and commercialisation is sometimes necessary, but these policies amounted to a subsidised mass roll-out of immature technologies, which is a very expensive path to decarbonisation, much more costly that other under-utilised and cheaper strategies, like energy efficiency. For example, in the early days of the FiT, the rate was 42 pence/kWh for solar, which works out at about £800/tonne for carbon abatement. Early offshore wind energy projects received contracts to produce electricity at £150-155/MWh. The costs of both technologies have since plummeted and the Government was much too slow to respond to reductions in costs, leading to surges in deployment when investor returns were excessive. British electricity consumers will be left paying the price for this for many years. Had the Government held back a few years on the deployment of solar PV it could have taken advantage of cost reductions elsewhere. There has been little benefit in terms of industrial strategy in the UK being a first mover in this regard, at least not enough to justify billions of pounds of subsidies.

The way in which the Government implemented policies to meet the RED meant that Government ministers ended up essentially choosing individual technologies that were in vogue at the time, rather than taking a hard-headed and cost-effective approach to reducing carbon emissions. In the early stages especially, the process was not technology neutral and DECC officials offered different levels of subsidy for each technology. In many cases this has led to choosing politically palatable technologies, like solar and biomass, that as well as being very expensive in the early stages also may end up increasing system costs through a requirement for investment in back-up power or large-scale energy storage (in the case of solar) or may not be low carbon (in the case of biomass). The ex-Chief Scientist to DECC admitted that ministers ignored their advice that subsidising solar was a bad idea and went ahead with it because it was an easier sell to the public.[46]

In European countries the pace of solar deployment has stalled due to subsidy schemes being phased out, in many cases due to doubts about the sustainability and life cycle carbon emissions of biofuels. These were not

44 McIlveen, R. (2010) *Greener, Cheaper*, Policy Exchange.

45 Howard, R. (2015) *The Customer is Always Right*, Policy Exchange.

46 Carrington, D. (2016). "Idea of renewables powering UK is an 'appalling delusion' – David MacKay", *The Guardian*. https://www.theguardian.com/environment/2016/may/03/idea-of-renewables-powering-uk-is-an-appalling-delusion-david-mackay

thought through properly in advance, resulting in biodiesel for use in road transport and wood pellets for use in power stations, the life cycle carbon emissions of which are highly disputed, with some saying that of they can be equivalent to burning coal (by energy).[47] The Directive now has new biofuel sustainability criteria to try to limit life cycle emissions from biofuels and ensure they are sustainably produced.[48]

Contracts for Difference (CfDs) are a subsidy scheme designed to supersede FiTs and the RO. They provide a guaranteed electricity price for new investments in low carbon electricity. If the wholesale price of electricity is below the CfD 'strike price', then the Government will make up the difference between the wholesale price and the strike price for those suppliers with contracts (paid for through a levy on consumer bills). If the wholesale price is above the strike price, then the supplier pays back the difference to the Government. Typical contracts have a duration of around 15 years from the time a project begins to produce electricity, but the proposed contract for the new Hinkley Point C nuclear power station would have a duration of 35 years.

Although CfD auctions were designed to introduce more competition and reduce the price of renewable electricity subsidies, the early projects were guaranteed very high prices. The first round of CfD auctions saw an offshore wind project receive a strike price of £120/MWh. DECC justified paying such a high price for these projects through modelling work that made an assumption of rising natural gas prices in the future. The fracking boom in America, combined with a dip in demand following the Great Recession, has meant the gas price has been much lower than anticipated, making the early CfDs relatively costly. Worldwide wind and solar costs have dropped dramatically in recent years and this, combined with increased competition, has led to the latest CfD auction winning bids coming in lower than many expected for offshore wind prices. Whether these low prices can be maintained or whether the companies involved have submitted low bids so that the returns are not sufficient to eventually raise project finance remains to be seen.

Renewable Heat Incentive

Decarbonising domestic heating is one of the most difficult challenges in the energy sector. In the long term it is likely to be done by replacing natural gas with biogas or hydrogen or by electrifying the whole system. Either of these would be a huge undertaking and that perhaps explains why little progress has been made in this sector.

The Renewable Heat Incentive (RHI) was set up in 2014 to help the UK meet its target of producing 12% of heating from renewable energy by 2020. It offers financial incentives for households, communities and businesses who install any of the following technologies:

- Biomass (wood-fuelled) boilers
- Biomass pellet stoves with integrated boilers providing space heating

47 Timperley, J. (2017). "Biomass subsidies 'not fit for purpose', says Chatham House", Carbon Brief. https://www.carbonbrief.org/biomass-subsidies-not-fit-for-purpose-chatham-house

48 European Commission (2016). 'Proposal for updated sustainability criteria for biofuels, bioliquids and biomass fuels'. https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria

- Ground to water heat pumps
- Air to water heat pumps
- Solar thermal panels providing hot water for your home

To May 2017, only around 55,000 homes and 16,000 businesses had received support under the RHI.[49] Under the non-domestic RHI, the majority of businesses chose to install biomass boilers (approximately 98%), whilst the most popular domestic technology has been air source heat pumps, though biomass boilers are also popular. Heating the entire UK housing stock with biomass is not likely to be sustainable, and, as previously mentioned, there are doubts about whether biomass can really be low carbon or not. This again shows the distorting effect of focussing on technology specific targets, rather than reducing carbon emissions in the most cost-effective manner. Expensive subsidies for a technology that is not scalable and may even have high embedded carbon emissions is one of the egregious examples of what can happen when Government sets these types of targets.

Claimed spill-over effects of renewable energy

The EU claimed that their 2020 climate and energy package would have a number of positive spill-over effects, including:

- Increased energy security by reducing dependence on fossil fuel imports
- Economic growth and 'green jobs'
- Making Europe more competitive

The first of these is at least partially true as every unit of electricity locally produced by solar or wind will displace a unit of electricity that would have been produced by natural gas or coal, some of which is imported. However, the ability of the electricity grid to manage increasing penetrations of intermittent renewable sources of power cannot be taken for granted - an issue covered extensively in our 2016 report, *Power 2.0*.[50] Whilst an increase in renewables reduces import dependency, it contributes to other energy security issues such as how to ensure adequate capacity and system stability – issues which policymakers are now having to contend with.

Renewable energy's contribution to economic growth, job creation and especially competitiveness is much less obvious. Germany undoubtedly did the world a favour by investing heavily in renewable energy through the exorbitant subsidies doled out through their Energiewende policies. This helped to generate the economies of scale to significantly bring down the cost of, in particular, solar photovoltaics, but it is unclear how much of the subsequent value of this investment was captured by Germany itself. Not one of the top 10 solar panel manufacturers in the USA is from Europe, for example, with more than half of them being from East Asia.[51]

The concept of 'green jobs', that we should subsidise renewable energy not only to reduce carbon emissions but also for job creation, is often

49 BEIS (2017). 'RHI deployment data: May 2017'. https://www.gov.uk/government/statistics/rhi-deployment-data-may-2017

50 Howard, R. and Bengherbi, Z. (2016). *Power 2.0: Building a smarter, greener, cheaper electricity system*, Policy Exchange.

51 EnergySage (2018). 'What are the top solar panel companies & manufacturers in 2018?' http://news.energysage.com/best-solar-panel-manufacturers-usa/

put forward by politicians and lobbyists. The idea that renewable energy creates jobs, or more accurately that it creates more jobs that investment in other energy projects, is disputed. A study published in Renewable and Sustainable Energy Reviews outlines the difficulties in even measuring job creation due to specific technologies.[52] This includes the time-lag between making the measurements and reporting the effects, which can be years. Taking solar as an example, employment intensity is likely to be higher in the early stages of the industry when producing the panels and installing them was labour-intensive, but with mass production and large-scale solar facilities, the labour requirements are reduced. Anyway, the energy industry is typically capital intensive compared to service sectors of the economy, which makes it a very expensive form of job creation, so 'green jobs' should never be a major factor in decision making. For example, it has been estimated that in the early stages of the German solar industry, each job created cost the German taxpayer 175,000 euros.[53] There may be some more merit in policies that promote energy research and innovation in general, as this will directly create high skill, high wage jobs and generate other positive externalities in the domestic economy.

Finally, inflating energy prices through climate policies has had the effect of making Europe less competitive. The shale gas boom in the United States flooded their economy with cheap and abundant natural gas, whilst Europe was becoming more dependent on importing energy from around the globe. High energy prices in Europe have been offset somewhat by improvements in energy efficiency, but not by enough to offset the effect of high prices compared to other parts of the world.

Energy efficiency

Energy efficiency is often portrayed as the low hanging fruit in the carbon emissions debate. Economic analysis of climate change mitigation measures consistently suggests that energy efficiency investments will pay for themselves without requirement for any subsidy. Unlike expensive subsides for certain renewable energy technologies, the 'cost of carbon avoided' energy efficiency measures is often very low or even negative. Home insulation measures, for example, will save homeowners money and reduce carbon emissions.

Analysis by the IEA (Figure 2.6) has highlighted the huge worldwide potential emissions abatement through energy efficiency. It is even greater than for renewables, nuclear power or CCS.

The EU has set an overall target to improve energy efficiency by 20% by 2020. Within this, individual Member States were permitted to set their own indicative national energy efficiency targets, and depending on country preferences, these targets could be based on primary or final energy consumption, primary or final energy savings, or energy intensity. Member states had a strong incentive to inflate their baseline scenarios in order to make the 20% savings much easier to achieve.

The overarching policies to meet efficiency targets have included the Energy Efficiency Commitment (2002-2005, 2005-2008), which was

52 Lambert, R.J. and Silva, P.P. (2012). 'The challenges of determining the employment effects of renewable energy', *Renewable and Sustainable Energy Reviews*, Vol. 16 pp. 4667-674.

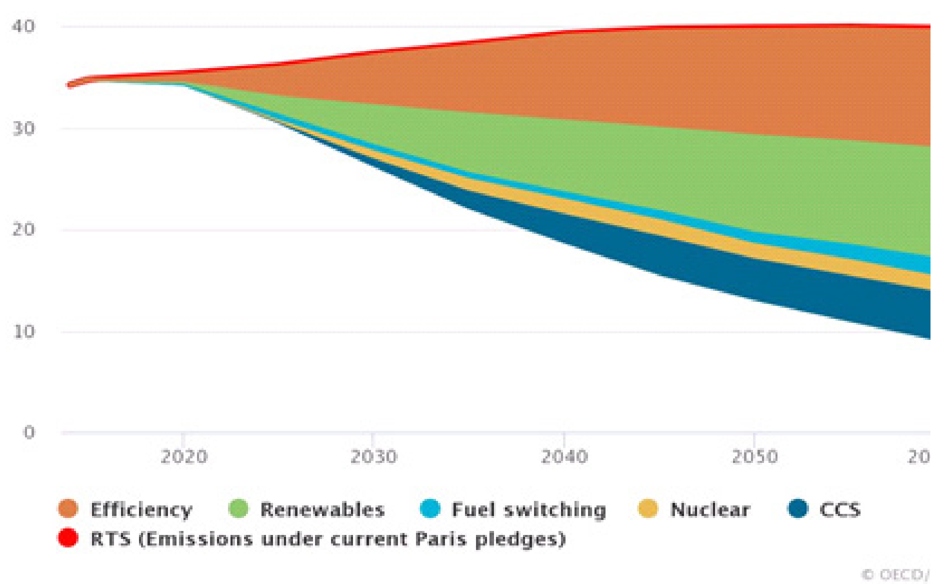
53 Frondel, M. (2010), 'Economic impacts from the promotion of renewable energy technologies', *Ruhr Economic Papers* 156, Ruhr University.

superseded by Carbon Emissions Reduction Target (ended 2012) and the Community Energy Savings Programme (2009), which was superseded by the Energy Company Obligation (ECO). The ECO is comprised of the Carbon Emissions Reduction Obligation, which obligates energy companies to promote measures such as insulation, and the Home Heating Cost Reduction Obligation, which obligates suppliers to promote measures to assist low income and vulnerable people to heat their homes. The UK's housing stock is old and inefficient compared to most other European countries and improving this has been a focus of Government policy for over a decade.

The concept of 'fuel poverty' entered the political discourse in the 1990s and political pressure to do something to help people, in particular the at-risk elderly, caused the Labour Government to introduce the Winter Fuel Payment in 1997. Today the policy still exists and it amounts to all pensioners 65 and over receiving between £100 and £300 come winter time. In the event of a particularly cold winter, additional assistance is provided through the Cold Weather Payment. Low income households also receive payments through the Warm Homes Discount.

EU product standards across various sectors have been introduced with the specific aim of making incremental improvements in energy efficiency over time. The percentage of domestic appliances sold in the EU which are required to meet efficiency standards has risen from less than 5% in 2000 to over 70% today. In the UK, perhaps the most famous of these has been the phasing out of incandescent light bulbs and, more recently, regulations to phase out the use of halogen bulbs. Although there was some opposition to these policies, due to a perception that energy efficient bulbs are inferior, this policy has generally been a success and there is potential

Figure 2.6: IEA analysis of where carbon emissions reduction could come from upon implementation of the Paris Agreement[54]



54 IEA (2017). *Energy Technology Perspectives* 2017. http://www.iea.org/etp2017/summary/

for further energy savings. National Grid have calculated that mass uptake of LEDs in the UK could reduce energy demand from lighting by 80%.[55]

Despite the obvious benefits of energy efficiency, investment decisions are not always made. Often this can be attributed to a lack of information, high up front costs, access to capital and misaligned incentives. Moreover, standards do not always work as intended. One example is the recent 'diesel-gate' scandal in which Volkswagen were found to be cheating on tests to measure emissions of nitrogen oxide. Less widely reported is the fact that vehicles across the board emit much more carbon dioxide and other pollutants under real driving conditions that they do in EU tests. Vehicle manufacturers have been designing cars to pass the test, rather than to reduce emissions in the real world, to the extent that vehicles on average emit 40% more carbon dioxide than their official fuel economy figures would suggest.[56] The New European Driving Cycle test that is currently used to measure the carbon dioxide emissions from road vehicles underestimated real-world emissions quite considerably. This is a lab-based test that did not accurately represent how people drive in reality and it also excluded the energy use from features like air conditioning. This shows that regulations must be carefully designed if they are to have the desired effect and that a robust emissions measurement scheme for all sectors of the economy is required if carbon pricing is to have the desired effect.

There is a case to be made for regulating the efficiency of domestic appliances and lighting. This is because the cost savings to individual consumers of having energy efficient appliances and lighting is small and therefore price signals alone may not be enough to incentivise their uptake. But over an entire country the potential energy savings from efficient lighting and appliances is considerable. Price signals may not always deliver the optimum outcome, but the cases where such regulation is appropriate should be clearly defined. Most importantly, the cost of carbon avoided of any energy efficiency regulations must be assessed. If the overall cost of additional regulations in terms of increased production costs (which will ultimately be passed on to consumers) is in excess of the other interventions that would be incentivised through the application of a general carbon price, then a particular product standard may be an inefficient way of reducing emissions.

However, there is some evidence that product standards have already helped to drive technological change leading to more efficient products. Household appliances worldwide have become much more efficient over time. According to the IEA, on average the energy performance of fridge-freezers has improved 16% in the last decade, washing machines 21%, home air conditioning units 23%, and light bulbs 26%. This is believed not to be due to improvements in technology alone. The IEA state that standards in the European Union and elsewhere 'have achieved increases of more than three times the underlying rate of technology improvement.' The IEA analysis also suggests that there is significant scope for further improvements.[57] The caveat with the general positive outlook for energy efficient homes and appliances is what is known as the 'rebound effect'. As

55 IEA (2016). *Energy Efficiency Market Report 2016*

56 ICCT (2015). 'Real-world vehicle fuel economy gap continues to widen in Europe.' [Press Release] http://www.theicct.org/news/real-world-vehicle-fuel-economy-gap-continues-widen-europe-press-release

57

we make these technologies cheaper and more efficient, people are more likely to buy and use them, resulting in energy savings being lower than anticipated or even negative.

The improved efficiency of household appliances has generally offset the poor performance in terms of improving the efficiency of the UK housing stock overall. Progress in upgrading older buildings has not been as good as hoped. The Government has recently had three main policies to address the energy efficiency of our buildings: the Energy Company Obligation (ECO), the Green Deal and Energy Performance Certificates.

The ECO obliges energy companies to take steps to promote technologies like cavity wall insulation and district heating, as well as to help low income households to heat their homes. Energy Performance Certificates were introduced in 2007 as a way of promoting energy efficiency in buildings. Any time a home is built or sold an energy efficiency assessment must be completed and advertised to the buyers. More recently the Government has begun to use EPCs to set certain minimum standards for houses or apartments before they are legally allowed to be let. Finally the Green Deal, which is not a regulation per se, but rather a government scheme in which free energy efficiency assessments were offered along with low interest loans to pay for recommended upgrades, was withdrawn by the Government after a low uptake from homeowners – just £114 million of the total £540 million pot has been distributed.[58] Businesses and homeowners have generally been reluctant to implement energy efficiency measures, even when it is in their economic interest to do so, an issue that Policy Exchange examined in its paper *Clean Growth: How to boost business energy productivity.*[59]

A messy policy landscape

Creating an energy system which meets the policy trilemma of secure, affordable and low carbon supplies was always going to be challenging. But the policies of successive UK Governments and the EU have often made the task more challenging. They have developed a hugely complex package of overlapping interventions that often pull in different directions, waste money and have artificially increased electricity prices, whilst providing only modest gains in reducing carbon emissions (particularly when viewed on a carbon consumption basis).

The early days of the Feed-in Tariffs were particularly egregious in using large amounts of public money to subsidise the mass roll-out of immature renewable energy technologies such as solar. Which projects to subsidise was often a decision made by administrative fiat, based on what was politically palatable, rather than competitive tender, meaning costs were high. Contracts that guaranteed paying high prices for low carbon electricity projects, typically 15 years or more, combined with declining wholesale costs as a direct result of increased penetration of these now lower marginal cost technologies, means that consumers are paying increasing amounts each year.

This process almost completely undermined the intention of the EU ETS and the carbon price floor: finding a least cost solution to reducing

58 Palmer, K. (2015). 'Green deal funding axed: what it means for assessments and unused vouchers', *The Telegraph*. http://www.telegraph.co.uk/finance/personalfinance/energy-bills/11758777/Green-Deal-funding-axed-what-it-means-for-assessments-and-unused-vouchers.html

59 Burke, J. (2017). *Clean Growth: How to boost business energy productivity*, Policy Exchange. https://policyexchange.org.uk/publication/clean-growth-how-to-boost-business-energy-productivity/

carbon emissions. These subsidies have contributed to the UK being close to the top of the table in world electricity prices. In 2015 average UK industrial electricity prices including taxes were the third highest in the IEA and third in the G7, and were 38% above the IEA median. Prices in the UK excluding taxes were the second highest in the IEA, sixth highest in the G7, and were 63% above the IEA median.[60] The difference in electricity prices is not just down to climate and energy policies, it is also due to the underlying structure of energy markets in different countries – for example, the emergence of shale gas in the US. However, badly designed climate and energy policies certainly haven't made things better.

In addition to this, a focus on renewable energy targets led to huge amounts of biomass being burned, both for power and heat, before adequately ensuring that the supplies of organic material were sustainable and low carbon.

The sum total of this policy mess has been rising electricity prices and only modest reductions in greenhouse gas emissions, which has largely been due to the off-shoring of manufacturing.

The one major success of energy policy in the UK has been the almost complete phasing out of coal power. The Carbon Price Support policy has tipped the economics in favour of natural gas as opposed to coal power generation, whilst the Emissions Performance Standard effectively banned new power plants fuelled by coal unless they were equipped with carbon capture and storage technology. Coal power, one of the biggest obstacles to overcome in the fight against climate change, has met its demise in the UK through a combination of good regulation and a modest carbon price, not through a state-subsidised renewable revolution. The next section explores the issue of carbon pricing in more detail, with an assessment of its effectiveness, both in the UK and in an international context.

60 BEIS (2017). International industrial energy prices. https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices

A Review of Current Approaches to Carbon Pricing

The concept of pricing carbon has become synonymous with climate change mitigation. It is considered to be one of the most cost-effective ways to reduce and capture the external costs of Greenhouse Gas (GHG) emissions, also known as negative externalities. These costs have historically been difficult to measure because the impact of the GHGs often fall far away from the point of production and take time to quantify. Crucially, this leaves future generations exposed to the impacts and not those responsible for the emissions. This results in a market failure as there is no direct incentive for polluters to account for these negative externalities. Attaching a price to carbon, for example, aims to make individuals and firms pay the full cost of emitting carbon and in doing so, shifting the burden of damage to those responsible, thus internalising the cost of this externality. The result of (all) externalities is that (in this case energy) prices are cheaper and demand is higher than what is socially optimum. Internalising the cost of these externalities is strongly supported by arguments of both efficiency and equity.

Implied carbon prices in the UK

Carbon pricing can take various forms. Many of the policies and taxes already mentioned in the previous section of this report are effectively carbon taxes. Table 3.1 shows the various taxes imposed in the UK that could, in a broad sense, be referred to as carbon taxes. Table 3.2 shows (partially aggregated) revenues generated. Although fuel duty was historically linked to the cost of maintaining the road network, in recent years it has been justified on the basis of the environmental harm done by driving and cleaner vehicles have been increasingly exempted from these taxes. Fuel duty on petrol, for example, amounts to an implicit carbon tax of £253 per tonne. The different scales of these 'carbon taxes' has negated the idea of having a single carbon price in order to find the most economically efficient path to lower emissions.

The current direct cost of supporting renewable electricity projects under the RO, FiT and CfD policies is around £5 billion, but this is set to rise to over £8 billion by 2020/21.[61] These policies are paid for by a surcharge on consumer electricity bills that currently accounts for around 10% of an average domestic electricity bill, but could rise to as much as 25% by 2020.[62] Subsidies under the Renewable Heat Incentive scheme are paid for directly by the Government and cost £554 million in 2016/17

61 BEIS (2016). *Consumer-funded Policies Report*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/572509/Consumer_Funded_Policies_Report_-_Version_2_24-11-16.pdf

62 House of Lords (2017). *The Price of Power: Reforming the Electricity Market*. https://publications.parliament.uk/pa/ld201617/ldselect/ldeconaf/113/113.pdf

Table 3.1: Effective carbon tax represented by various UK-specific climate policies[61, 62, 63]

	Rate charged	Units	Implied carbon price (£/t)
Petrol fuel duty	0.5795	£/litre	253
Diesel fuel duty	0.5795	£/litre	218
CNG fuel duty	0.247	£/kg	97
LPG fuel duty	0.3161	£/kg	107
Climate Change Levy (gas)	0.00203	£/kWh	11
CCL (electricity)	0.00583	£/kWh	18
CCL (LPG)	0.01304	£/kg	4
Carbon Price Floor	–	–	18
EU Emissions Trading Scheme	–	–	12.64[64]
Air passenger duty	£13 & £78*	Per passenger	Varies

Table 3.2: Revenues from environmental taxes[65]

	2016/17 revenue (£ bn)
Road transport fuel duties	28.0
Aviation passenger duty	3.2
Climate Change Levy	1.9
EU Emissions Trading Scheme	0.5
VAT domestic electricity	2**

and are forecast to rise to £804 million in 2020/21. Each year at the Government Spending Review caps are set on the budget of the RHI to ensure costs are controlled.

So the total revenues in Table 3.2 exceed the projected ~£9 billion cost of funding our various low carbon policies. However, as stated above, road fuel duty revenue is largely used for maintaining and upgrading our road network (which currently costs around £4 billion per year for maintenance, with new infrastructure being in addition[68]) and, as outlined in our report *Driving Down Emissions*[69], the imminent shift towards electric vehicles could sharply reduce revenues from fuel duties in the coming years. Subsidy commitments to new low carbon energy projects combined with decreasing revenues from taxation of fossil fuels has major fiscal implications for the UK that the Government will need to address.

Although the various taxes below can be considered implicit carbon taxes, when people refer to 'putting a price on carbon' they are more commonly thinking of **emissions trading schemes** or **carbon taxes**.

* Air passenger duty is charged at £13 per passenger per flight on short haul (<2000 miles) flights and £78 per passenger per flight on long haul (>200 miles) flights. These rates are for standard class. Higher amounts are due for business and first class travel.

** Estimate

63 Source 1: Source 1:https://www.gov.uk/tax-on-shopping/fuel-duty

64 Source 2: Source 2: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/541006/Annex_A_web.pdf

65 Source 3: Source 3: https://www.gov.uk/government/publications/rates-and-allowances-climate-change-levy/climate-change-levy-rates

66 EU ETS permit price as of 14 May 2016 (adjusted from Euro to GBP). Source: https://sandbag.org.uk/carbon-price-viewer/

67 ONS. Source: https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsenvironmentaltaxes

68 Statista (2018). 'Public sector expenditure on national roads in the United Kingdom (UK) from 2011/12 to 2016/2017'. https://www.statista.com/statistics/298667/united-kingdom-uk-public-sector-expenditure-national-roads/

69 Howard, R. et al (2017). *Driving Down Emissions: How to clean up road transport?*, Policy Exchange. https://policyexchange.org.uk/publication/driving-down-emissions-how-to-clean-up-road-transport/

Tax or trade?

The most common types of carbon pricing are trading schemes (quantity instrument) or a tax (price instrument). In many ways they are the opposite side of the same coin, conceptually at least, as carbon taxes and trading schemes both reduce emissions by placing a cost on emitters. However, in reality the outcomes differ significantly. This raises the question: to tax or to trade?

Emissions trading schemes can take various forms, but the general principle is always the same. The organisation running the scheme will set a cap on the emissions it wants to achieve for a given time period and then polluting companies covered by the scheme will have to purchase permits for each tonne of carbon dioxide they emit during this time. As these permits are tradable, the price of the permit will be determined by the market. Policy makers will reduce the cap in line with targets each year. This system gives flexibility to how and where carbon emissions are produced and in theory should produce the lowest cost path to decarbonisation.

A **carbon tax** is somewhat simpler to administer than schemes involving the trade of permits. With a carbon tax a government will set a price for emitting carbon, as well as the sectors of the economy covered, and collect revenue based on greenhouse gas emissions. The tax can be collected *upstream*, at point sources of fossil fuel production, like refineries, or collected *downstream* at the point of sale to the consumer.

The key difference between the two schemes is that with a cap and trade system the Government fixes the total allowed carbon emissions for a given period and the price fluctuates, whereas with a carbon tax the Government fixes the price and allows for some uncertainty over the total level of emissions that will result.

An important difference between the two policies is how the cost of reducing pollution is distributed. The implementation of a cap and trade system almost always involves an initial free allocation of permits, known as grandfathering. This is argued to enable industry to comply in a much more cost effective way, at least during the early part of the scheme as only additional permits need to be purchased. As such, this approach has been particularly popular with industry as the immediate financial impact of the scheme is reduced. Conversely, the financial impact of a carbon tax is immediate as emitters are required to pay a set price per unit of pollution. Grandfathering certainly helps improve near-term business profitability but is this the best societal outcome? It could be argued that giving away free permits deprives the Government of the ability to raise revenues that can be used to reduce other distortionary taxes or offset regressive consequences of the scheme on poorer households.[70] This idea will be explored later in the report. In practice it is often hard to end or reduce such grandfathering exceptions.

A trading scheme and a tax also differ in the certainty they provide. The former gives certainty in the quantity of emissions that can be emitted but is prone to fluctuations in price depending on supply and demand.

70 Taschini et al (2014). 'Which is better: carbon tax or cap-and-trade?', London School of Economics. http://www.lse.ac.uk/GranthamInstitute/faqs/which-is-better-carbon-tax-or-cap-and-trade/

Conversely, the latter gives a clear and stable price (which is important for the predictability needed for business investment decisions), but the quantity of emissions that can be emitted is uncertain.

The reality is that neither a cap nor a tax is mutually exclusive. Indeed, there is an underlying duality exemplified by the UK, which has adopted a hybrid approach that combines a cap and trade system with bounds on how much the price can vary through a price floor and ceiling. Such an approach is advocated in order to reduce price volatility[71] and some economists (Fankhauser et al[72], Snyder[73], Philibert[74]) would argue it is preferable to the 'pure' tax or trade policy instruments but adding this level of complexity often requires more regulatory intervention. Similarly, a tax based system could include measures to ensure that the tax rate increased if it has not delivered the required emission reductions.

The EU Emissions Trading Scheme

The EU Emissions Trading Scheme follows the cap and trade principles above. Introduced in 2005, it covers emissions from large-scale facilities in the power, industry, and aviation sectors, which account for around 45% of the EU's greenhouse gas emissions. The scheme is now in its third phase, which lasts until the end of 2020. The target for 2020 is for the emissions from these sectors to be 21% lower than in 2005.[75]

The EU ETS has been undermined by the fact that the price of permits has been much lower than anticipated, resulting in it not having the intended effect. The EU claim that the ETS has delivered on its objectives due to the fact that emissions have fallen largely in line with the cap, but in reality emissions have declined *in spite of the ETS*, rather than because of it. The price crashed from 2008 onwards primarily due to:

- The Great Recession which reduced industrial activity and the associated demand for energy;
- An increase in energy efficiency and higher energy prices, reducing demand for power;
- An increase in renewables - reducing need for coal/gas generation.

The European Commission has taken steps to try and reform the market and reinforce the price (e.g. Market Stability Reserve, withdrawing allowances, etc.), with small recent cost rises suggesting that this has had some effect. But they are now trying to manage both quantity and price simultaneously, which undermined the whole point of the ETS in the sense that it is supposed to be a free market solution for reducing emissions in the most cost-effective way.

Recognising that depressed permit prices were always a possibility in an ETS scheme, the UK Government introduced the Carbon Price Floor in 2013 in order to give some certainty to businesses when making new low carbon investments. The idea was to set a minimum carbon price of £16 per tonne in the UK that large emitters would have to pay if the ETS price was below this. The price floor was supposed to escalate to £30 per tonne in 2020 and

71 PWC (2009). *Carbon Taxes vs Carbon Trading*. http://pwc.blogs.com/files/carbon-taxes-and-trading---final---march-2009.pdf

72 Fankhauser, S. et al (2010). 'Combing multiple climate policy instruments: how not to do it', *Climate Change Economics*, Vol. 1, No. 3, Pages 1-17. https://scholar.harvard.edu/files/jisungpark/files/fankhauser_hepburn_park_-_cce_2010.pdf

73 Schneider, B.F. (2014). 'Tax and trade: a hybrid climate policy instrument to control carbon prices and emissions', *Climate Policy*, Vol. 15, Pages 743-750. https://www.tandfonline.com/doi/abs/10.1080/14693062.2014.965655

74 Philibert, C. (2006). *Certainty versus Ambition: Economic Efficiency in Mitigating Climate Change*, IEA Working Paper Series LTO/2006/03

75 European Commission (date unknown). 'Emissions Trading System'. https://ec.europa.eu/clima/policies/ets_en

Figure 3.1: EU ETS permit prices over time[76]

£70 per tonne in 2030. However, the certainty that this was supposed to give to businesses was undermined when then Chancellor George Osborne cancelled the planned escalations in the carbon price in 2014, just a year after it was introduced. There is currently a cap of EU ETS + £18 per tonne placed on the floor, which is legislated to stay in place until 2020/21.[77]

The EU ETS beyond 2020

In November 2017, member states approved a provisional deal for further reform of the EU ETS. The reform focusses on ensuring that the EU meets an emissions reduction target of at least 40% by 2030 whilst ensuring innovation and low carbon technologies. Measures include:

- A cap on the total volume of emissions, which will be reduced annually by 2.2% (linear reduction factor);
- Doubling the number of allowances to be placed in the market stability reserve (MSR) until the end of 2023 ;
- Regularly reviewing carbon leakage rules and the linear reduction factor;
- Provisions to protect industry against carbon leakage and avoid the application of a cross-sectoral correction factor;
- Auctioning 57% of allowances with a conditional lowering of the auction share by 3% if the cross-sectoral correction factor is applied;
- Better aligned free allocation rules with the production levels.[78]

The reforms seem to have already had a small upward effect on prices, with permits trading above 10 euro per tonne for the first time in six years, but to establish if these reforms will be sufficient could take between 5-10 years. Irrespective of this, one fundamental problem is that reforms only touch supply and not the demand for permits. Even with MSR there could still be a surplus owing to changes in carbon intensive generation, greater energy efficiency measures or future economic shocks.

76 Source: https://sandbag.org.uk/

77 HM Revenues & Customs (2014). *Carbon price floor: reform*. https://www.gov.uk/government/publications/carbon-price-floor-reform

78 New Europe (2017). 'EU Ambassadors endorse ETS reform deal with European Parliament'. https://www.neweurope.eu/article/eu-ambassadors-endorse-ets-reform-deal-european-parliament/

Overview of UK carbon taxes

The UK carbon tax landscape has multiple fiscal policies that interact. The main three are the Carbon Price Support (CPS), the Climate Change Levy (CCL) and Climate Change Agreements (CCAs). The UK carbon tax is applied through the Climate Change Levy (CCL). The CCL is a tax on electricity, gas, and solid fuels such as coal, lignite, coke and petroleum coke and is designed to encourage businesses to reduce their energy consumption or switch to energy from renewable sources. It is possible to get a reduction on the main rates of CCL if you're an energy intensive business and have entered into a Climate Change Agreement (CCA) with the Environment Agency. A CCA is a voluntary agreement between UK industry and the Environment Agency. In return, operators receive a discount on the Climate Change Levy (CCL) between 60-90 %, depending on the taxable commodity.[79]

One success of the Carbon Price Floor is that even the low price of £22 (£4 permit price + £18 UK top-up) per tonne was high enough to make gas generation favourable compared to coal, and thus it helped accelerate the phase out of coal generation in the UK.

A number of international examples illustrate ways in which carbon taxes can be implemented effectively. Experience from British Columbia demonstrates how a 'phased approach', beginning with carbon taxes at a low level, and then progressively expanding their coverage and price can help to ease the transition to carbon pricing. This kind of introduction to carbon pricing can help to increase political and social support as it enables households and business to adapt gradually to increases in the cost of energy.

British Columbia's Phased Carbon Tax

The British Columbia carbon tax launched in 2008 at an initial rate of $10 Canadian dollars per tonne of CO2. The Government then introduced a phased approach with four annual increases of $5 Canadian dollars/tonne, allowing the tax to reach a pre-determined rate of /tonne in July 2012.

Despite the initial price being relatively low, the predictable and transparent increase in the price enabled the Government to raise the tax with minimal political controversy, because the increases were clear and anticipated. The more stringent price was implemented with less opposition than if $30 Canadian dollars was introduced from the outset. Polls in 2013 showed 65% of all British Columbia residents supported the carbon tax and a more recent (2016) poll found 62% saying they'd support a minimum carbon price that applies across the country.[80]

All this was done with limited impact on commodities such as gasoline prices. When the tax was first introduced the carbon tax led to an increase in the price of gasoline of around Can$0.0234 per litre. By 2012 British Columbia's carbon price contributed $0.067 Canadian dollars to the average $1.38 Canadian dollars per litre of gasoline in Vancouver, compared to approximately $0.40 Canadian dollars contributed by other local, provincial and federal taxes.

79 Gov.uk (2018). Environmental taxes, reliefs and schemes for businesses. https://www.gov.uk/green-taxes-and-reliefs/climate-change-levy

80 Cheadle, B. (2016). 'Poll suggests majority support for national carbon price', CTV News. https://www.ctvnews.ca/politics/poll-suggests-majority-support-for-national-carbon-price-1.3099002

Another important lesson, supported by experiences in Ireland, is that carbon taxes are easier to introduce as part of a broader fiscal reform in conjunction with lengthy and detailed stakeholder engagement. In 2010, two years after the beginning of the financial crash, the Government of Ireland introduced carbon tax CO_2 emissions from natural gas oil used in transport, space heating in buildings as well as fuel used in agriculture. By 2012 the carbon tax stood at €20 per tonne CO_2 emitted. A study by Convery et al[81] examined how the tax – which was high relative to the EU ETS price – became socially accepted. They concluded that comprehensive stakeholder engagement, particularly with sectors with a strong lobby – such as the agricultural sector – was key to making the tax politically acceptable. In addition to this the carbon tax was framed as a catalyst to transform Ireland to a low carbon economy with greater emphasis on energy efficiency.

Both a carbon tax and a cap and trade system require enforcement; penalties need to be imposed if carbon taxes are not paid or if companies do not posses the requisite allowances. However, the allocation of allowances provides an administrative headache, one that has permeated every phase and iteration of the EU ETS as outlined above. Given this, a tax is likely to be far more straightforward and less costly to administer, and less prone to pressure from special interests for exemptions or favorable treatment.

Has the EU ETS been successful?

Decarbonisation targets

By the end of phase three, i.e. 2020, the EU ETS had set the target of cutting GHG emissions by 20% compared to 1990 levels.[82] So how well has the schem fared against its own criteria?

Figure 3.2 illustrates that by 2015, the EU countries on average had already cut GHG emissions by 20%, reaching the target 5 years early. Notable exceptions are Turkey, Cyprus and Iceland which highlights the inter-country differences. But what does this look like in terms of actual emissions?

Total EU ETS emissions increased by 0.63% in 2015, from 4.42 billion tonnes of CO_2 equivalent in 2014 to 4.45 billion tonnes of CO_2 equivalent in 2015. A further increase of 0.3% occurred from 2016-2017. Although these increases are counter to the trend: EU emissions have fallen on average by 0.99% every year from 1990 to 2015, this is a worrying sign. Despite the overall trend being one of decline, with emissions falling by 23% from 1990-2015, it is important to question whether this is because of the EU ETS or despite it?

Looking further ahead, by 2030, the ambition was to cut GHG emissions by 40%. However, if the current emissions reduction pathway is extrapolated to 2030 – illustrated by the projection above – then the EU will miss its target by 7% (circled in black). A step change is needed to meet 2030 targets, something the EU recognises as current policies alone will not suffice.[83]

81 Convery, F., Dunne, L. and Joyce, D. (2013). 'Ireland's Carbon Tax and the Fiscal Crisis: Issues in Fiscal Adjustment, Environmental Effectiveness, Competitiveness, Leakage and Equity Implications,' OECD Environment Working Papers, No. 59, OECD Publishing, Paris

82 European Commission (2016). 'The EU Emissions Trading System (EU ETS)'. https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf

83 http://climateactiontracker.org/countries/eu.html

84 Data source: Eurostat. http://ec.europa.eu/eurostat/tgm/table.84do?tab=table&init=1&plugin=1&language=en&pcode=t2020_30

85 Data source: Eurostat. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge&lang=en

86 Data source: Eurostat. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge&lang=en

Figure 3.2: EU member state greenhouse gas emissions vs 2020 emissions target[84]

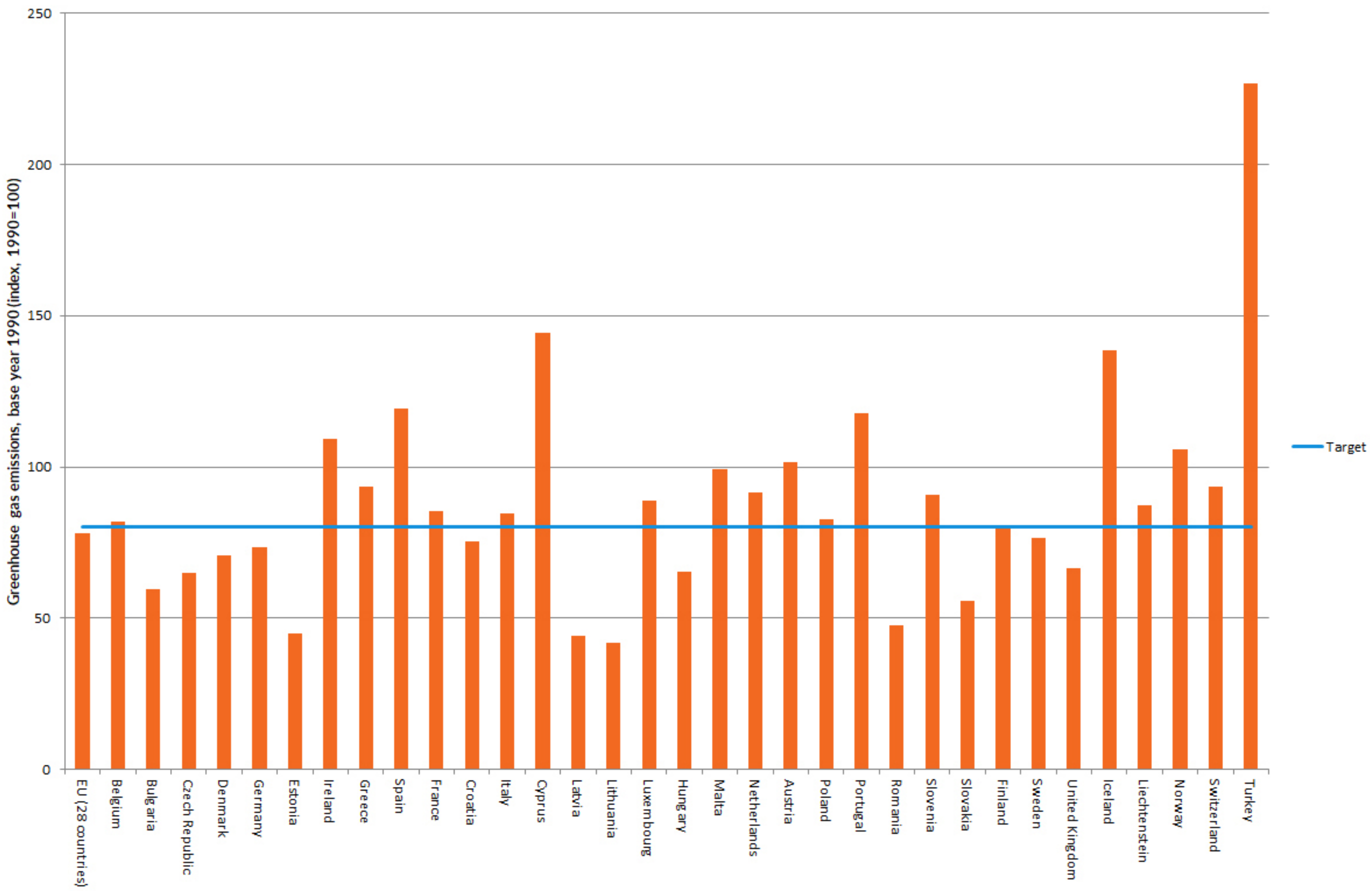


Figure 3.3: Average EU emissions per year, with percentage change[85]

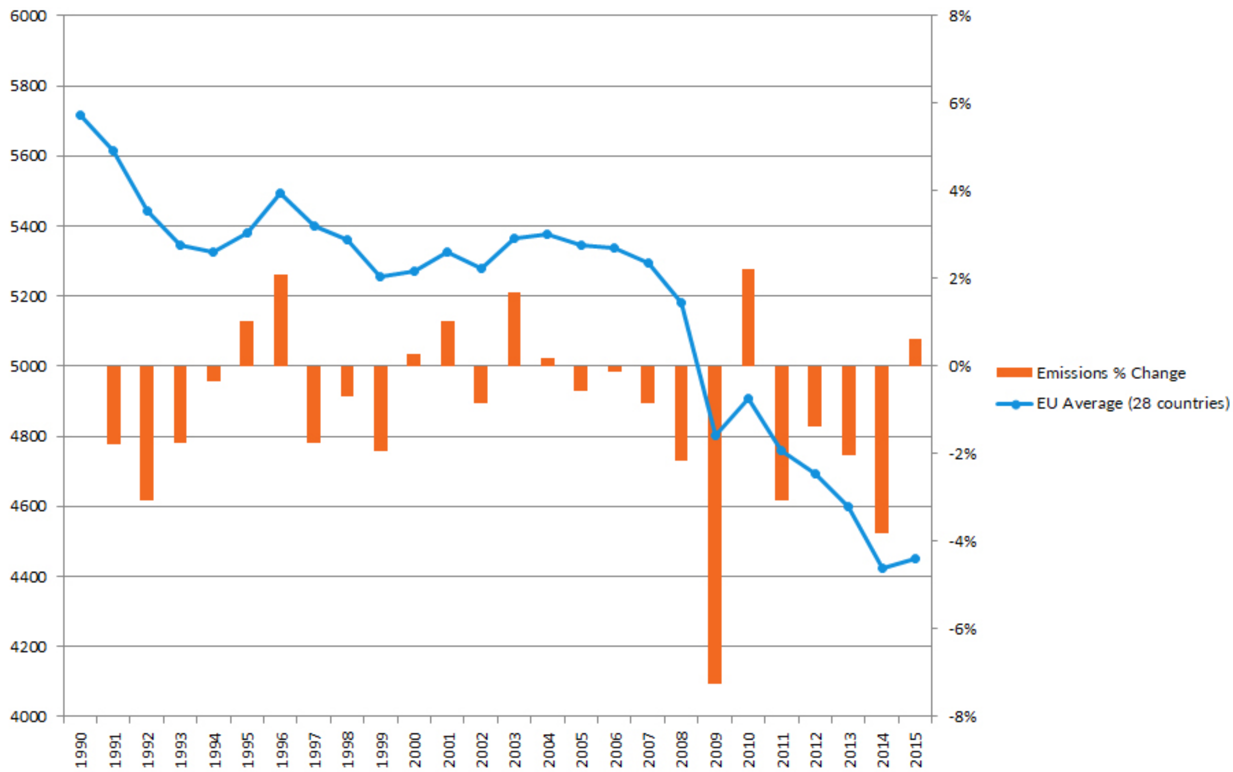
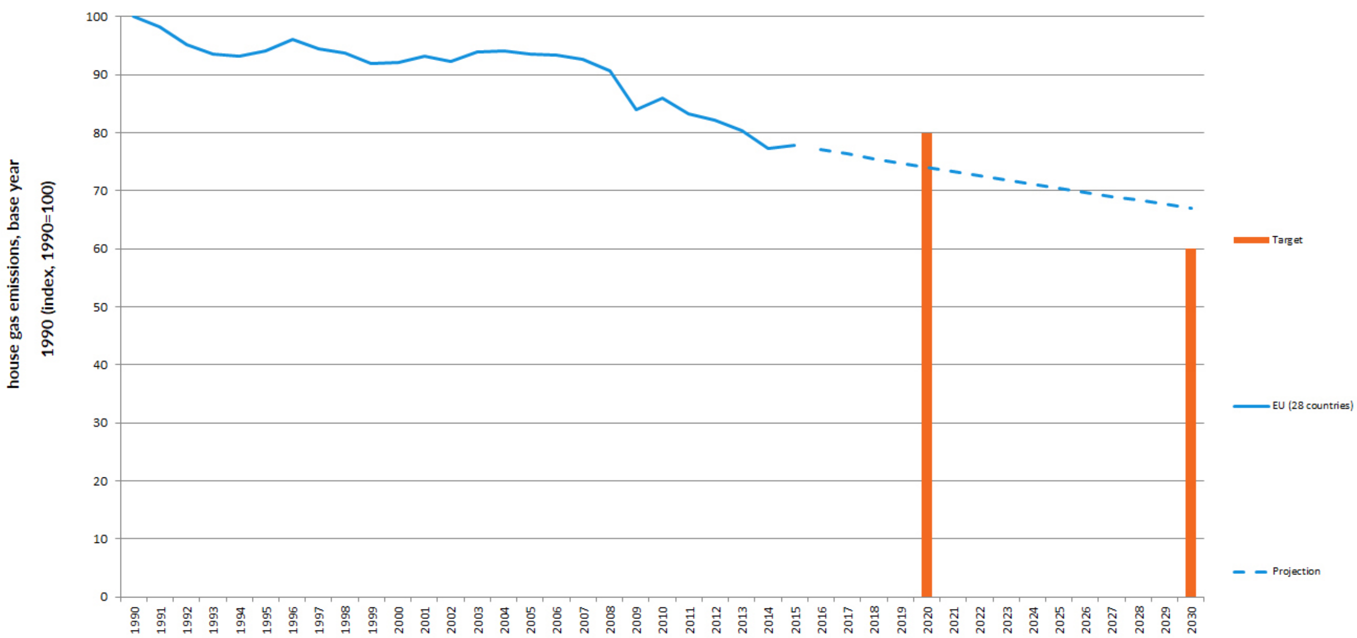


Figure 3.4: Actual EU emissions and a 'business as usual' projection versus target emissions[86]



Price

It is widely acknowledged (OECD[87], Doda[88]) that the low EU price of carbon has been a weak driver of decarbonisation. The biggest drop off in emissions (7.26%) was a result of the global economic crash in 2008 and not because of the efficacy of the scheme. The continued decrease thereafter can in part be attributed to the legacy effect of the crash and subsequent economic slowdown.

Economic theory suggests that if a product is scarce, its price increases. In the case of emissions trading schemes, the volume of emissions is set by a central administrative body and the permits are progressively withdrawn year-on-year thus making them scarce and increasing the price.[89] If the EU ETS was functioning as intended, what we should have seen is a reduction in emissions as the price gradually increases, illustrated by the projection below. Empirical evidence from British Columbia supports this and demonstrates that in a functioning market this trend is borne out as emissions reduced as the price was incrementally increased. Yet in the EU ETS, contrary to this, the volume of emissions and the price have simultaneously crashed.

Evidently, the EU ETS is not operating in an optimal and efficient way due to its low price, a view also espoused by the Committee on Climate Change (CCC). In their fourth carbon budget report in 2010 they concluded that a carbon price which reached at least £27/tCO_2 in 2020 and rising through the 2020s would provide the most appropriate signals.[90] The price at the beginning of 2017 was 6.12 euros – far below what the CCC recommends. One of the aims of the EU ETS was to achieve a stable and sufficiently high price of emissions to incentivise investment in low-carbon technologies. Looking at the EU ETS through this lens, it could be argued that the scheme has failed in its objective.

87 Dender, K.V. (2017). 'Carbon prices are still far too low to prevent climate change', OECD Insights. http://oecdinsights.org/2017/11/13/carbon-prices-are-still-far-too-low-to-prevent-climate-change/

88 Doda, B. (2014). *How to price carbon in good times... and bad*, Grantham Research Institute on Climate Change and the Environment. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/12/How-to-price-carbon_Dec_2014.pdf

89 Kaufman, N. et al (2016). *Putting a Price on Carbon: Reducing Emissions, World Resources Institute*. https://www.wri.org/sites/default/files/Putting_a_Price_on_Carbon_Emissions.pdf

90 CCC (2010). *The Fourth Carbon Budget – reducing emissions through the 2020s*. https://www.theccc.org.uk/publication/the-fourth-carbon-budget-reducing-emissions-through-the-2020s-2/

Figure 3.5: EU emissions vs EUA price[91]

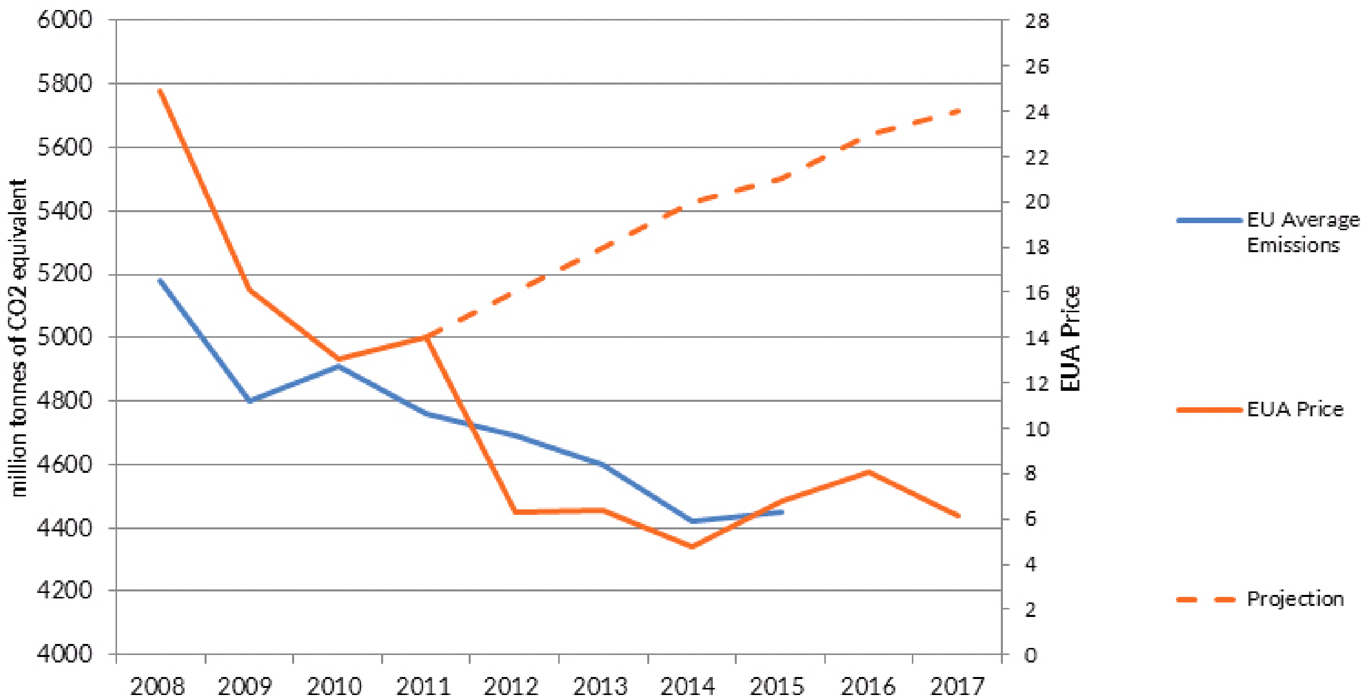


Figure 3.5 illustrated that the EUA price for CO_2 allowances under cap-and-trade automatically and continuously adjusts for changes in abatement cost over time. This is usually in response to changes in the prices of fossil fuels, the demand for electricity, and the rate of technological change.[92] In the context of emissions trading, the ability for carbon price to be elastic can be viewed positively as if there is an increase in price, there will be a bigger percentage decrease in demand – the objective of the EU ETS. That said, it is precisely this price elasticity – the very thing that was seen as a benefit – which has in fact been detrimental to the success of the scheme.

Another way of looking at how effective the EU ETS has been in driving down emissions is to compare emissions reduction from the sectors covered by the EU ETS and those that are not. Figure 3.6 demonstrates that both sectors – those covered and those not – both achieved emissions reduction over the last ten years. However, despite ETS covered emissions reduced by 18% and non EU ETS emissions falling by 11% over the same period, the latter has seen consecutive increases in emissions over the last two year – 1.7% and 0.8% respectively. The recent uptick in Effort Sharing Decision (ESD) emissions underpins arguments for an economy-wide carbon tax.

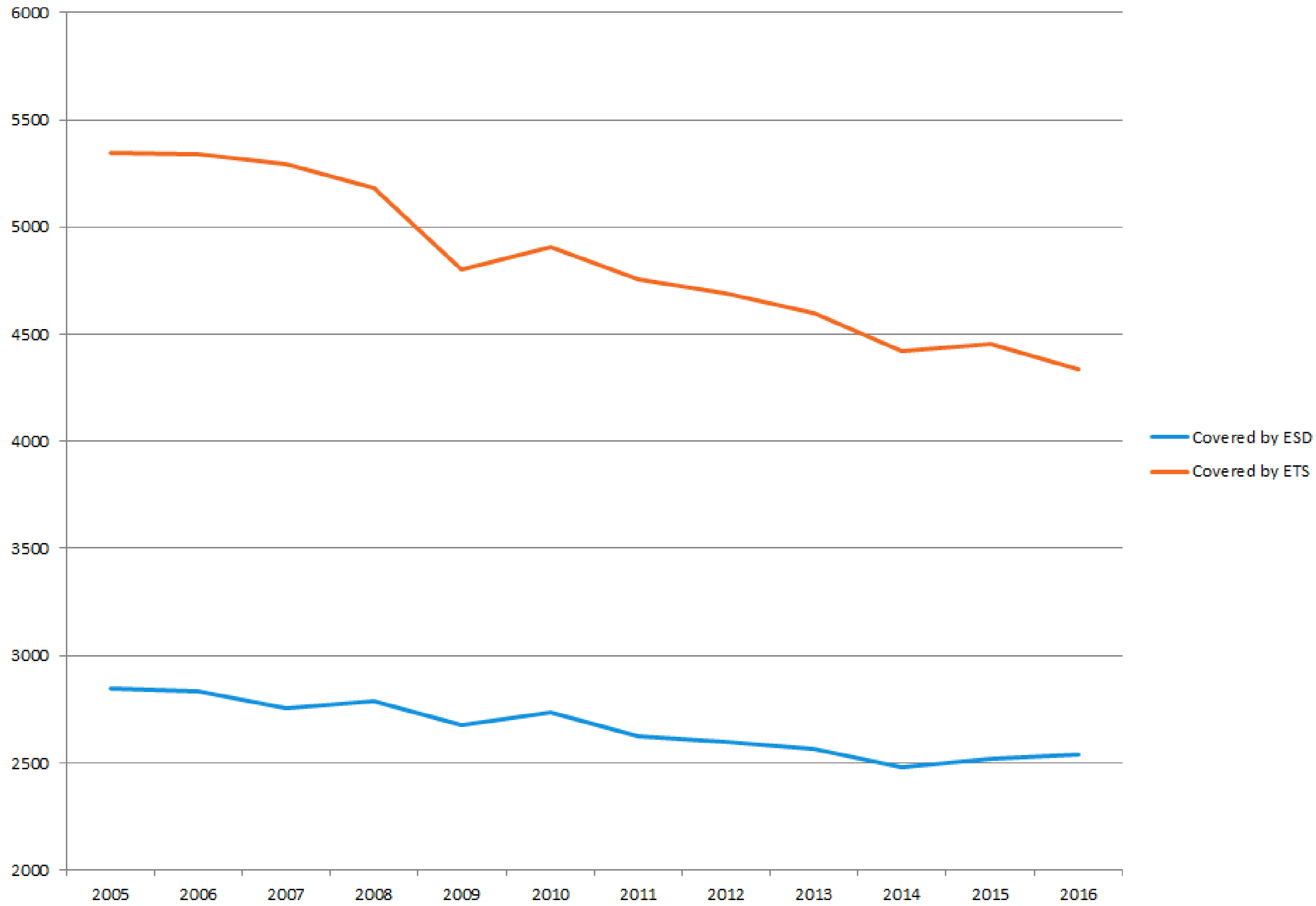
Overall, this information suggests that the EU ETS price signals are not the main driver of decarbonisation. Aside from the economic crash in 2008, other big drivers have been greater penetration of renewable energy, energy efficiency and a switch from coal to gas for power generation, for reasons that will be explained later in the report. As the White Paper on Electricity Market Reform concludes: 'the carbon price resulting from this cap has not been stable, certain or high enough to encourage sufficient investment in low-carbon electricity generation in the UK.[93]

91 Sources: European Environment Agency (EEA) and https://www.eex.com/en/market-data/environmental-markets/spot-market/european-emission-allowances#!//

92 Frank, C. (2014), 'Pricing Carbon: A Carbon Tax or Cap-And-Trade?', the Brookings Institution. https://www.brookings.edu/blog/planetpolicy/2014/08/12/pricing-carbon-a-carbon-tax-or-cap-and-trade/

93 DECC (2011). *Planning our electric future: a white paper for secure, affordable and low-carbon energy*. https://www.gov.uk/government/publications/planning-our-electric-future-a-white-paper-for-secure-affordable-and-low-carbon-energy

Figure 3.6: ETS vs non-ETS emissions reduction (Source: Eurostat)[94]



The effect of the UK's Carbon Price Support policies

Decarbonisation

Undoubtedly the biggest success of the UK's Carbon Price Support (CPS) policy has been in reducing the utilisation of coal-fired power stations and increasing the development of gas-fired power plants. This in conjunction with strong regulation such as the EU's Large Combustion Plant Directive – which placed limits on emissions of pollutants from power plants – have been powerful tools in decarbonising the UK's grid. The consensus at the time of implementation was that it would not only increase bills, but it would also fail to drive a switch from coal to gas. No one envisioned such a rapid decline of coal in the UK energy mix – a view that transcended both green NGOs and industry voices. At the time Greenpeace suggested that 'The CPF [Carbon Price Floor] is putting up people's energy bills for no environmental gain – giving 'green taxes' a bad name without achieving anything'[95] while the manufacturing industry Group, EEF, urged the Government to stop 'simply hitting firms with the big stick of ever-higher carbon taxes and levies' and instead offer 'the carrot of tax breaks to invest in potentially very profitable advanced low carbon technologies'.[96]

As Figure 3.7 illustrates, the role of coal generation as part of the UK energy mix has significantly changed. In 1970 coal contributed over 45%

94 Source: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&p-code=t2020_35

95 Carbon Brief (2013). 'Unpopular but tenacious: A guide to the UK carbon price floor'. https://www.carbonbrief.org/unpopular-but-tenacious-a-guide-to-the-uk-carbon-price-floor

96 EEF (2015). 'Government urged to turn 'stick' of ineffective green taxes into 'carrot' in energy policy review'. [Press Release] https://www.eef.org.uk/about-eef/media-news-and-insights/media-releases/2015/sep/government-urged-to-turn-stick-of-ineffective-green-taxes-into-carrot-in-energy-policy-review

Figure 3.7: Evolution of UK electricity supply mix, 1970-2016

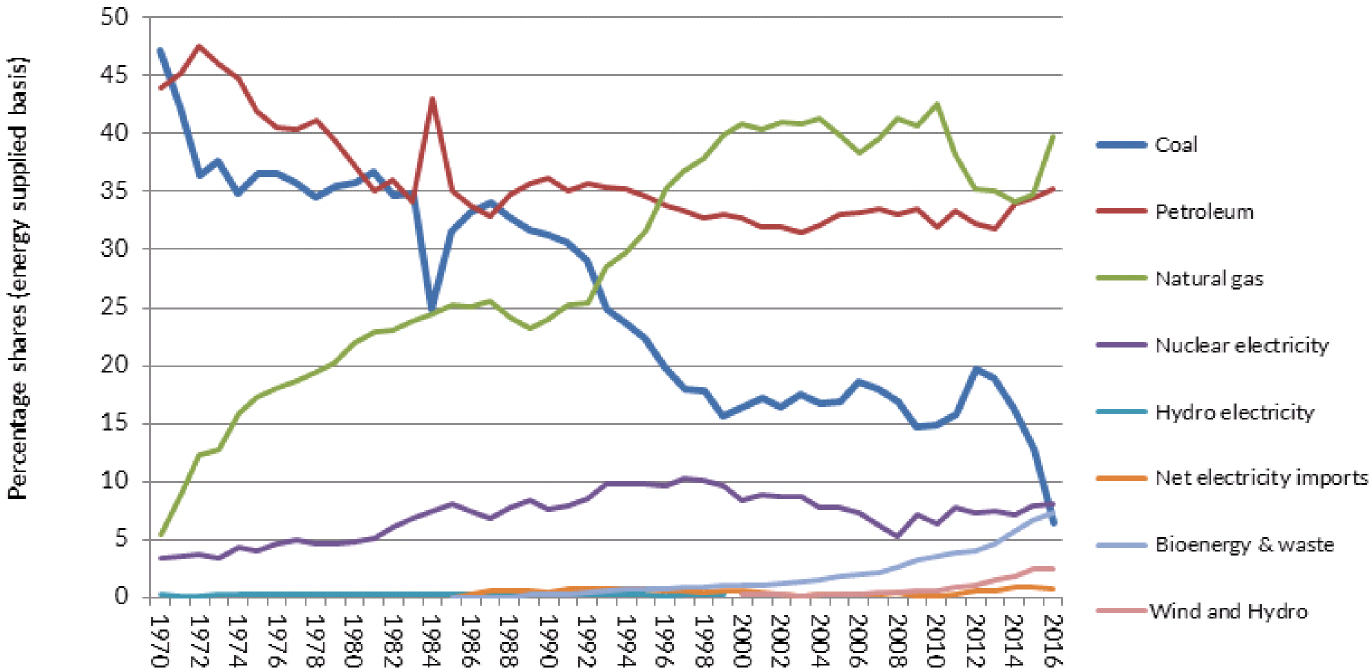
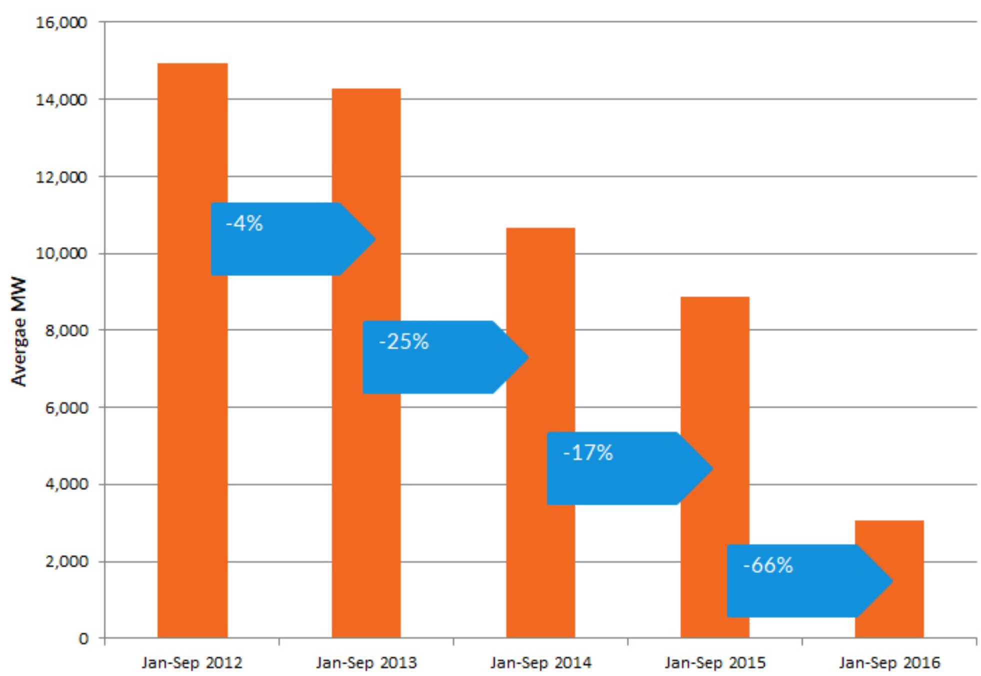


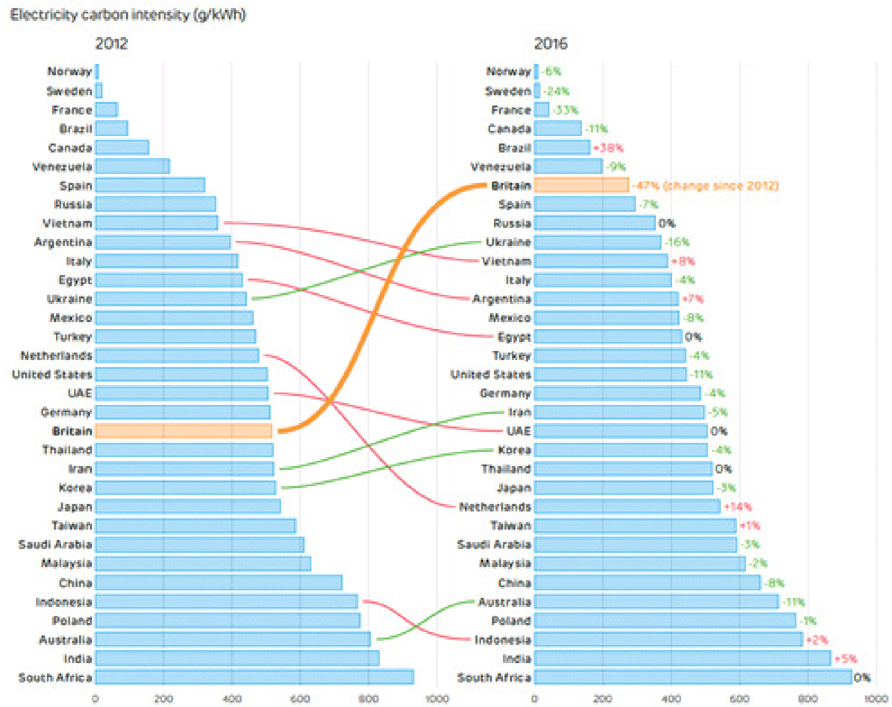
Figure 3.8: Decline of coal power in the UK energy system[97]



to the UK energy mix and in 2016 this had dropped to just 6%. Apart from a large drop due to the miners' strike in 1983 – which subsequently rebounded – the most dramatic and sustained decline of coal generation coincides with the introduction of the CPS in 2013. Between 2012 and 2015 the proportion of coal in the UK energy mix fell by 4%, 14 % and 20% respectively and in the last year alone (2015-16) this has fallen by

97 Evans, S. (2016). 'Factcheck: The carbon floor price and household energy bills', Carbon Brief. https://www.carbonbrief.org/factcheck-carbon-floor-price-household-energy-bills

Figure 3.9: International comparison of electricity decarbonisation process (2012-2016)[98]



50%. The decline in coal generation, measured by average MW output, is even more pronounced.

The CPS alone caused 73% of the reduction in coal generation from 2012 to 2016[99], either directly through the impact on coal economics or indirectly by partially levelling the playing field so that renewable energy and gas can take up some of the slack. Particularly for renewables, the CPS, in conjunction with rapid technology cost reduction has meant that they have almost reached grid parity and a world when they can consistently compete without subsidies is not beyond reach.

This pace of decarbonisation is unrivalled: the carbon intensity of electricity production has fallen more than twice as fast as any other major country, catapulting Britain 13 places up the 'Low Carbon League Table' from 20th to 7th place.[100]

So how has the CPS driven this? The CPS has fundamentally changed the economics of coal relative to other electricity sources, most importantly gas turbine. This is due to the high carbon intensity of electricity from coal power which is approximately 0.9 t/MWh, almost double that of combined cycle gas turbines (0.4 t/MWh).[101] Because of the greater carbon intensity of coal, it is subject to greater pressure from the CPS, which increases the variable cost of coal generation relative to gas or other technologies. The impact of this has been significant in making coal less competitive as illustrated in the chart below. Consequently, the proportion of natural gas in the UK energy mix has increased, with a particularly sharp rise from 2015.

Variable fuel costs are still much cheaper for coal in comparison to gas,

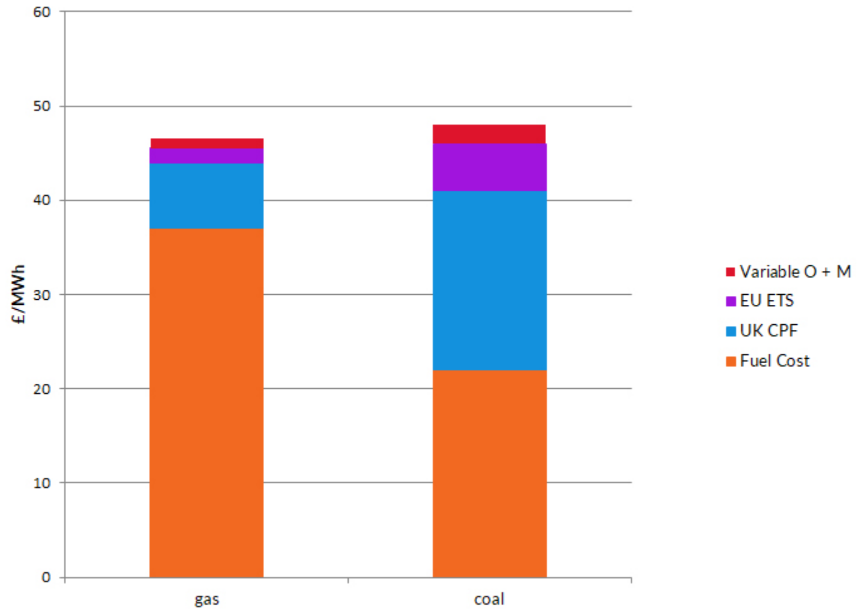
98 Drax (2017). 'Britain enters top ten low carbon power league'. [Press Release] https://www.drax.com/press_release/britain-enters-top-ten-low-carbon-power-league/

99 *Aurora Energy Research (2017). The carbon price thaw: Post-freeze future of the GB carbon price.*

100 Drax (2017). July to September 2017: Electricity Insights Quarterly. https://s3-eu-west-1.amazonaws.com/16058-drax-cms-production/documents/Report_PDF---Q3-2017.pdf

101 Timera Energy (2013). 'Carbon price floor impact on the UK power market'. https://www.timera-energy.com/carbon-price-floor-impact-on-the-uk-power-market/

Figure 3.10: Example of how cost components of coal and gas power stations can vary (including carbon tax cost)[102]



but the CPS means that coal faces a higher cost of carbon which makes gas overall more competitive. However, whilst this has certainly been the case over the last two years, recent research from Aurora Energy Research[103] has concluded that because of changing fuel price dynamics, maintaining the carbon price at the current level risks a revival of UK coal generation from existing plants in the early 2020s until 2025 – the point at which coal generators are required by law to cease operating (new coal plants in the UK have effectively been banned unless they use carbon capture and storage to significantly reduce emissions).

Although the CPS has historically been the key driver behind the rapid decline of coal, particularly since 2013, Aurora argues the current price is no longer high enough. To achieve the Government target of phasing out coal generation by 2025, using price signals alone, would require CO_2 prices to rise above £40/tCO_2 by 2025 – nearly twice the current price which has been frozen at £18 per tonne of CO_2 until 2021. This provides a strong rationale to retain and increase the CPS at least until the early 2020s to support the Government's ambition to phase out coal generation.

Moreover, previous research by Policy Exchange conducted in 2010 highlighted that a 'high and focused carbon tax would accelerate the closure of existing coal plants, bringing down the capacity margin, thereby inducing high and volatile electricity prices, and, at the limit, inducing serious security of supply concerns'.[104] Despite the rapid closure of coal plants in subsequent years, from a security of supply perspective these concerns have not been borne out. Given the relatively small contribution coal now makes to indigenous supply, this issue may be considered superfluous to the debate. It is also worth pointing out that once coal is

102 Ibid

103 Aurora Energy Research (2017). The carbon price thaw: Post-freeze future of the GB carbon price. https://www.auroraer.com/wp-content/uploads/2017/10/GM-CPS-final_publication_Nonsubscribers.pdf

104 Policy Exchange (2010). *Greener, Cheaper*. https://www.policyexchange.org.uk/wp-content/uploads/2016/09/greener-cheaper-jul-10.pdf

off the system – and the grid more decarbonises – the consumer impact becomes less.

One area that the CPS has been less successful has been in directly incentivising investment in low carbon technologies. It is fair to say that the CPS in conjunction with rapid technology cost reduction has enabled renewable technologies to be cost competitive relative to more carbon intensive fuels, however this alone has not provided a route to market for technologies such as offshore wind or solar. In most contexts – although with some exceptions – these technologies are still reliant on subsidies such as Contracts for Difference to be commercially viable and on the delivery of sufficient returns on investment to leverage private capital.

Impact of carbon taxes on competitiveness

Almost without exception, worldwide, attempts to introduce carbon pricing in any form have faced a need to address fears over competitiveness in the face of differing national climate policies. Critics have often cited both the EU ETS and the CPS as having a detrimental impact on the competitiveness of UK industry. It is important to examine how distorting carbon price schemes have been and at what scale.

Starting with the former, one way to examine this is to look at the ability of certain sectors to recover additional costs in the product market from consumers. Evidence[105] suggests that power sector companies are able to recoup the costs of EU permits by increasing electricity prices to account for the additional permit costs. The extent to which these costs can be recovered depends on a number of factors such as a generators position in the market and how willing consumers are to accept higher costs - this is referred to as the elasticity of demand. Higher prices can be expected if a product or service is inelastic.

One thing that sets the power sector apart from the industrial sector is that it tends not to compete in international markets so losing market share or offshoring of industry is less of a problem. That said, the rise of electricity interconnection illustrates the changing market dynamics which could have an impact on future price elasticity.

Between 2001 and 2009 energy and carbon intensive industries such as iron and steel have been able to recover a high proportion of their permit costs in the market place. In the UK, the cost pass through of diesel and petrol for the period 2005-06 was between 50-75%, whereas the cost pass through for European refineries on petrol retail prices between 2005 and 2007 was 100%.[106] This evidence suggests that in the early stages of the EU ETS companies were able to recover their costs.

What sets the EU ETS apart from a carbon tax in terms of competitiveness is the initial free allocation of permits. The impact of a carbon tax is instant where as the impact of the EU ETS has been staggered. For example, in phase 1 almost 100% of permits that entered the market were given out for free. During phase 2, this fell to 96%. It was only in phase 3 that auctioning became the default method of allocation and free allowances entering the market fell to 53%.[107] However, recent analysis from Sandbag[108] suggests

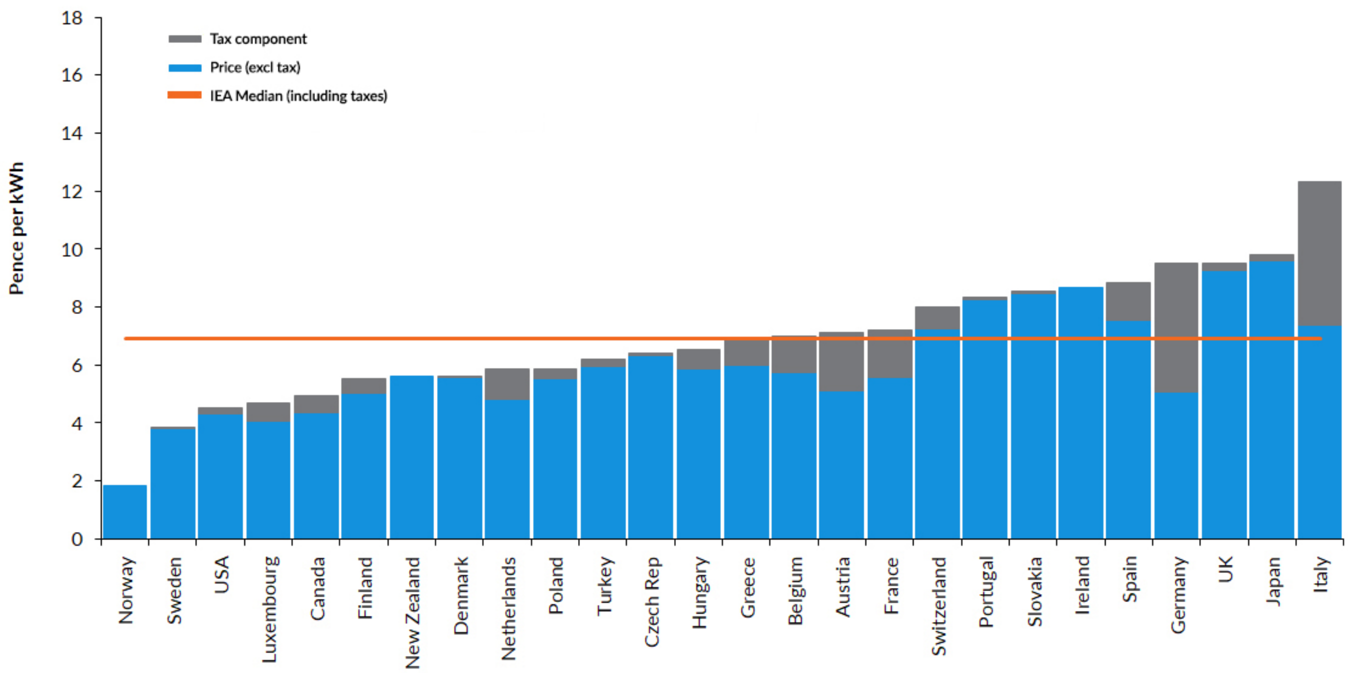
105 Bushnell, J. B., Chong, H., and Mansur, E. T. (2013). 'Profiting from regulation: Evidence from the European Carbon Market', *Economic Policy*, Vol. 5 (4), Pages 78-106

106 Muûls, M. et al (2016). *Evaluating the EU Emissions Trading System: Take it or leave it? An assessment of the data after ten years*, Imperial College London.

107 Evans, S. (2017). 'Q&A: Will the reformed EU Emissions Trading System raise carbon prices?', Carbon Brief. https://www.carbonbrief.org/qa-will-reformed-eu-emissions-trading-system-raise-carbon-prices

108 Ibid.

Figure 3.11: Industrial electricity prices in International Energy Agency countries[109]



that the proportion of free allowances that will enter the market in phase 4 (2021-30) could increase to 60% – an increase of 7% from the previous phase. The free allocation of permits during the early stages of the ETS was designed specifically to safeguard the competitiveness of the regulated industries and avoid offshoring and carbon leakage. This did not work and continuing this approach - with the majority of permits still being allocated for free - raises questions about the efficacy of the scheme in driving emissions reductions. Having too many allowances constitutes an indirect subsidy.

Secondly, the CPS – administered through the Climate Change Levy (CCL) – is often blamed for high electricity costs that UK heavy industry is subjected to. This is framed as the 'policy costs' that increase the cost of electricity. There is no doubting energy costs need examining as the UK does have high industrial electricity prices compared to other countries in Europe and the G7.[110] But how much is down to policy costs?

In 2015, average UK industrial electricity prices including taxes (such as the CCL) were the third highest of International Energy Agency (IEA) member states and third in the G7, and were 38% above the IEA median. Prices in the UK excluding taxes were the second highest in the IEA, sixth highest in the G7, and were 63% above the IEA median. The 'policy costs' or the CCL in the chart above to be more specific, represents a small component of the industrial electricity prices.

Taking this further, policy costs can also be examined through the lens of production costs. Using the UK steel industry as an example, high electricity costs is often cited as the key driver in the decline of UK steel production. As illustrated above the UK does have relatively high industrial

109 Source: https://www.gov.uk/government/collections/quarterly-energy-prices

110 BEIS (2017). International industrial energy prices. https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices

electricity prices, but are additional policy costs to blame? To understand the impact of policy costs on the competitiveness of the UK steel industry it is important to understand the share of electricity in total production costs. Raw material, freight and labour costs make up the majority of production costs[111] and according to the Committee on Climate Change[112] energy only accounts for 6% of production costs for integrated steel works and even less (5.2%) for basic metal production. The EEF claim that policy costs account for around 1/3 of energy prices[113] – the equivalent of £31.55/ MWh. Figure 3.11 indicates a much smaller policy contribution, closer to £2.50/MWh, but this only accounts for the CCL and not additional renewable or energy efficiency policy costs. Using the EEF's figure of £31.55/ MWh and applying 85% compensation for the total policy cost of low carbon energy subsidies, the policy cost would be £4.73/MWh – less than 1% of production costs. The impact of a 1% increase in production costs on profit margin is a key determinant of whether investment will go elsewhere. Given that the impact on production costs is modest, other things being equal, it is unlikely that this will have a significant impact on relative profits. This worked example supports research from Zhang and Baranzini[114] who concluded that carbon and energy taxes seem not to have significant impact on competitiveness losses.

Governments across the world have designed and implemented policies to mitigate the impacts of carbon pricing schemes. In the example above the UK Government uses Climate Change Agreements to allow companies to receive a discount on the amount they pay through the Climate Change Levy. Variations on this approach are found in other countries across the world.

Another way in which policy costs can be examined is to look at the

Measures to alleviate competitiveness concerns[115]

Sweden

Sweden places a nitrogen oxide (NOx) charge on large boilers, stationary combustion engines and gas turbines. This charge applies to entities in proportion to their energy output but a proportion of the revenue from the nitrogen oxide charge is refunded. Although not strictly a carbon pricing instrument, the logic still applies and the redistribution penalises emissions and rewards NOx reductions while maintaining production levels. The money stays in the sector and companies are incentivised to become more efficient.

Denmark

From 1993 Denmark applied a carbon tax rebate to businesses in a scheme similar to that of the UKs CCAs. The Danish Government offered up to a 97% discount on carbon tax payment to energy intensive firms. Of this, 22% is conditional on signing agreements to reduce energy use; akin to the voluntary agreement UK industry has to agree with the Environment Agency.

111 Source: http://www.steelconsult.com

112 CCC (2015). *Low-carbon policy costs and the competitiveness of UK steel production.* https://www.theccc.org.uk/publication/technical-note-low-carbon-policy-costs-and-the-competitiveness-of-uk-steel-production/

113 Evans, S. (2015). 'Factcheck: The steel crisis and UK electricity prices', Carbon Brief. https://www.carbonbrief.org/factcheck-the-steel-crisis-and-uk-electricity-prices

114 IGES (2017). The Feasibility of Pricing of Carbon Emissions in Three Northeast Asian Countries: Japan, China and the Republic of Korea. https://www.files.ethz.ch/isn/179055/PB_29_E_0403.pdf

115 OECD (2015). *The FASTER Principles for Successful Carbon Pricing: An approach based on initial experience.* https://www.oecd.org/env/tools-evaluation/FASTER-carbon-pricing.pdf

impact the rates of CPS have on industrial input costs. Studies have sought to quantify the impact of climate change policies on certain business sectors as the example above demonstrates. However, less is known about how these sectors pass on policy costs through their value chain and ultimately to the consumer.

Grover et al[116] have applied a theoretical carbon of £20/tonne – not much greater than the current CPS of £18 – to electricity inputs, uniformly across the UK in order to understand the impact of the current CPS. Their modelling showed that at a price of £20/tonne the impact on almost all sectors was negligible with 94 of the 106 total industries that make up the UK economy seeing input increases of less than one percent. They suggest that this is because electricity forms a relatively small proportion of energy costs, even in the most carbon-intensive sectors. The biggest impact was felt by coke and refined petroleum products (12.3% increase) followed by electric power generation (11% increase). That said, the overall result of this theoretical carbon price on economy wide final UK consumer prices, assuming full cost recovery, is 0.9% and therefore minimal and smaller than a one-off 2-3% increase in labour costs or a 1 per cent fall in market size.

The authors conclude that the impact of the current CPS on increasing input costs is relatively small in most cases, and there is scope to substantially increase the CPS. Using Grover's data on input costs, the distributional impact of different theoretical carbon prices across multiple business sectors is examined below.

Effect of carbon pricing business and consumers

Effect on business

Policy Exchange has created a simple industry model to analyse the impact on the profits of UK industries at different levels of a carbon tax. The cost impact on UK industries is estimated using the results of Grover.[117] For various carbon prices we estimate the cost increase on 107 industries, expressed as a percentage of input costs. We then calculate an 'adjusted cost impact' assuming that the revenue raised by the carbon tax is used to compensate industry as a whole. If industry input costs increased on average by 2%, then each industry receives 2% of its costs in the form of a rebate. This leaves industry overall unaffected but still imposes higher costs on energy intensive industries with high emissions, such as coal, oil and gas and steel. Note that for some industries in the services sector with minimal CO_2 emissions the adjusted cost effect is negative i.e. costs are reduced. Finally, using input output analysis and assumed rate of return on capital of 10% per annum we estimate the effect on each industry's profits of both the non-adjusted and adjusted i.e. rebated cost increases. By assessing the effect on profits the model gives a guide as to the relative effect on economic returns. Just as wages are a return on labour so profits are a return on capital, and it is changes in these rates of return that influence the allocation of resources in an economy. Though obviously implausible in the real world, for illustrative purposes this model assumes

116 Grover, D. et al (2016). *The competitiveness impact of a UK carbon price: what do the data say?*, Centre for Climate Change Economics and Policy. http://eprints.lse.ac.uk/65622/1/Grover-et-al-policy-paper-January-2016.pdf

117 Ibid.

Table 3.3: Effect of £20 per tonne CO_2

Industry	% cost increase	% cost increase adjusted for rebate	cost increase as % of profits	adjusted cost increase as % of profits
Coke and refined petroleum products	12.3	11.4	528.5	489.6
Electricity, transmission & distribution	11.0	10.1	96.6	88.8
Gas, distribution of gaseous fuels	9.5	8.6	83.4	75.7
Dyestuffs, agro chemicals	4.4	3.6	57.8	46.7
Fishing and its support services	3.2	2.4	43.6	32.2
Coal and lignite	5.9	5.0	27.9	23.9
Concrete, cement and plaster	2.2	1.4	36.8	23.0
Other basic metals	3.3	2.5	26.6	19.9

Table 3.4: Effect of £70 per tonne CO_2

Industry	% cost increase	% cost increase adjusted for rebate	cost increase as % of profits	adjusted cost increase as % of profits
Coke and refined petroleum products	43.1	39.1	1849.8	1679.6
Electricity, transmission & distribution	38.5	34.7	338.2	304.5
Gas, distribution of gaseous fuels	33.3	29.6	292.0	259.6
Dyestuffs, agro chemicals	15.4	12.2	202.3	160.3
Fishing and its support services	11.2	8.1	152.5	110.6
Coal and lignite	20.7	17.3	97.8	82.0
Concrete, cement and plaster	7.7	4.7	128.7	78.9
Other basic metals	11.6	8.5	93.0	68.1
Basic iron and steel	11.2	8.1	90.1	65.4
Paper and paper products	5.6	2.7	122.6	58.6
Industrial gases and fertilisers	7.0	4.0	91.9	53.0
Air transport services	6.7	3.7	91.1	50.7
Glass and porcelain products	6.0	3.0	99.4	50.4

100% cost absorption by industry with no knock-on effects to consumer prices. Clearly this is an oversimplification and there is likely to be some pass-through into prices. But assuming the rate of pass through does not vary hugely between industries, the model will illustrate the relative impact of a carbon tax.

The model is estimated using two levels of carbon tax: £20 and £70 per tonne. The tables below show, for each carbon price, the most negatively affected sectors in order of the percentage impact on profits after costs have been adjusted for the tax rebate. All three levels of the carbon tax result in 30 of the 107 industries covered suffering some reduction in adjusted profits with 77 gaining. But the scale of the effects clearly increases as the level of the carbon tax rises. We arbitrarily take a 33% reduction in profits as the threshold beyond which the impact of the carbon tax is judged to be significant. The tables below show for each carbon tax level those industries estimated to suffer a significant reduction in profits: at £20 per tonne there are 4 such industries, at £40 per tonne there are 10 and at £70 per tonne there are 13.

Grover concludes that an economy-wide carbon tax of £20 per tonne would not result in a major risk of carbon leakage, though it is also clear that a much higher level of tax will increase the risk of carbon leakage.

Effect on consumers

Cornwall Energy estimates that the CPS alone adds around £36 per year to the average household electricity bill whilst the EU ETS adds a further £10 per year – together making up 9% of the average household electricity bill.[118] This falls roughly in the middle of the £29-£68 range that consumer group 'Which?'[119] estimate. In contrast, and as noted above, Grover et al suggest the overall result of an economy wide carbon tax, assuming full cost pass-through, would increase consumer bills by 0.9 %. The authors argue that in reality the impact on consumers is likely to be even less given that the carbon tax should incentivise behaviour change and energy efficiency. Evidently, accurately calculating the true consumer cost is difficult.

Irrespective of the quantum that both the EU ETS and the CPS have added to consumer bills, this has been offset by increases in energy efficiency which has resulted in a net saving. According to the Committee on Climate Change, low carbon policies in 2016 comprise just 9% of a typical household bill of £1160 but improvements in energy efficiency have saved UK households around £290 per year since 2008.[120] Much of this will have been driven by stronger product efficiency standards on buildings and appliances, and government programmes, though some of the improvement may have happened anyway in the absence of such policies.

The distributional impact of an economy-wide carbon tax on consumers is analysed in further detail in Chapter 4 of this report.

Carbon pricing and bankability (business certainty)

The effectiveness of carbon pricing schemes is predicated on providing polluters with long term clarity and certainty. This is a pre-requisite in order for business to adapt and innovate accordingly. International examples demonstrate that the careful phasing-in and phasing-out of carbon pricing policies is key to maintaining trust and confidence from individuals and businesses. Anything to the contrary will invariably limit the efficacy of carbon pricing schemes.[121] An example of how not to implement carbon pricing can be found in Australia.

Ongoing political uncertainty and interference in the market has limited the ability of the carbon price to provide the stability and certainty investors and large industries need.[122] The political wrangling over how to price carbon began in the early 1990s and has continued to the present day.

118 BEIS (2016). 'Domestic Energy Price Statistics'. https://www.gov.uk/government/collections/domestic-energy-prices

119 Carbon Brief (2013). 'Unpopular but tenacious: A guide to the UK carbon price floor'. https://www.carbonbrief.org/unpopular-but-tenacious-a-guide-to-the-uk-carbon-price-floor

120 CCC (2017). *Energy Prices and Bills Report 2017*. https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/

121 Grantham Institute (2017). *Carbon pricing in the UK post-Brexit: tax or trade?*, Discussion Paper, Imperial College London. https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/discussion-papers/Carbon-pricing-in-the-UK-post-Brexit.pdf

122 O'Gorman, M. and Jotzo, F. (2014). *Impact of the carbon price on Australia's electricity demand, supply and emissions*, Working Paper 1411, Centre for Climate Economic and Policy, Australia National University. https://ccep.crawford.anu.edu.au/sites/default/files/publication/ccep_crawford_anu_edu_au/2014-07/ccep1411.pdf

The period 2008-2017 provides a snapshot of public policy mess.[123] Following Kevin Rudd's ratification of Kyoto protocol in 2007, details of a cap and trade system were proposed in late 2008. This was subsequently voted down by parliament in August 2009 and revived by the Federal Government a few months later. By December 2009 Rudd agreed a deal with the opposition leader Malcolm Turnbull, only for him to be replaced by Tony Abbot shortly after. In April 2010 Kevin Rudd announced that the ETS would be on hold until 2013. By June 2010 Rudd was replaced by Julia Gillard who ruled out a carbon tax only to U-turn and unveil plans for a carbon tax in early 2011. This was passed in the Senate by November 2011 and came in to force in July 2012. In July 2013 Kevin Rudd replaced Julia Gillard and announced that the Government would terminate the carbon tax and replace it with a trading scheme. A change of government happened in September 2013 with Tony Abbott taking the helm and also promising to abolish the carbon tax. By July 2014 the senate passed a bill to repeal the carbon tax.

This example clearly illustrates the need for ongoing bipartisan support in favour of carbon pricing. Without it, substantial structural changes in electricity supply will not be achieved. In comparison, it seems like cross party consensus has finally been in achieved in the UK.

Policy reversals undermine confidence, a point the Institute for Fiscal Studies pointed out, noting that after the 2014 Budget 'the plans for a rising price floor were shelved, and a new floor level, not increasing over time, was announced. This sort of reversal clearly undermines the purpose of the policy.'[124] As the carbon price support is part of an annual review of tax, it is subject to continued speculation as to whether it will remain in place, giving investors no long term certainty. In a recent investor's perspective critique of the CPF, the Climate Change Capital stated that 'Investors have to hope that every Parliament will continue to vote for increasing carbon price support until 2030'.[125] Unlike government support through the Contracts for Difference which is underpinned by a long term 15 year contract, the Government can effectively remove the CPF with the stroke of a pen. The intrinsic regulatory risk presents a real barrier to innovation and has a significant impact on investment decisions.

This manifests in a number of ways. Firstly, the lack of certainty otherwise provided through contractual obligations, means that investors apply a heavy discount rate to the CPS in their decision making.[126] A higher discount rate means low net present value, which makes it harder to build the business case for energy infrastructure projects. Secondly, investors in energy projects expect a rate of return from projects to compensate them for investing in the project. The greater the risk, the greater the expected rate of return, otherwise known as the hurdle rate. If a high hurdle rate is too high then again, a project may not progress. Thirdly, regulatory uncertainty and the risk this presents will also impact on cost of capital, serving only to increase it. Overall, this combination of factors, resulting from regulatory risk and uncertainty, increases the cost of infrastructure projects, which is invariably passed on to the consumer.

123 ABC News (2014). 'Carbon tax: a timeline of its tortuous history in Australia'. http://www.abc.net.au/news/2014-07-10/carbon-tax-timeline/5569118

124 IFS (2016). Carbon pricing in the United Kingdom. https://www.ifs.org.uk/publications/8349

125 Timera Energy (2012). 'Discounting the UK carbon price floor'. http://www.timera-energy.com/discounting-the-uk-carbon-price-floor/

126 Ibid.

Unintended consequences of carbon pricing

Carbon leakage through interconnectors

The idea of a carbon price floor that applied to the UK only is not without its flaws, as depending on the level of price it has the potential to put industry at a competitive disadvantage compared to our European neighbours. It has also incentivised the import of electricity via interconnectors from countries where the carbon price was lower. The UK Carbon Price Floor eventually made the British price of carbon five times higher than the EU average. Previous analysis by Arup, referenced in Policy Exchange's report *Next Steps for the Carbon Price Floor*[127], highlighted even more perverse effects of having a higher carbon price in the UK than mainland Europe. As this favours electricity imports from parts of the EU where power stations are on average older and less efficient than the UK, the Carbon Price Floor could end up actually *raising* EU wide emissions, even if it reduces UK based emissions. The carbon intensity of French imports is approximately 53 g/kwh, Dutch imports are 474 (g/kwh) and Irish imports are 458 (g/kwh)[128], yet despite the increasing share of imported electricity, it is treated as zero carbon when calculating national emissions inventories[129] and carbon taxes do not apply. This is not a valid route to decarbonisation as emissions are still released to the atmosphere, just not in the UK. This exporting of emissions underpins arguments for a BCA.

Biomass

The geopolitics of a global carbon tax poses a significant barrier to implementing such a policy. One manifestation of this surrounds the use of biomass as an energy feedstock. This will inevitably be a source of future contention as fierce debate already surrounds the environmental impacts of biomass as an energy feedstock.

Numerous studies support the assumption that it is carbon neutral and at best even carbon negative. At the most basic level, these studies suggest that carbon dioxide emissions from biomass are sequestered by growing biomass over time. Consequently, emissions from bioenergy production have traditionally been excluded from most emission inventories.[130] Indeed, the methodology specified in the 2009 EU Renewable Energy Directive and many national policy frameworks count combustion emissions as zero. Instead only emissions associated with harvesting, drying and transporting feedstock is counted.

On the other hand, studies such as Chatham House's *Woody Biomass for Heat and Power*[131] suggest that the use of biomass in electricity and heat production 'can release more greenhouse gas emissions into the atmosphere than the fossil fuels it replaces'. This is because woody biomass is less energy dense than coal and has a higher moisture content.

The environmental impact of biomass is clearly nuanced and a source of contention. Accurately reflecting and quantifying the environmental impact of biomass is crucial and has huge implications for the implementation of a global carbon tax. For example, countries like Sweden, Latvia, Italy, the UK

127 Howard, R. (2016) *Next Steps for the Carbon Price Floor*, Policy Exchange.

128 Ibid.

129 Staffell, I. (2017). 'Measuring the progress and impacts of decarbonising British electricity', *Energy Policy*, Vol. 102, Pages 463-475.

130 Science Daily (2011). 'Carbon dioxide emissions from biomass combustion.' https://www.sciencedaily.com/releases/2011/03/110316084907.htm

131 Brack, D. (2017). *Woody Biomass for Power and Heat Impacts on the Global Climate*, Chatham House. https://reader.chathamhouse.org/woody-biomass-power-and-heat-impacts-global-climate#

and Germany use a lot of biomass. Under current EU guidance, emissions from biomass would not be included as part of a global carbon tax. However, given that recent research highlights the negative environmental impacts of biomass, it begs the question of whether biomass should be subject to carbon taxes. Countries that have invested heavily in biomass infrastructure will vehemently oppose any regulatory changes that could lead to competitive losses or stranded assets. How this unfolds will ultimately be dictated by geopolitics and not science.

The Potential for an Independent UK Carbon Tax

A new approach to carbon pricing is required in order to decarbonise the whole economy. Such an approach should provide price predictability for business, prevent carbon leakage and protect the poorest citizens from burdensome taxes. The following components of our plan for an independent carbon tax ensure these criteria are met:

Carbon tax policy:

- A steadily rising, economy-wide carbon tax – after leaving the EU ETS at the end of the third trading period in 2021, this would initially continue at the level of the UK's Total Carbon Price at the time (currently ~£25 per tonne) to provide continuity for business, but would steadily increase year-by-year, with future rises signposted in advance by the Government. An independent body, the most appropriate being the Committee on Climate Change (CCC), would set the level and trajectory of taxation required to meet decarbonisation targets in order to insulate the issue from the day-to-day volatility of party politics and give more certainty to investors. Any deviation from the trajectory recommended by the CCC would require a vote in Parliament and a Public statement by the Chancellor. The tax would be progressively expanded to cover all sectors of the economy.
- Border carbon adjustments – to create a level playing field for domestic and international producers a system will be set up to ensure that companies that export carbon intensive products into the UK will be subject to the same level of carbon taxation as domestic industries, and UK exporters of such goods are rebated at the border thus preventing carbon leakage.

Regulatory simplification:

- Rationalisation of environmental regulations – with the gradual implementation of an economy-wide carbon tax many policies will become redundant and could be phased out thus reducing the regulatory burden on business. This will in no way reduce environmental protection and where regulation is still required to correct market failure (e.g. product standards) it will be retained.

Revenue recycling:

- Dividends – the proceeds of carbon taxation will be directly returned to the populace in order to give voters an immediate interest in the fight against climate change and lock in carbon taxation as a political imperative. This would turn an otherwise regressive and unpopular carbon tax into a popular and even populist policy that promoted more inclusive economic growth and enables the vast majority of UK citizens to benefit financially from this new climate solution.

Each of these four components and the specifics of how they might be implemented in a UK context will now be examined.

Policy implementation: carbon tax

The British Government has already made it clear that they want a clean break from the EU. Part of this means no longer accepting the jurisdiction of the European Court of Justice (ECJ). As the ECJ is the adjudicating body for disputes relating to the EU Emissions Trading Scheme, the UK could no longer remain in without accepting ECJ oversight. The EU may also insist on the UK accepting freedom of labour movement as a condition, which would also be unacceptable to the UK Government. Anyway, an independent carbon price with border adjustments is not practical in the long term whilst remaining in a parallel ETS. We have already seen the problems this would cause because the UK already has carbon price support to top-up the ETS permit price. Because emitting greenhouse gases from power stations is cheaper on mainland Europe than Britain, we have the perverse effect of electricity from coal power stations in Europe displacing electricity from much cleaner natural gas-fuelled power stations in Britain.

Should the UK choose to exit the EU ETS it should look to progressively scrap the various explicit and implicit carbon pricing schemes and replace them with a single steadily rising carbon tax. The most logical time for the UK to leave the scheme would be after Phase 3 has ended in 2021, as doing so beforehand would be immensely complicated.

Policy recommendations

- **Continued membership of EU ETS and internal energy market during Brexit transition period.** This will remove any risk of an imminent cliff edge for trading businesses and for the import and export of electricity through international interconnectors and will allow for continued participation in the EU ETS during the transition period.
- **Exit the EU ETS in 2021.** The third trading period of the EU ETS (phase 3) will come to an end at the beginning of 2021. This is the most suitable time to leave the scheme and begin the implementation of a new independent British carbon tax with border carbon adjustments.

- **Create a new independent UK carbon tax.** The level of the tax will initially be set at the existing Total Carbon Tax at the beginning of 2021 to minimize disruption during the transfer period. Revenues will be collected by the Treasury, but subsequent changes to the level of the tax and its future trajectory will be defined by an independent body – such as the Committee on Climate Change – that will set the rate of increase for the following five years.
- **After the Brexit transition, mirror the technical and safety requirements of the Internal Energy Market (IEM) to allow trade in fuel and electricity to continue. Continued linkage in some form beyond the transition date may be desirable, but should only be agreed to if compatible with border carbon adjustments.** If the UK leaves the IEM, it should take observer status (like Norway) in the European Energy Community and seek to create bilateral agreements relating to the import and export of electricity through the interconnectors.

A carbon tax is a necessary policy tool to incentivise a low carbon energy transition, but in certain sectors it may not be sufficient to spur innovation. Therefore, we recommend that the Government should:

- **Invest in large-scale energy research and development.** Carbon taxes are a necessary but not sufficient condition to spur innovation of certain large-scale low carbon technologies, for example, carbon capture and storage. The Government should invest directly in energy infrastructure and in some cases large-scale demonstration programmes that, due to investment risk and regulatory hurdles, cannot reach market without government involvement. Indeed, in dealing with industries with such long term liabilities, like nuclear power and CCS, the Government will still need to play a key role, though direct subsidies, once past the demonstration phase, should be avoided as this would negate the efficient and technology neutral approach of the carbon tax.

Policy implementation: Border carbon adjustments

The logical place to start with the implementation of border carbon adjustments (BCAs) would be with electricity that is imported into the UK via interconnectors. This will be based on the interconnector's average quarterly emissions intensity[132] multiplied by gross/net export over the period. The interconnector company will pass through costs to contracting parties – including generators – in order to change their economic rational and ultimately alter EU generator dispatch decisions. This should not be an indiscriminate process and low-carbon generators should be exempt from this. A pan-European certification regime already tracks the output of every renewable generator to the end consumer. Renewable generators can use these Certificates of Origin when selling power via interconnectors so that they can be excluded from pass-through costs.

132 The average carbon intensity of imported electricity can be calculated using monthly generation mix data, and the estimated carbon intensities of fossil plants. See: http://electricinsights.co.uk/#/reports/methodology?period=1-year&start=2016-02-07&_k=iy91km

The UK is a net importer of electricity and relies on interconnectors with other countries for a significant fraction of its electricity supplies, but it also exports electricity at times when market conditions are favourable. Currently, Britain has four interconnectors with neighbouring countries, with a total capacity of 4 GW, comprised of:

- 2GW to France (IFA) (53g/kwh)
- 1GW to the Netherlands (BritNed) (474g/kwh)
- 500MW to Northern Ireland (Moyle) (458g/kwh)
- 500MW to the Republic of Ireland (East West)[133] (458g/kwh)

There are more interconnectors planned, to EU countries such as Germany and the non-EU countries of Iceland and Norway. A total of seven new interconnectors for the UK with a total 7.3 GW capacity are contracted to come online by 2022.[134] This represents an increase in the UK's total interconnector capacity to over 12%.

Much (3.4GW) of this will come from France where the marginal plant intensity is relatively low and with increasing penetration of intermittent renewable energy in countries across Europe, interconnectors between countries are seen as important for ensuring security of supply. They are usually mutually beneficial so there is unlikely to be any desire on the part of the British Government or our EU neighbours to halt this process of electricity network integration. The overall aim should be to increase interconnectivity as it is likely to reduce UK wholesale prices, reduce the cost of integrating renewables, and enhance UK industrial access to low cost generators on the continent[135] which will help maintain industrial competitiveness – reasons that were previously set out in Policy Exchange's *Getting Interconnected: How can interconnectors compete to help lower bills and cut carbon?*.[136]

A significant concern will be those interconnectors that are more carbon intensive and continental carbon intensive generators that are not subject to a similar carbon price. This might enable them to undercut UK generators and is likely to increase EU wide emissions. Applying BCA here will help address these concerns.

Following implementation of BCAs on imported and exported electricity, it would also be possible to put a tax on the import of carbon intensive commodities like steel and aluminium, though care would need to be taken to design the system in such a way as to not damage domestic industry. The initial focus should be on the largest, most polluting sectors such as cement, steel, and aluminium production, which are responsible for approximately 30% of global carbon dioxide emissions.[137] There has been some support already for border carbon adjustments at the EU's borders, with France's President Emmanuel Macron in 2017 calling for both a minimum European carbon price and carbon tax at the bloc's borders on imported goods.[138] This should not be seen as a measure of protectionism. All products in their destination markets should reflect domestic emissions. This is the same arithmetic that informs excise duty adjustments at the point of import and export. Differential alcohol duty

133 Ofgem (2018). 'Electricity Interconnectors'. https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors

134 Grubb, M. and Drummond, P. (2018). *Industrial Electricity Prices: Competitiveness in a low carbon world*, Institute for Sustainable Resources, University College London. https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/uk_industrial_electricity_prices_-_competitiveness_in_a_low_carbon_world.pdf

135 Ibid.

136 Moore, S. (2014). *Getting Interconnected: How can interconnectors compete to help lower bills and cut carbon*, Policy Exchange. https://policyexchange.org.uk/publication/getting-interconnected-how-can-interconnectors-compete-to-help-lower-bills-and-cut-carbon/

137 Carbon Pricing Leadership Council (2018). *How can consumption-based carbon pricing address carbon leakage and competitiveness concerns?* https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/5ad8d232758d46c25386e589/1524159026153/27916-CPLC-ExecBrief-CarbonPricing-v7.pdf

138 Felix, B. (2017). 'French President Macron says Europe needs significantly higher carbon price', Reuters. https://uk.reuters.com/article/us-france-eu-carbon/french-president-macron-says-europe-needs-significantly-higher-carbon-price-idUKKCN1C12H7

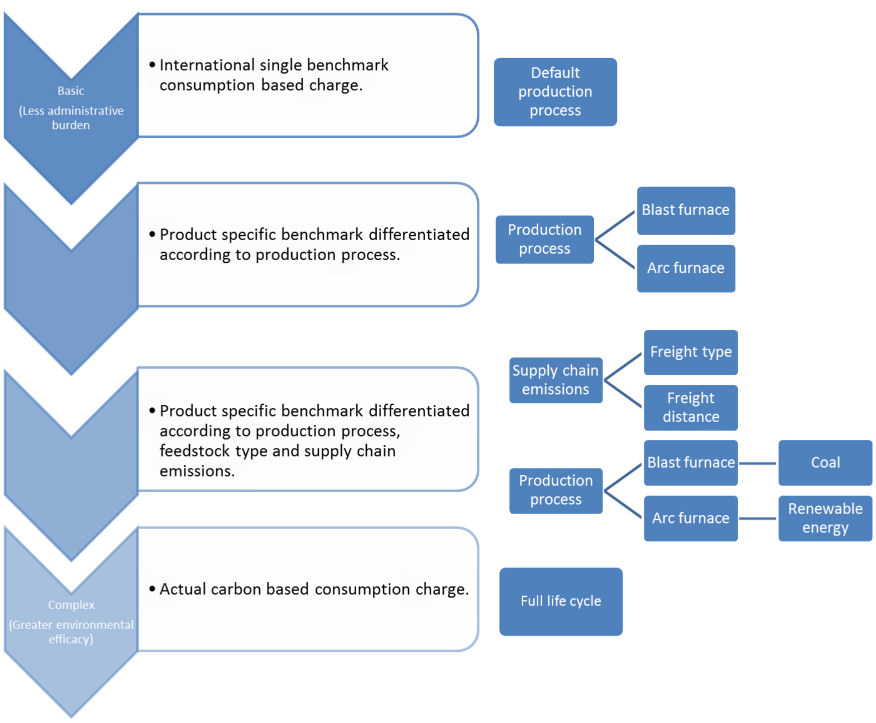
rates provide a good example. These rates are applied depending on the level of alcohol in the product, with higher concentrations of alcohol charged a higher rate. Although, determining embedded carbon is more difficult than determining alcohol content, this can be overcome as the section below outlines. Given this, carbon adjustments at the border would be looked at as a form of excise duty akin to alcohol duty and not a trade barrier, as such charges are entirely compatible with WTO.

A continuum of potential methods for applying consumption based pricing exists, ranging from a single benchmark consumption based charge – which is easier to administer – to an actual carbon consumption based charge which is much more complex but potentially encompasses greater environmental efficacy. In reality, each position is one extreme in a range of options. Figure 4.1 provides an indicative example of the options available and this is by no means exhaustive.

A single benchmark consumption based charged would be far easier to administer and would make for a good starting point in order to overcome the difficulties in establishing between different production processes. However, in the long term this might inadequately incentivise upstream low-carbon innovation.[139] Therefore, companies should have the ability to provide details demonstrating that they have taken steps to reduce the carbon content of their products which can reduce their exposure to carbon taxation giving them an incentive to increase the sustainability of their manufacturing process and improve their competitive position.

The most sensible way forward may be a compromise between the basic and the complex charging methodologies, beginning with an undifferentiated approach and evolving to become more complex. It

Figure 4.1: Continuum of consumption-based charges



139 Carbon Pricing Leadership Council (2018). *How can consumption-based carbon pricing address carbon leakage and competitiveness concerns?* https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/5ad8d232758d46c25386e589/1524159026153/27916-CPLC-ExecBrief-CarbonPricing-v7.pdf

should also be noted that whilst it may be advantageous to move away from a default single benchmark consumption based charge, it should be done in way that doesn't penalise producers who can't implement efficiency savings as this could be construed as a non-tariff barrier.

As for implementing BCAs across the rest of the economy, this would be a complicated administrative process with diminishing returns as many products have relatively small carbon footprints that would not justify the administrative burden of calculating the precise carbon content. We do not recommend doing so.

Research is required into how to design the border carbon adjustment system so that the administrative load is not excessively large and that there are not unintended consequences for domestic industry and the nation's carbon emissions.

Policy recommendations

- **Interconnectors should be classified as quasi-domestic generators and the implementation of border carbon adjustments on electricity imports and exports should begin. Seek bilateral agreements with neighbouring countries** with the condition that electricity will be traded based on the UK carbon tax. Given the complexity in identifying the specific generation sources that serve interconnectors, owners of the interconnectors will be subject to the carbon tax. Payment could be based on the interconnector's average quarterly emissions intensity[140] multiplied by gross export over the period.
- **Create a new cross-department body to design the implementation of border carbon adjustments beyond electricity.** Implementation of border carbon adjustment of electricity traded through interconnectors would be the logical place to start, followed by imports of carbon intensive commodities such as cement, steel, and aluminium production, which are responsible for approximately 30% of global CO_2 emissions[141]. A continuum of potential methods for applying consumption based pricing is proposed, ranging from a single benchmark consumption based charge – which is easier to administer- to an actual carbon consumption based charge which is more complex but encompasses greater environmental efficacy.

There are two specific issues relating to the implementation of border carbon adjustments: 1) BCAs in the context of international trade law and whether they would be allowable under World Trade Organisation rules (discussed in an appendix at the end of this report); 2) the practicalities of implementing BCAs and whether new technologies could make the process more efficient.

140 The average carbon intensity of imported electricity can be calculated using monthly generation mix data, and the estimated carbon intensities of fossil plants. See: http://electricinsights.co.uk/#/reports/methodology?period=1-year&start=2016-02-07&_k=iy91km

141 Carbon Pricing Leadership Council (2018). *How can consumption-based carbon pricing address carbon leakage and competitiveness concerns?* https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/5ad8d232758d46c25386e589/1524159026153/27916-CPLC-ExecBrief-CarbonPricing-v7.pdf

Practical issues with border carbon adjustment implementation on goods

The practical and political barriers to implementing a carbon tax with border carbon adjustment (BCA) could be significant. Finding a solution to these challenges will be an important step in moving towards a more effective model of international carbon pricing. The advent and speed at which computing technology is evolving offers a possible remedy, one that can complement existing methods of measuring product footprints.

From an operational point of view, establishing a carbon tax with BCA requires monitoring and accounting infrastructure in order to fairly distribute the cost of GHG emissions. In particular, the carbon intensity of power and embedded carbon of products that are traded across borders need to be known and attributed to each user. Whilst the latter is perhaps more difficult, the former – traded through interconnectors that link the UK to the continent – is a logical place to begin for reasons outlined above.

Methods for calculating the carbon intensity of traded power are crude and tend to be based on either the average emissions intensity of the country in which the power originates or the marginal plant intensity. Determining embedded carbon can be a challenge because of complex supply chains. This usually involves extraction, production and transportation of raw materials, processing of raw materials, manufacture or service provision, assembly and packaging, distribution (transport, storage and handling), consumer use, end of life treatment and disposal of a product.[142]

Once emissions have been quantified, some form of publicly auditable record of CO_2 emissions attributed to every user must be made available, which may raise confidentiality issues. The effectiveness of any carbon tax and BCA arrangement is contingent upon building trust and transparency in the process and accountability of relevant institutions and governance frameworks[143], something the ETS and (some) businesses have failed to do.

Part of the problem with the EU ETS is the centralised way in which it is administered, making it inherently difficult to depoliticise and independently manage key issues such as the surplus of permits. Moreover, emissions are measured in a variety of ways and the devices can be subject to manipulation as the VW emissions scandal illustrates. This exposed how self reporting in the automotive sector failed and how emissions reporting can be an avenue of misrepresentation. Consequently, this created a loss of trust in existing structures of governance. Therefore, the accuracy and reliability of transaction record-keeping and accounting will be paramount to the success of networked carbon markets and the application of a BCA.

Going forward, achieving greater emissions granularity across both traded power and product dimensions will be necessary to increase the efficacy of carbon pricing.

Research suggests that blockchain technology might help to overcome these barriers (see the box below for a technical explanation).[144] It could address multiple concerns – transparency, trust and robust accounting – that often impede (but are not limited to) climate negotiations. The

142 Clear About Carbon (2018). *Are You Clear About Embedded Carbon and Product Carbon Footprints*, Cornwall Development Group. http://www.cornwalldevelopmentcompany.co.uk/assets/file/Low%20Carbon/CAC%20Info%20sheets/13.03.28%20CAC%20Info%20sheet%207.pdf

143 Macinante, J. (2016). *Networking Carbon Markets – Key Elements of the Process*, Discussion Paper, World Bank Group. http://pubdocs.worldbank.org/en/974651467928322884/Networking-Carbon-Markets-Macinante-2016-dft-2-230616-jdm-clean-copy.pdf

144 Swan, M. (2015). *Blockchain: Blueprint for a new economy*, O'Reilly, California, USA.

UNFCCC has recognised this and following the climate change agreement made in Paris, the Climate Ledger Initiative was established between the UNFCCC Secretariat, the World Bank Group and the Massachusetts Institute of Technology to look at opportunities to overcome areas where scepticism is high such as transferring mitigation options in Article 6 of the Paris Agreement.[145] Given that the technology can offer greater transparency and help to better track and report emissions more accurately, it can be applied more widely to issues such as double counting – a key policy concern to Parties to the United Nations Framework Convention on Climate Change (UNFCCC). This can also serve as a tool to monitor progress against Nationally Determined Targets under the Paris Agreement.[146]

Policy recommendation:
Blockchain solutions that ensure device integrity and minimise data manipulation rely on cloud computing to work. The Government should champion this pan sector solution and use UK Research and Development Hubs to advance cloud computing and to test proof of concept to understand if blockchain can be fully utilised in this context.

Simplifying the policy landscape

The first section of this report outlined the complicated policy landscape that comprises energy and climate policy in the UK. The aim over time should be to phase out many of the policies that will become redundant with the implementation of an economy wide carbon tax and replace them with border carbon adjustments. This is not about weakening environmental legislation, but making it more effective.

Leaving the EU gives the UK an opportunity to review energy and climate policies and implement better policies. The EU Renewable Energy Directive (RED) is also a policy the UK should seek to withdraw itself from on exiting the EU. It increases prices, reduces the efficiency of carbon price schemes and may have unintended negative environmental consequences in terms of land use change and life cycle carbon emissions. Whether we no longer remain under the Directive will be dependent on the outcome of negotiations with the EU. It may be that they seek to make being part of the RED a condition of electricity trading with EU countries. However, this would not be in anyone's interest so should be resisted.

UK renewable energy subsidies (and any remaining fossil fuel subsidies) should be almost completely abolished over time, with the exception of CfDs. Some legacy payments will be owed for decades, but subsidy payments of this type can occasionally be justified to push a new technology over the valley of death between the lab and commercialisation. CfDs will stay, but the total subsidy will be much smaller.

Lastly, the Climate Change Act and the associated targets for reducing greenhouse gas emissions should be retained, but altered to measure emissions on a consumption rather than production basis.

Certain specific policies will simply be redundant after the implementation of the Carbon Dividends plan. The following could be phased out:

145 https://dailyplanet.climate-kic.org/attention-role-blockchain-implementing-paris-agreement/

146 UNFCCC (2017). 'How Blockchain Technology Could Boost Climate Action'. https://unfccc.int/news/how-blockchain-technology-could-boost-climate-action

Blockchain technology

Blockchain is constructed by a fundamentally different architecture to existing systems of governance. Rather than relying on a centralised network, it is based on mutual distributed networks.[147] Online ledgers, referred to as the blockchain, contain information that is identically distributed across networks of computers. It is precisely this architecture that could improve governance as it avoids monopolistic controls over the centralised or decentralised networks which are currently exerted by older bureaucratic institutions like political parties and local governments.[148] Instead, any changes have to be agreed by consensus as the distributed file system means multiple participants keep copies of files.[149]

All transactions are recorded and the system is constantly reconciling itself which means that it is almost impossible to corrupt transactions because if anyone tried to change the record of a transaction, the entire system would be out of balance and immediately identify the inconsistency.[150] Evidently this can help issues of governance. But how can it be applied to better track and report greenhouse gas (GHG) emissions?

Blockchain enables greater levels of traceability throughout a product lifecycle. This could be particularly helpful when establishing levels of embedded carbon within traded goods such as cars and steel. During the manufacturing stage of products, data can be automatically generated by sensors to record the environmental impacts of certain processes to include how much energy, water or raw materials are used.[151] This information can be digitalised so that overall embedded emissions can be recorded in the blockchain.

That said, lots of new sensors are going to be needed to collect, analyse and report on emissions (one of the major implementation problems), and any errors will be costly in brand, tax and penalties as the VW emissions scandal demonstrated. **Blockchain can be used to protect device integrity**. For example, the devices used to measure emissions can check that their internal configurations are correct by attempting to write a message about the state of its configuration to a device integrity blockchain application. The blockchain can accept the message if the configuration matches the configuration of other true measurement devices. A device that has been altered would find its message would not be accepted by the blockchain. A message could then be sent to company management to alert them to possible device manipulation.[152] Once this data has been accurately recorded it must not be susceptible to subsequent manipulation. **Blockchain can minimise data manipulation** as devices could record the actual measured emissions taking down parameters such as volume, location, type, source and date stamp. This would be logged to an emission blockchain application that is visible and transparent. Once this happens the emission data can no longer be tampered with, adjusted or deleted for the reasons outlined above.

147 UNFCCC (2017). 'How Blockchain Technology Could Boost Climate Action'. http://newsroom.unfccc.int/climate-action/how-blockchain-technology-could-boost-climate-action/

148 Giungato, P. et al (2017). 'Current Trends in Sustainability of Bitcoins and Related Blockchain Technology', *Sustainability*, Vol. 9 (12). http://www.mdpi.com/2071-1050/9/12/2214/htm

149 Faber, N.R.; Hadders, H. (2016). 'Towards a blockchain enabled social contract for sustainability, Creating a fair and just operating system for humanity', *Proceedings of the First International Conference on New Business Models*, Toulouse, France, 16–17 June 2016. [Google Scholar]

150 Climate Ledger Initiative (2018). 'What is Blockchain / distributed ledger technology and why should the climate community be interested?' https://www.climateledger.org/en/Focus/DLT-Blockchain.16.html

151 Ibid.

152 Digital Oil & Gas (2017). 'How blockchain could ease emissions tracking'. http://digitaloilgas.com/how-blockchain-could-ease-emissions-tracking/

- Large and Medium Combustion Plant Directives
- Climate Change Levy
- Carbon Price Support
- Renewable Heat Incentive
- Emissions Performance Standard

Some policies will still be required, or at least be desirable, after the implementation of a carbon tax, including:

- The **Capacity Market** or some other equivalent mechanism will still be required to ensure a secure and continuous supply of electricity.
- Many domestic appliance **energy efficiency standards** correct market failures, because consumers will not pay for incremental improvement in energy efficiency, but collectively these small changes can result in cost effective large reductions in energy use.
- Similarly, **buildings regulations** are required to ensure the construction industry continuously works to improve the energy efficiency of buildings.
- **Energy labelling**, particularly for cars, as recommended in our Driving Down Emissions report, should be kept and improved. Consumers want clean, efficient cars and they should be given the information they need to make informed decisions as consumers. They should be labelled with accurate CO_2 emissions information, including embedded emissions.
- The **smart meter roll out** was a good idea in principle, but the first generation of smart meters were not good enough. The roll-out of the next generation of genuinely smart technology should be continued, including smart charge points for electric vehicles.
- The **Industrial Emissions Directive** focuses on reducing emissions of pollutants that are directly harmful to human health, not greenhouse gases. The UK should legislate for its own directive that mirrors the EU version.

Figure 4.2 reproduces the complicated EU-UK policy landscape that was shown in Figure 2.2 and Figure 4.3 shows how a simplified and more effective UK energy policy could look post-Brexit and after implementation of the carbon dividends plan. Many of these regulations can be abolished or improved upon implementation of the carbon dividends plan post-Brexit.

Figure 4.2: UK energy policy before/after leaving the EU and implementing carbon dividends

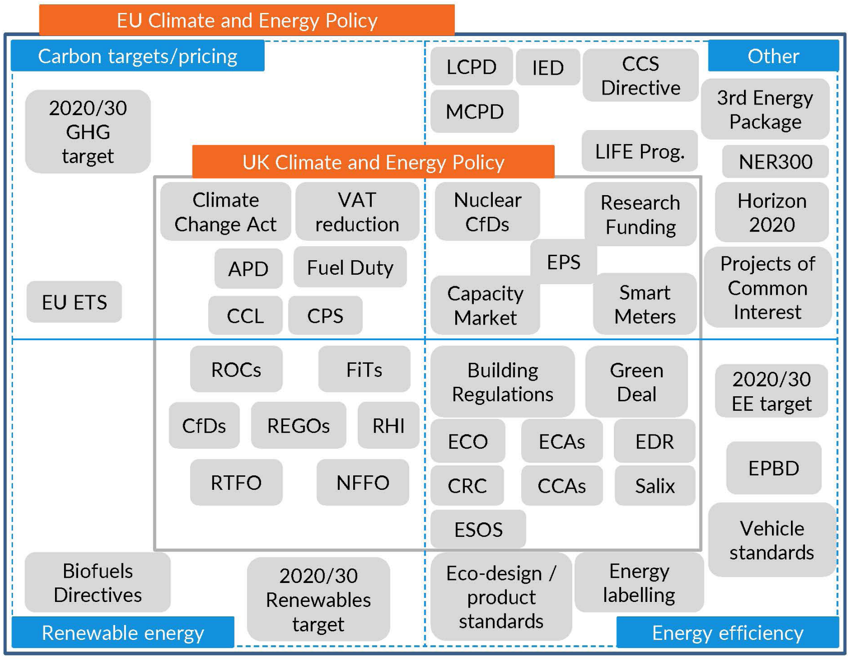
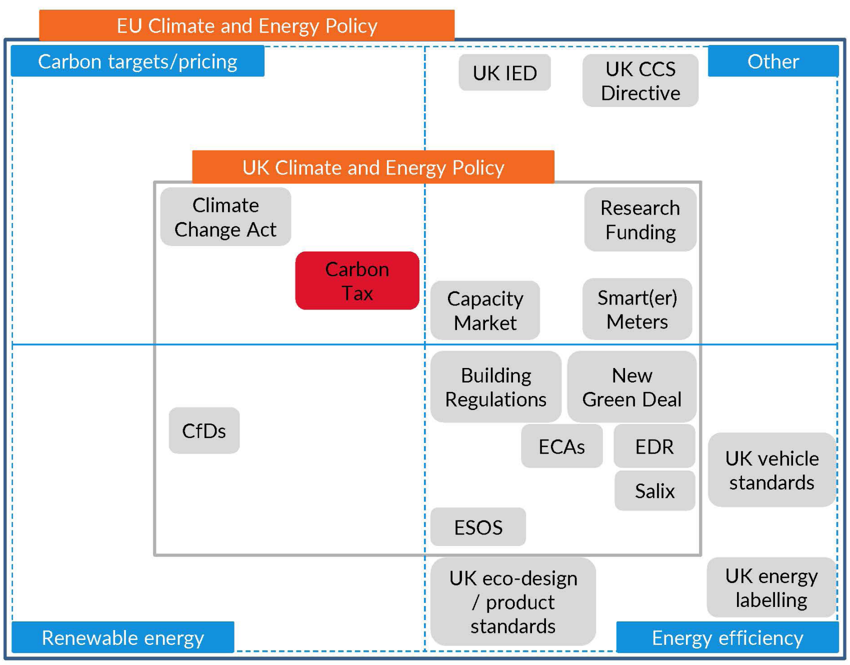


Figure 4.3: Regulatory roll back: UK climate policies that should be retained



Revenue recycling – carbon dividends

Returning the proceeds of carbon taxation to the populace in the form of a dividend will give voters an immediate interest in the fight against climate change and ensure that the majority of the population will be better off after the implementation of an economy-wide carbon tax. Dividends therefore help overcome what would otherwise be two downsides of carbon taxes.

The first downside of carbon taxes compared with emissions trading schemes is that, by themselves, they provide less certainty for business. With some recent historical examples to point to, businesses will say that governments cannot be trusted to stick to a given upward trajectory of carbon tax (as in the UK with the freezing of the Carbon Price Floor in 2014[153]) or even not to scrap the tax altogether (as in Australia, also in 2014 [154]).

A second downside of carbon taxation, of any tax increase really, is that although it may be paid by large hydrocarbon businesses or heavy industry through an upstream carbon tax, most if not all of the costs will eventually be passed through to consumers through higher prices for the goods they buy. Poorer households would lose a higher proportion of their income in paying these new energy taxes and such a change would, by itself, be regressive.

Carbon dividends are a way to solve both these problems and are favoured by behavioural and political studies that emphasise the importance of distributional fairness, revenue salience, political trust and policy stability amid partisan changes in government.[155] In our plan the proceeds of carbon taxes will be recycled and redistributed to voters through a cash rebate. The independence of the body setting the level and trajectory of the carbon tax combined with the political and public popularity of a dividend paid to all citizens will make this policy incredibly difficult to reverse. There are a number of real world examples to support this:

1. **Alaska's Permanent Fund Dividend:** Every year since 1982, residents of Alaska who have been resident in the state for the preceding calendar year receive a dividend based on the profits of the Alaska Permanent Fund Corporation, a state owned entity that manages their sovereign wealth fund, which has been built up to an estimated $55 billion since it was created in 1976. The fund has been mostly built up through the state's oil and gas revenues and citizens have typically received between one and two thousand dollars per year.
2. **The UK's Winter Fuel Payment:** This policy was first introduced in 1997 by then Labour Chancellor Gordon Brown. Every year people over the age of 60 years old receive a payment that is intended to cover the additional costs incurred from heating homes through cold winter months. The amount paid depends on various factors, but a single pensioner in 2017 received £200 through the scheme.

The longevity of these policies point to their popularity. Two attempts to reform the Winter Fuel Payment to make it means tested (only paid to

153 HM Revenue & Custom (2014). 'Carbon price floor: reform'. https://www.gov.uk/government/publications/carbon-price-floor-reform

154 BBC (2014). 'Australia votes to repeal carbon tax'. http://www.bbc.co.uk/news/world-asia-28339663

155 Klenert et al (2017). *Making Carbon Pricing Work*, INET Oxford Working Paper no. 2017-11, Oxford University.

poorer pensioners) in the UK have been followed by poor election results for the party proposing the reforms. The policy change was subsequently dropped, by Labour following their 2010 election loss and by the Conservatives after losing their majority in 2017.

By linking the carbon tax directly to payments to individual citizens it will both win support for action on climate change and ensure that the carbon tax is bankable. This is favoured among behavioural and political studies that emphasise the importance of distributional fairness, revenue salience, political trust and policy stability amid partisan changes in government.[156] Dividends are popular, especially after they have been introduced and people stand to directly lose out if they are withdrawn.

Household emissions

Carbon dividends also make carbon taxes progressive. On average, the higher your income the higher your carbon footprint. This has been confirmed to be consistent in numerous studies across different countries, including the UK.[157, 158, 159]

Although there are other determining factors other than income, it is consistently one of the strongest indicators of a household's carbon footprint. A study by the Potsdam Institute for Climate Impact Research found that an additional £600 per week in income resulted in an increase in per capita carbon emissions of one tonne (with the UK average at the time of the study being 12.5 tonnes).[160]

In 2013 the Joseph Rowntree Foundation published an extensive report outlining the carbon footprint of British households and sorted them by income decile and certain other key characteristics.[161] The richest 10% of households were found on average to have almost three times the carbon footprint of the poorest 10%. The average yearly carbon footprint of the poorest 10% of UK households is 5.5 tonnes, whilst for the richest 10% it is 14.

The measurement of carbon emissions in the study was limited to home heating, electricity usage and transport. The embedded emissions of the goods people bought were excluded.

Nevertheless, given this limitation, using this data it is possible to calculate the relative effect of an economy-wide carbon tax on households based on their income and lifestyle.

The data relates to households rather than individuals as it would be very difficult to allocate emissions to individuals when multiple people share a property. With these caveats, a number of calculations can be made to give an indication of the effect of carbon taxation combined with revenue recycling.

Figure 4.4 below shows the distributional impact of a carbon tax of £25 per tonne applied to household domestic emissions on a production basis (excluding imports) with the revenue recycled with an equal dividend for all households. Around 70% of households – the least well off 70% - would be better off or largely unaffected by such revenue recycling.

However, in this example only household-related emissions have

156 Klenert, D. et al (2017). Making Carbon Pricing Work, Working Paper no. 2017-11, Oxford Institute for New Economic Thinking. https://www.inet.ox.ac.uk/files/Making_INET_Klenert_et_al.pdf

157 Buchs, M. and Schnepf, S.V. (2013). *UK Households' Carbon Footprint: A Comparison of the Association between Household Characteristics and Emissions from Home Energy, Transport and Other Goods and Services*, Institute of Labour Economics, Bonn, Germany. http://ftp.iza.org/dp7204.pdf

158 Roberts, D. (2017). 'Wealthier people produce more carbon pollution — even the "green" ones', Vox.com. https://www.vox.com/energy-and-environment/2017/12/1/16718844/green-consumers-climate-change

159 Druckman, A. and Jackson, T. (2016). 'Understanding Households as Drivers of Carbon Emissions', Chapter 9, Taking Stock of Industrial Ecology, Springer International Publishing.

160 Institute of Physics (2013). 'Researchers map carbon footprint of UK towns and cities'. http://www.iop.org/news/13/sep/page_61111.html

161 Preston, I, Thumim, J. et al (2013). *Distribution of carbon emissions in the UK: Implications for domestic energy policy*, Joseph Roundtree Foundation. https://www.jrf.org.uk/report/distribution-carbon-emissions-uk-implications-domestic-energy-policy

been considered. It assumes that carbon taxes are only paid by domestic consumers and recycled equally to all households. These only account for around 40% of total UK emissions. If we assume that emissions from all sectors of the economy on a production basis can be taxed and recycled to households in the form of a dividend then without making any other assumptions about cost and price changes it looks like every household will benefit substantially from the carbon tax. In reality, some of the additional cost to business will be passed through to consumers in the form of higher prices, therefore the effect would be somewhere between these two graphs in Figures 4.4 and Figure 4.5. But it is clear that most households would benefit from such a policy and the poorest would benefit the most.

Now this is just for one worked example of a tax of £25 per tonne applied to 100% of domestic emissions. Various effects could change

Figure 4.4: Distributional impact of a carbon tax with dividends

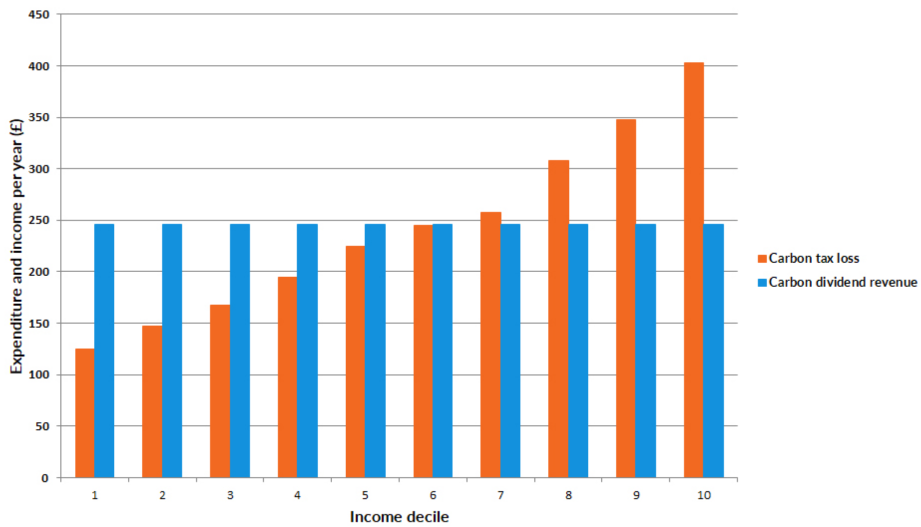
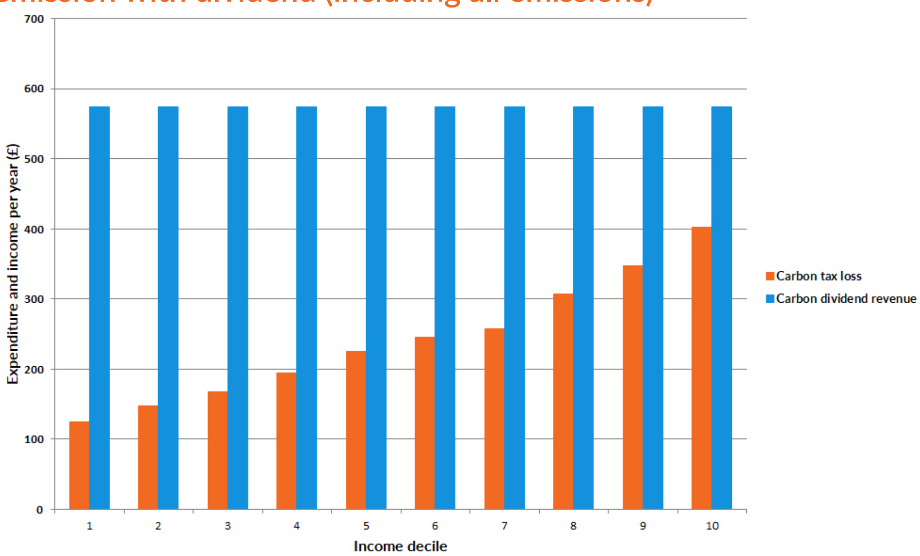


Figure 4.5: Distributional impact of carbon tax on household emission with dividend (including all emissions)



the revenue generated and therefore also the resulting dividend. It will take some time, for example, to have a tax that covers close to 100% of domestic emissions and so revenue in the beginning will be lower. The above revenue does however exclude any net revenues generated from border carbon adjustments. Also £25 per tonne is perhaps a modest carbon tax and this would likely have to increase steadily over the next couple of decades to have the desired effect, which would increase revenue.

Individual emissions and complicating factors

The analysis above focusses only on emissions from households as a whole and divides them by income decile only. Although income is perhaps the main indicator in estimating a person's carbon emissions, in fact there are many others. The analysis in the Joseph Rowntree Foundation report highlights the following:

- Working age households have higher emissions than those containing the young and the elderly.
- Households in rural areas have higher emissions than urban.
- The type of heating system is a strong determinant of household emissions, with oil being highest, followed by gas, then electric (with the progress in decarbonisation of the electricity system since this study, the advantage will have increased).
- The number of vehicles owned by the household is a strong indicator of emissions.
- Owner-occupied properties have higher emissions than those that are rented.
- Typically couple households (either pensioners, working-age childless, or working-age families) have more than double the emissions of single adult households (childless or single-parent).

Most of these factors further indicate the progressive nature of a carbon tax with dividends policy. In general people will be bigger winners from the policy if they are: young or old; living alone; renting.

The Government should, however, ensure that certain low income groups are not disproportionately affected due to their particular circumstances. For example, a low income person living alone in a rural area who needs to drive to work and has oil central heating could be one of the few low income people who end up worse off under a carbon tax with dividend policy. Targeted policies to help this small number of people may be necessary (e.g. boiler replacement schemes or subsidies for low emissions vehicles).

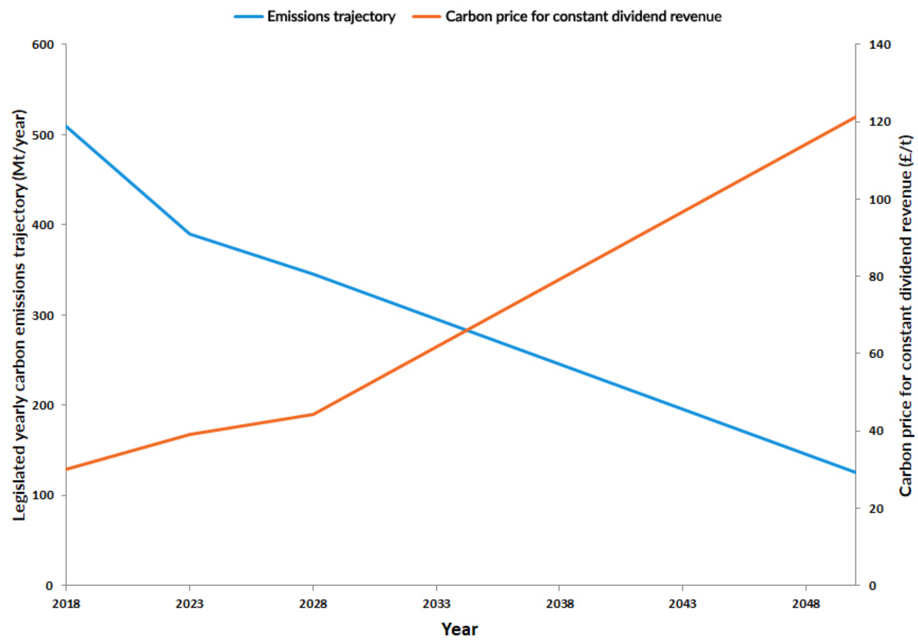
Additionally, children in a household will increase emissions, though not as much as each additional adult. Therefore, although we recommend that the full dividend be paid to adults only, those with dependent children should receive some additional compensation as part of the dividend scheme.

Carbon tax revenue trajectory

The point of a carbon tax is to reduce emissions, so won't the revenue dry up quite quickly and erode the value of the dividend? Well eventually it will, but it is not a problem to worry about in the near future.

Figure 4.6 below shows the required trajectory of UK carbon emissions to meet our obligations under the Climate Change Act and also shows the level of carbon tax required to maintain a constant level of dividend for 45 million people. A quadrupling of the tax between now and 2050 will be sufficient to maintain constant revenues. Eventually, of course, the money will dry up and the dividend will have to be scrapped or paid out of general taxation, but this is a problem for the second half of the century.

Figure 4.6 Plot of CCC's carbon emissions trajectory along with how much the tax would need to increase each year to maintain the revenue



Along with border carbon adjustments, we strongly believe that carbon dividends are a necessary component of carbon tax policy as they lock in political and public support for fighting climate change. In their implementation, we recommend the following policies to the Government.

Policy recommendations:

- **Create a system of payments to citizens, a carbon dividend, payable quarterly or yearly, funded by expanding the scope of carbon taxation to cover the whole economy.** Every adult will be receive the same amount and those with children will receive an additional payment to reflect the fact that parents will have to pay for their children's share of the additional taxation.
- **Investigate inventive ways of paying the dividend to ensure that**

the most vulnerable receive it. Linking the dividend to national insurance numbers would be one a way to pay the dividend, but this may mean that the most vulnerable miss out. The Government should investigate whether new technology can be used to pay the dividend securely through a mobile app to ensure it goes to as many people as possible. Relevant Government departments should be consulted in development of the policy details to minimise any additional administrative burden that might result from distributing the dividends.

Energy efficiency is known as the 'low hanging fruit' in the energy industry – the economics of investing in energy efficiency usually make sense even in the absence of subsidy, but for various reasons people are often reluctant to make up front investments for long term paybacks. Policy Exchange analysed this phenomenon in a business context in 2017 in our report *Clean Growth: How can we improve business energy efficiency?*[162], though individuals are also reluctant to invest in home energy efficiency and various Government incentives have fallen short of targets. It is for this reason that the Government should allow people to borrow against their future dividend payments for certain approved energy efficiency investments. Hopefully this will nudge a proportion of those receiving dividends towards investments that would offset any increase in bills caused by greater carbon taxes. As the CCC set out in 2017, low-carbon policies added just over £100 to the typical household in 2016, but this was more than offset by improvements in energy efficiency which have saved the typical household around £290 per year since 2008.

- **Allow citizens to borrow against their future dividend payments for investments in energy efficiency.** Government incentives for home energy efficiency have largely failed to meet their targets, which means the country has not been taking advantage of one of the most cost effective paths to decarbonisation As the Committee on Climate Change set out in 2017, low-carbon policies added just over £100 to household bills in 2016, but this was more than offset by improvements in energy efficiency which have saved the typical household around £290 per year since 2008. The total borrowing against future dividends will be capped in order to control costs whilst evaluating the effectiveness of this policy. The Government should also ensure schemes are in place to help the small number of low income people who may be disproportionately affected by carbon taxes and less likely to insulate their homes.

162 Burke, J. (2017). *Clean Growth: How to improve business energy efficiency*, Policy Exchange. https://policyexchange.org.uk/clean-growth-how-can-we-improve-business-energy-efficiency/

Postscript: The Future of Carbon Pricing

At the time of writing we do not know for sure what the Government will decide with regard to carbon pricing after leaving the EU. Staying a full member of the scheme seems unlikely as this will require the UK to accept the jurisdiction of the European Court of Justice and be a rule taker with regard to EU energy policy. The EU may even seek to make freedom of movement a condition of being a member. This would make EU ETS membership politically unpalatable for any UK Government.

There are, however, a number of options in between being in the EU ETS and having a completely independent carbon tax. The UK could have its own emissions trading scheme, for example. This could be completely independent or it could be linked to the EU ETS or another trading scheme. European political leaders are beginning to point to the need for a floor price for the EU ETS and for border carbon adjustments on goods imported into the EU. The new UK-EU border could be the testing ground for innovative international carbon pricing.

One thing that is clear is that carbon taxation needs to be expanded to cover the whole economy and for this to work properly the embedded emissions for imported electricity, fuel and goods needs to be taken into account. Our analysis has shown that this can be done at existing levels of carbon taxation without significantly affecting the competitiveness of domestic industry.

Carbon pricing is taking off around the world, with over 13% of greenhouse gas emissions covered by some form of tax or trading scheme. We need to get to 100%. Doing so will require political will, international co-operation and inventive policy making.

Afterword

By Martin Feldstein, Ted Halstead and George P. Shultz

Brexit offers the United Kingdom the opportunity to rethink major aspects of its climate policy and consider alternatives to the European Union Emissions Trading System. With this report, Policy Exchange provides an important contribution to that debate by outlining a popular, equitable and cost-effective strategy for the U.K. to meet its climate objectives.

This plan put forward by Policy Exchange shares much in common with one that we introduced last year in the United States, along with our co-authors James A. Baker, III, N. Gregory Mankiw, Henry M. Paulson, Thomas Stephenson and Rob Walton. Our U.S. plan, entitled *The Conservative Case for Carbon Dividends*, has received considerable media attention and is increasingly seen as the best hope for breaking the U.S. climate stalemate.

Both the U.K. and U.S. plans call for the enactment of a gradually rising carbon tax, whose proceeds would be rebated to all citizens as dividends. Both include a system of border carbon adjustments on imports and exports that would protect national competitiveness and prevent carbon leakage. And both lay out the rationale for simplifying regulations that would be rendered unnecessary by the adoption of a carbon tax. The scope and political case for the latter, however, may be greater in the United States.

Our U.S. carbon dividends plan rests on the enduring principles of free markets and limited government. At the same time, it would achieve significantly greater emissions reductions than all current and prior U.S. climate-related regulations, while helping both workers and businesses to get ahead. According to the U.S. Treasury Department, the bottom 70 percent of American households would be better off under our program because the dividend they would receive would more than offset the increase in the costs of the energy they consume.

A carbon dividends program would also steer the economy towards a path of more durable economic growth. Not only would it help free businesses from unnecessary regulation, but a carbon tax that rises over time would send a consistent market signal that encourages technological innovation and large-scale substitution of existing energy and transportation infrastructures, thereby stimulating new investment in clean energy.

Recent polling indicates that the American public supports a carbon dividends plan by a two-to-one margin, including support among Republican voters by a 23-point margin. A surprisingly broad coalition of top companies, opinion leaders and environmental NGOs recently joined

163 Condon, M. and Ignaciuk, A. (2013). *Border Carbon Adjustment and International Trade – A Literature Review*, OECD. http://dx.doi.org/10.1787/5k3xn25b386c-en

as Founding Members of the Climate Leadership Council, an organization dedicated to promoting our carbon dividends plan.

The policy framework put forth by Policy Exchange could have similar broad appeal in the United Kingdom. In particular, it could strengthen the U.K. economy and benefit British families while reinforcing Britain's position at the forefront of international efforts to solve climate change.

164 Nordhaus, W. (2014). 'Climate Clubs Designing a mechanism to overcome free-riding in International Climate Policy', Presidential Address to the American Economic Association 2014. http://carbon-price.com/wp-content/uploads/2015-01-Nordhaus-Climateclub_123014-main-wm.pdf

Appendix: Border Carbon Adjustments and Trade Policy

UK free to determine trade policy – once outside the EU

From a UK perspective the first thing to establish is that until the UK leaves the EU – and specifically leaves the customs union – it is unable to act unilaterally in trade-related matters. Trade policy is determined at the EU level so while it remains a member, the UK is unable to determine its own trade policy. The UK is due to leave the EU on 29th March 2019, although there will almost certainly be a transition period ending in December 2020 that will require the UK to observe the rules of the EU customs union.

Beyond this date the UK will be free to determine its own independent trade policy. The UK's membership of the World Trade Organisation (WTO) is independent of our membership of the EU – there will be no need to re-apply and we will remain subject to its rules and schedules. The issue then becomes whether a BCA is compatible with international trade law and this is not a clear cut issue. Import tariffs can be used as a protectionist measure to shield domestic industries from foreign competition as well as a tool to reduce carbon emissions in an economically efficient way. Hence the case for BCAs has to be made.

BCA and WTO rules[163]

A key requirement and principle of the WTO is one of no discrimination. First there should be no discrimination between domestic and foreign producers of 'like products'. This should not be a major obstacle provided that the carbon tax applies to both domestic and foreign producers.

BCA measures should also not discriminate between 'like' products based on the country of production – this is the so-called most favoured nation principle (MFN). So for example if a country imposes a 2.5% tariff on, say, TVs from Japan then it has to charge the same rate on imports of TVs from all other countries – it cannot discriminate between countries by charging differential tariffs on TV imports. There is no definition of 'like' products in the WTO rules, but it is a relevant issue for BCA measures. Is a tonne of steel made using coal in a blast furnace 'like' a tonne of steel made using low carbon electricity in an electric-arc furnace? Through various trade dispute cases the 'likeness' in this respect has been judged to depend mainly on the physical properties and use of the product. So consumers are likely to regard a given quantity of 'dirty' steel as 'like' the same quantity of 'clean' steel.

165 Flannery, B. (2018). 'Solution to a Vexing Climate Policy Problem: WTO-Compliant Border Adjustments'. http://www.rff.org/blog/2018/solution-vexing-climate-policy-problem-wto-compliant-border-adjustments

A second and crucial factor for effective BCAs is that they should take into account the differences prevailing among producers. Therefore, it would be unacceptable to simply set a national baseline of carbon emissions for all producers within a given sector in a given country. This would have the perverse effect of punishing the highly efficient producers in a sector where average carbon emissions were high and giving no real incentive to the least efficient to reduce their emissions. At the very least such measures should be calibrated at the firm level, which adds to complexity. There is a trade off between efficiency and effectiveness at the root of much of BCA design.

Finally, before unilateral action can be taken there must have been ultimately fruitless but good faith efforts at a multilateral solution to the problem that a proposed BCA is now seeking to address. This relates not to the BCA itself but the actions which precede it.

Environmental gateways

However, there is another way in which a BCA could be approved under international trade agreements. Article XX (g) of the GATT allows exceptions for trade measures that are related to the conservation of exhaustible natural resources and are made effective in conjunction with restrictions on domestic production or consumption. Recent WTO judgements would tend to support the case that a BCA can be said to relate to the conservation of exhaustible natural resources i.e. clean air. Another possible exception is provided by Article XX (b) which allows an exception for measures that are necessary to protect human, animal or plant life or health.

The environmental gateways are the best way for most BCA measures to be compliant with WTO rules.

Carbon clubs[164]

These trade arguments can be extended to so-called carbon clubs, where several countries form a club with a common carbon price and with external tariffs imposed on non-members. Such sanctions on non-members are necessary to promote participation in agreements to supply global public goods, such as reduced carbon dioxide emissions. One issue for a carbon club is whether to impose tariffs related to the carbon content of imports coming from non-participants or a uniform penalty tariff on all imports from non-participants. The latter would have the advantage of simplicity and effectiveness in encouraging participation in the club. Realistically, however, a carbon club would have to impose a BCA on energy intensive imports of non-participants.

Of course the above discussion has taken place in the context of existing WTO laws and rules. Given the global scale of the environmental problem caused by carbon emissions it may be possible for parties to agree to rules allowing some degree of flexibility. For example, by decreeing that differences in carbon intensity in the energy used in the production of certain product does make two otherwise similar products e.g. a tonne of

166 Rocamora, A. (2017). *The Rise of Carbon Taxation in France: From Environmental Protection to Low-Carbon Transition*, Institute for Global Environmental Strategies. https://pub.iges.or.jp/pub_file-246/download

167 World Bank Group (2017). *State and Trends of Carbon Pricing 2017*. http://documents.worldbank.org/curated/en/468881509601753549/State-and-trends-of-carbon-pricing-2017

steel no longer 'like' another tonne of steel because of energy used in its production.

A potentially WTO compatible Carbon Tax/BCA Scheme[165]

There is a BCA proposal that is WTO compliant while achieving the desired objectives. The tax would operate in a similar way to Value Added Tax with the carbon tax applied to different consumer goods reflecting their accumulated carbon content. Significantly, the relevant WTO rules permit VAT to be rebated on exported products and imposed on imports. Moreover, by taxing domestic and imported goods equally, the scheme is non-discriminatory. Much of the information required to implement the proposal is currently available based on objective methods to measure and report GHG emissions from facilities and operations. The scheme would require two major innovations in information supply: the first is to specify how GHG emissions from suppliers (e.g., of electricity and commercial fuels) and on-site operations across the world contribute to credibly determine the cumulative GHG emissions required to produce various individual products. The second is to determine how GHG emissions from entire facilities (and operations) can (again, credibly) be apportioned to their products. This new framework will require potentially large additional efforts and cooperation (perhaps in voluntary public-private partnerships) among firms, trade associations, regulators, and other stakeholders. The benefit is a BCA that is not only WTO compliant but also shifts the focus of the carbon tax from the location of production to that of consumption.

Carbon taxes and the EU ETS

A carbon club can trade with an ETS, such as that prevailing in the EU. The UK is currently a member of this scheme as a member of the EU. It has not yet decided whether or not to remain in the ETS after the UK leaves the EU in 2019. If the UK leaves the ETS, it will have to introduce alternative policies in order to meet its commitments on reducing CO_2 emissions. A comprehensive carbon tax would raise the question as to whether there can be tariff free trading between the UK and the countries in the ETS (27 EU members plus 3 EEA). Since the ETS is a cap and trade scheme, members of the scheme are already limiting or reducing emissions through the trading of permits. Hence to impose a BCA on members of an ETS could amount in effect to a form of double taxation. WTO objections to this can be overcome by ETS countries exempting their exports to countries applying BCA. However, if there was a reciprocal agreement between the UK and EU countries to pay the higher of either country's total carbon tax, this obstacle could be overcome.

If the UK decides to remain in the ETS then its options for independent action will be curtailed, probably completely for ETS sectors. It will be difficult for the UK to impose a carbon tax in those areas that are subject to the ETS. However, the ETS covers an estimated 45% of the EU's GHG emissions, mainly those generated by power stations and energy intensive industries such as the production of steel, cement and aluminium. These are also the obvious areas where a carbon tax would be applied. But there would be scope to apply carbon taxes in areas not covered by the 'cap and trade' scheme. For example, France does have a carbon tax which is applied to certain goods not covered by the ETS.[166] The coverage of the carbon tax is restricted to fossil fuels (petrol, diesel, heating oil, natural gas and coal). This covers around 40% of France's GHG emissions. Set at €30.50 tCO_2 in 2017 the tax is scheduled to rise to €100tCO_2 by 2030. In 2017 the tax raised around €6bn but at least two-thirds of this is rebated in the form of tax credits for business and 'green checks' for households. Several other EU countries also use carbon taxes in addition to the ETS to reduce emissions. Sweden and Finland are the other EU countries that have carbon taxes with rates and coverage which are likely to have a material effect on emissions.[167] (Sweden currently has a carbon tax of $140 tCO_2.) Several other EU countries have carbon taxes, including Poland, Ireland, Denmark and Portugal. But the rates and coverage of these are fairly low.

Continued UK membership of the EU's ETS would not preclude the UK from adopting carbon taxes . However, it is likely that such taxes would have to 'fit around' the areas covered by the ETS, similar to the French model. This hybrid approach, involving both an ETS and carbon tax, has become a fairly common approach in addressing climate change.

Glossary of Key Terms

Term	**Definition**
BCA	Border Carbon Adjustment – a mechanism for ensuring that imported goods pay the same carbon taxes that domestic producers are liable for.
BEIS	Department for Business, Energy and Industrial Strategy.
CCS	Carbon capture and storage – collective term for technologies that capture carbon dioxide, which is subsequently compressed and stored underground indefinitely.
CO_2	Carbon dioxide (CO_2) is the main greenhouse gas. The vast majority of CO_2 emissions come from the burning of fossil fuels such as coal, gas and oil.
CO_2e	Although carbon dioxide is the main greenhouse gas, there are others and they vary in their warming effect on the atmosphere. This unit, carbon dioxide equivalent, converts the volume of other greenhouse gases into what would be the equivalent volume to have the same warming effect if they were carbon dioxide.
CPS, CPF, Total Carbon Price	The Carbon Price Support (CPS) policy is what was originally called the Carbon Price Floor (CPF). It ensures that a minimum carbon price is always paid by UK power producers and energy intensive industries, regardless of the EU ETS permit price. UK companies therefore pay the Total Carbon Price, which is equal to the EU ETS permit price plus the Carbon Price Support top-up.
DECC	Department for Energy and Climate Change – a predecessor to BEIS.
EU ETS	European Union Emissions Trading Scheme.
gCO_2/kWh	Grams of carbon dioxide emissions per kilowatt hour of energy used or produced. A measure of 'carbon intensity' of a fuel.
GW	Gigawatt: a measure of power or electrical output. 1 GW = 1,000 megawatts = 1,000,000 kilowatts.
IPCC	Inter-governmental Panel on Climate Change.
kWh	Kilowatt-hour – a measure of electrical energy equivalent to the power consumption of one kilowatt for one hour.
RED	Renewable Energy Directive – an EU regulation that set targets for renewable energy deployment in member states.
t, kt, Mt, Gt	Tonne, kilotonne, megatonne, gigatonne (1 Gt = 1,000 Mt = 1,000,000 kt = 1,000,000,000 t)

One of the many uncertainties facing the UK as we leave the EU is what system of carbon pricing ministers will implement post-Brexit. Staying in the EU emissions trading system has not entirely been ruled out, but may end up being unpalatable to the Government. If we choose to leave, what are the alternatives? One is an independent carbon tax.

In this report, Policy Exchange lay out a strategy for implementing such an independent UK carbon tax.

An economy-wide carbon tax is considered to be a key policy not only to help companies transition to a clean energy future, but also to ensure this transition is done in an efficient manner, therefore not unduly punishing taxpayers and consumers.

To ensure that we can raise our own carbon price without businesses offshoring their emissions, a system of border carbon adjustments would be created. Companies that wish to export electricity or carbon intensive goods into the UK should have to pay the same carbon tax that our domestic companies do in order to facilitate a level playing field. Similarly, UK companies exporting such goods to countries without a carbon tax would receive a rebate.

Finally, we recommend that the revenue of rising and expanding carbon taxation be directly returned to the voters to ensure that carbon taxation is fair and to lock in continued political support in the fight against climate change.

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