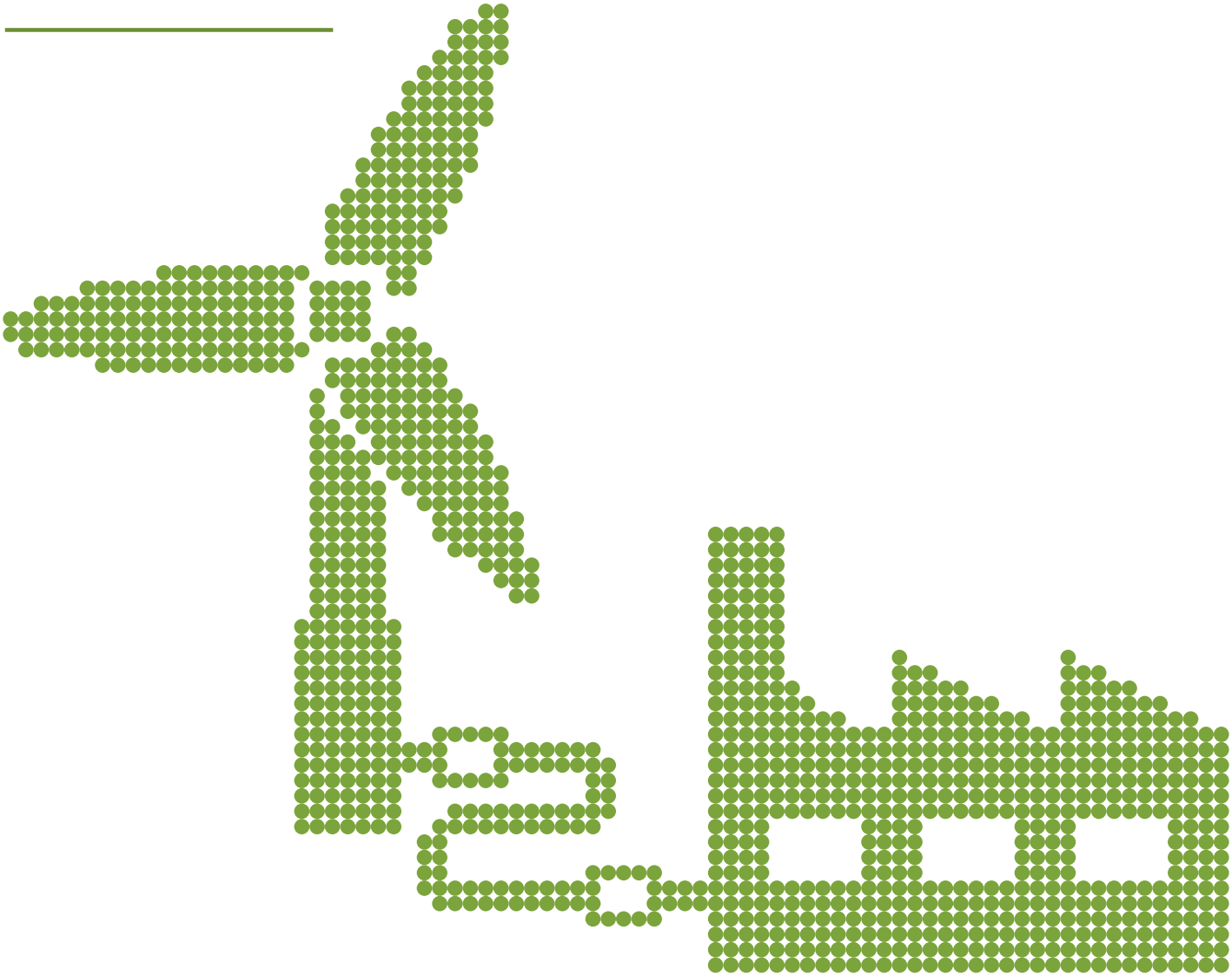
A zero-carbon power grid and the electrification of heavy industry: how to deliver on a twin challenge



ALDERSGATE GROUP
LEADERS FOR A SUSTAINABLE ECONOMY

UCL

Contents

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Aldersgate Group

The Aldersgate Group is a politically impartial, multi-stakeholder alliance championing a competitive and environmentally sustainable economy.

The Aldersgate Group is an alliance of major businesses, academic institutions, professional institutes, and civil society organisations driving action for a sustainable and competitive economy. Our corporate members, who have a collective turnover in excess of £600bn, believe that ambitious and stable low carbon and environmental policies make clear economic sense for the UK.

Our policy proposals are formed collaboratively and benefit from the expertise of our members who span a wide range of industry sectors and public interests. Our breadth and collegiate approach allows us to formulate progressive policy positions to benefit all organisations and individuals.

ORGANISATION MEMBERS

Recommendations made in this report cannot be attributed to any single organisation and the Aldersgate Group takes full responsibility for the views expressed.

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BRITISH STEEL

BOC

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CBRE

CELSA STEEL

CEMEX

CHEMICAL INDUSTRIES ASSOCIATION

CMS

COOP

CRODA INTERNATIONAL

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Summary for Policymakers

The energy crisis has many victims. Whilst the major political focus has, understandably, concerned the impact on households, many businesses, small and large, are also struggling with high energy bills. **Several industrial sectors that were already struggling to compete internationally due to high energy bills and labour costs, have seen electricity prices almost double since 2019.** This is happening at a time where there is growing urgency and business appetite to decarbonise heavy industry. Given the high capital cost of new low carbon production methods and the important role that electricity is likely to play in these, the current economic and policy context makes it particularly challenging for heavy industries to embark on such a transition.

The recently published Independent Review of Net zero, led by Chris Skidmore MP, identified **Energy Intensive Industries (EIIs) as facing uniquely difficult challenges to decarbonise, especially as they generally compete in international markets.** The review found that decarbonisation of EIIs and the subsequent **benefits will not be realised without competitive energy prices, measures to mitigate the risk of carbon leakage, and government financial support** for innovation and large-scale decarbonisation demonstrations.

This report offers fifteen recommendations for government; six to accelerate decarbonisation of the electricity sector; six to support electrification of industry as a means of decarbonisation; and three to enhance demand for low carbon products, as summarised in the table below. Through such actions, **government can create a long-term future for sustainable, internationally competitive industries,** thereby supporting thousands of jobs as well as manufacturing capabilities that are strategically important to the UK. This in turn can foster investor confidence in the UK's ability to capitalise on new industrial opportunities that will emerge during this transition.

This report comes at a time when **governments around the world are jockeying for position in the transition to Net zero.** The USA's recently announced Inflation Reduction Act (IRA) – partly prompted by the scale of Chinese investment in low carbon technologies – has triggered a frenzied response elsewhere, including fear of emerging industries relocating to the US. The EU's Green Deal Industrial Plan (GDIP) announced in February set out the Commission's response, loosening state aid rules to boost public investment, and streamlining planning and consent regulations. China, the US, and the EU all aim to reap the benefits of leading in the rapidly growing low carbon technology industries required for the transition. The IRA is seen by investors as both simple and generous. **To compete in an increasingly competitive global low carbon race, the UK needs to target sufficient support to EIIs that are most at risk.**

UK industry has long been calling for decisive government action on both power sector and heavy industrial decarbonisation, with a particular **focus on affordable and plentiful supplies of low carbon electricity** being available. Given the context above, this is now increasingly urgent. **The policy priorities set out in this report can help ensure the UK meets its goal of a fully decarbonised power grid by 2035, while also securing the future of existing heavy industry** and encourage the growth of new low carbon industries in the UK.

Table of Recommendations

1.	Accelerate reforms to the grid connection process to significantly cut connection waiting times and prioritise projects that are ready to deploy. As part of this, ensure industrial network connections/upgrades are included.
2.	Include a commitment in the promised action plan on accelerating network development to further develop the regulatory RIIO Framework to enhance anticipatory investment in network capacity.[1] .
3.	Treat construction of the necessary grid infrastructure as a national endeavour, requiring collaboration with supply chains to make best use of scarce resources.
4.	Streamline the planning process for low carbon and network infrastructure by installing a presumption in favour of net zero aligned projects, creating a priority fast-track for significant projects, and scaling up personnel at national and local level to manage the increased demand on these bodies.
5.	Extend the Contracts for Difference (CfD) scheme while developing it to support greater locational diversity (e.g., through some weighting / differentiation by zones) and exploring incremental reforms to improve operational signals.
6.	Continue to explore the REMA option of transitioning to a dual-market approach,[2] creating a Green Power Pool alongside the wholesale market to allow consumers to directly access reliable and increasingly cheap renewable electricity.
7.	A bold support fund for industrial decarbonisation is required to secure private co-investment in innovation and deployment of new low carbon production technologies at the scale required.
8.	We welcome the commitment from government to 'rebalance' electricity and gas prices, shifting policy costs currently levied on electricity bills to gas bills in order to incentivise investment in electrification. However, this change should be implemented as part of the broader policy framework that makes electrification more technologically and economically accessible to heavy industries, along with targeted, time-limited exemptions for industries without viable electrification options.
9.	Government should consider both expanding existing exemptions from policy and carbon costs across Energy Intensive Industries and introducing a new exemption for capacity market costs.
10.	Explore the possibility of facilitating industrial access to cheap, predictably priced low carbon electricity via Green Power Pool(s).
11.	Consider the case for targeting electricity from the currently limited volume of a CfD-derived renewables pool to include steel production, as an integral part of a transition support package.
12.	Explore options to enhance the PPA market, including mitigating the risk of off-taker payment default, for example by developing standardised, tradeable PPA contracts, or offering state guarantees.
13.	Set out plans for the introduction of mandatory product standards, in line with the recommendations from a recent report by Frontier Economics and the Aldersgate Group,[3] to enhance demand for low carbon products and ensure a level playing field.
14.	To support this, an ambitious Green Public Procurement Strategy would provide a strong market signal to industry and help kick-start the market for low carbon products.
15.	Review the UK Emissions Trading System so as to chart a path from the current structure of compensation and free allowances, towards a system compatible with the EU CBAM, and interactions with mandatory product standards.

1: RIIO: allowable Revenues to network companies related to Investment, Innovation and Outputs.

2: REMA refers to the Government's Review of Electricity Market Arrangements.

3: (Frontier, 2022)

Executive Summary

UK Industry currently emits about 60 $MtCO_2$/yr, c. – 15% of UK (territorial) emissions.[4] Other countries are already taking action to decarbonise their industry and moving to protect those industries from high-carbon competitors (e.g., via the EU's Carbon Border Adjustment Mechanism). **If the UK fails to move quickly on industrial decarbonisation, it will lose out on the opportunity to establish itself in a growing global market** for low carbon industrial products.

This report focuses on the role of electrification in decarbonising three key UK industrial sectors: steel, chemicals, and cement, all of which have cited electrification as one of the primary means to reducing their emissions. It draws on interviews with companies in each of these sectors, which are central to UK manufacturing capacity and account for the bulk of industrial emissions. Several other EIIs exist, such as glass, ceramics, and paper, and they face a range of decarbonisation and affordability challenges. While potential solutions for these sectors may include a degree of electrification, other measures, such as the transition of kilns from gas to hydrogen, will be necessary, all of which cannot be covered within the scope of this report.

The energy crisis has underscored the exposure of the electricity system to the volatility of fossil fuel prices, which itself is a deterrent to the strategic investments required. **Electricity is projected to account for over half of industrial energy demand by the late 2030s** (Figure 2, p.14) and for electrification to act as an effective decarbonisation pathway for industry, **the electricity system itself must be decarbonised.** We therefore begin by identifying key measures required for a fully decarbonised electricity system by 2035.

4: (BEIS, 2021a)

Context

The UK has to date performed well in decarbonising the electricity sector. Between 1990 and 2019, emissions from electricity fell 71%, and in just the last decade the share of coal in the power generation mix has plummeted from 28% to 2%, while renewables expanded from 7% to 37%. **But consumers are not feeling the cost benefit of this transition to increasingly cheap, reliably priced renewable electricity.** Industrial energy price pressures have been exacerbated by the energy price crisis and, in particular, the fact that **electricity prices remain driven by the cost of gas, which in 2021 set the price of electricity 98% of the time** despite being only 40% of generation.

To deliver a decarbonised power system by 2035, **the UK needs to install on the order of 200GW of low carbon generation and storage infrastructure in the next 12 years.**[5] That level of deployment is unprecedented; decisive government policy is needed to further accelerate investment in generation, networks and storage, and to incentivise industrial electrification by the government's target date of 2035. Below, we set out the top priority policies areas that government should be focusing on to achieve these aims.

A. Policy Priorities for a Decarbonised Power System by 2035

Infrastructure: Electricity networks and connection

Major and rapid network investment will be needed to accommodate this dramatic increase in generation capacity and to deal with sizeable net power flows across the country due to the location of variable renewables such as onshore and offshore wind. The increased delivery rate for this infrastructure is many times the recent trend and ramping up will severely test the global supply chain. **This is a challenge but also an opportunity for greater local content, which will require a national endeavour,[6] with industry and government working collaboratively to make the best use of scarce resources.** The recent Ofgem decision to introduce a new Accelerated Strategic Transmission Investment (ASTI) framework is a positive development on this issue.[7]

5: (National Grid ESO, 2022a)

Recommendations:

1 **Accelerate reforms to the grid connection process to significantly cut connection waiting times and prioritise projects that are ready to deploy. As part of this, ensure industrial network connections/upgrades are included.**

2 **Include a commitment in the promised action plan on accelerating network development to further develop the regulatory RIIO Framework to enhance anticipatory investment in network capacity[8].**

3 **Treat construction of the necessary grid infrastructure as a national endeavour, requiring collaboration with supply chains to make best use of scarce resources.**

6: (Shinde and Knight, 2022)

7: (Ofgem, 2022)

8: RIIO: allowable Revenues to network companies related to Investment, Innovation and Outputs.

Planning regime

Planning applications play a key role in the development timeline of low carbon infrastructure required for a decarbonised power system (both grid infrastructure and renewable power generation projects). Developers – of both grid infrastructure and low carbon generation projects – have for several years been complaining that a **complex, bureaucratic, and under-resourced system can result in applications taking up to ten years.** In December 2022, the government published a consultation on the relaxation of onshore wind planning regulations which proposes to remove National Planning Policy Framework wording that allows one local objection to derail a project. This is a welcome move, overturning the effective ban on new onshore wind projects in England and Wales, but **further planning reform is required to achieve the infrastructure deployment rate required for a decarbonised system by 2035 while creating benefits for local communities.**

4 Streamline the planning process for low carbon and network infrastructure by installing a presumption in favour of net zero aligned projects, creating a priority fast-track for significant projects, and scaling up personnel at national and local level to manage the increased demand on these bodies.

Accelerating low carbon investment whilst enhancing locational diversity and efficient asset operation

The rapid **growth and cost reduction of low carbon generation since the mid-2010s has been principally due to government underwriting** (for new renewables investment) the risk of wholesale market price uncertainties, through contracts-for-difference (CfDs). This remains an important principle for accelerating investment further, but **contract and auction designs may need development to support diversity in location and efficient operation.** In addition, private sector **Power Purchase Agreements (PPAs) provide a complementary route and may be well suited to some smaller-scale renewables investment,** especially as other obstacles are removed. However, while private PPAs may have an increasingly valuable role to play in the coming years, there is no evidence that the pace of low carbon generation deployment required can be delivered solely through private PPAs (between 2019 and 2021, only 1.3GW of subsidy-free PPA capacity was signed in the GB market).[9]

In November 2022, we published a working paper that develops specific options for the design and implementation of a Green Power Pool (GPP) in Great Britain.[10] Set out in detail in Annex D, a GPP could potentially address some suggested guiding principles for market reform, whilst preserving security of supply and enhancing conditions for low carbon investment and efficient operation of an expanding electricity system.

Creating a GPP alongside the wholesale market would allow consumers to access the real cost of cheap renewable power, reducing the exposure of the taxpayer to supporting energy bills in future energy crises (the cost of energy bill support in the recent crisis is estimated at £50bn).[11] Furthermore, over time, this could create a market based on long-run marginal cost – presenting a more investible proposition for developers than the current wholesale market, and opening the possibility to move away from government-backed contracts in the long-run – and would reveal the true backup and balancing costs of variable renewables.

5 Extend the Contracts for Difference (CfD) scheme while developing it to support greater locational diversity (e.g., through some weighting / differentiation by zones) and exploring incremental reforms to improve operational signals.

6 Continue to explore the REMa option of transitioning to a dual-market approach,[12] creating a Green Power Pool alongside the wholesale market to allow consumers to directly access reliable and increasingly cheap renewable electricity.

9: (Cornwall Insight, 2021)

10: (Grubb et al., 2022)

11: (Commons Library, 2023)

12: REMA refers to the Government's Review of Electricity Market Arrangements.

B. Policy Priorities for Industrial Electrification

Investment support for industrial decarbonisation

We welcome the recent decision from government to extend the Industrial Energy Transformation Fund (IETF) by £185m from 2024, however, beyond this commitment, there is currently no additional UK government funding available to support industrial electrification and **no further clarity on the £600m funding proposed for the conversion of blast furnaces to electric arc technology.** Meanwhile, other countries have announced big public contributions to secure the opportunities of industrial decarbonisation and the broader transition. **The US IRA committed $370 billion,** Germany has proposed a $190 billion fund and France has committed $32 billion.[13]

Given the significant capital costs associated with electrification, the present cost and volatility of energy, and the competitive pressures industrial companies are currently facing in both existing markets and from these programmes abroad, **public funding is needed to retain industry,** whilst supporting its decarbonisation via electrification.

Recommendations:

7 A bold support fund for industrial decarbonisation is required to secure private co-investment in innovation and the deployment of new low carbon production technologies at the scale required.

Ensuring competitive electricity prices for electrified industry

In addition to support with capital costs as mentioned above, **industrial companies will need some form of assurance that they will pay a competitive price for electricity** in future before they invest significant capital in electrification.

13: (Reuters, 2022)(US Gov, 2022) (Reuters, 2022) (French Gov, 2020)on 3 September 2020 the French government set out its "France Relance" recovery plan.

Government has recently committed to 'rebalancing' electricity and gas prices following recommendations made in Chris Skidmore MP's *Mission Zero* report, and is expected to outline its approach by the end of 2023/4 and make significant progress affecting relative prices by the end of 2024. The disparity between the cost of fuels is one of the biggest barriers to the decarbonisation of industry, and does not reflect the extent to which electricity generation has decarbonised in the last decade. As things stand, around 12% of electricity bills are made up of 'environmental and social levies', compared to just 3.4% of gas bills.[14] 'Rebalancing' these policy costs would significantly reduce the cost of electrification for domestic and industrial consumers. As such, this is a positive move helping shift incentives in favour of electrification although it will need to be executed with care to anticipate and address any unintended consequences for those industries that current rely heavily on gas and where the switch to electricity is either currently not possible or may only become possible over a transition period (e.g. ceramics).

There are a number of options for moving policy costs from electricity to gas bills. Foremost is directly moving some of the levies onto gas bills, leaving overall dual fuel bills unchanged. This could include the Renewables Obligation, an environmental levy introduced to support early renewables projects when costs were higher than they are now. This could be accompanied by moving the Feed-In Tariff to gas bills. Such a move would send a strong message to investors that electrification is the direction of travel.

However, we caution that **such a move would create additional cost for industries, such as ceramics, glass and cement, whose processes cannot be currently or quickly electrified (and will therefore need support to transition to non-fossil gases and appropriate exemptions until options to decarbonise are available).** Furthermore, for other industries where electrification is the lead option, rebalancing electricity costs must come as part of a broader policy framework to make electrification more technologically and economically accessible to industry. Without a comprehensive approach which both rebalances cost and makes electrification genuinely feasible, rebalancing prices by itself will simply add further cost to fossil-based UK industry that lacks the ability to electrify.

The largest component of environmental levies concerns the cost of legacy Renewables Obligation certificates, which were signed for 20 years. To the extent that these generators could be persuaded to move to CfD-like contracts instead, with the benefit of more secure future prices, this could reduce the levy costs for all.

Recommendations:

8 **We welcome the commitment from government to 'rebalance' electricity and gas prices, shifting policy costs currently levied on electricity bills to gas bills in order to incentivise investment in electrification. However, this change should be implemented as part of the broader policy framework that makes electrification more technologically and economically accessible to heavy industries, along with targeted, time-limited exemptions for industries without viable electrification options.**

Government already provides support to industry with electricity prices by offering exemptions from a range of costs, such as policy costs (i.e., renewables support) and carbon costs (i.e., ETS exemptions). However, these **exemptions are applied unevenly across industries and there are opportunities to offer further relief** to industries under unprecedented energy price and competitiveness pressures.

Recommendations:

9 **Government should consider both expanding existing exemptions from policy and carbon costs across Energy Intensive Industries and introducing a new exemption for capacity market costs.**

In previous papers, we have set out our proposal to reform the GB electricity market to create one or more 'Green Power Pools' (GPP) alongside the wholesale market.[15] **This would allow vulnerable household and business consumers to access electricity at prices reflecting the actual cost of renewable power,** which is cheaper when based on long-term contracts. Where government underwrites these contracts, government has the potential to target this cheap power to priority beneficiaries.

Recommendations:

10 **Explore the possibility of facilitating industrial access to cheap, predictably priced low carbon electricity via Green Power Pool(s).**

Not all industries are the same. **The strategically important steel sector is the biggest emitter and faces the most immediate threat to international competitiveness.** We identify four reasons for steel production to be a priority beneficiary from a GPP based on the existing pool of CfD-backed electricity generation: strategic economic and environmental importance, combined with imminent risk of closure and large-scale job losses; its inability to strike direct long-term contracts with low carbon generators (i.e., via PPAs), given these uncertainties; the flexibility of electric arc production to respond efficiently to varying renewables outputs; and proximity (at least of the current blast furnaces) to existing or potential offshore renewables generation.

The most obvious priority for its decarbonisation is to convert one or both of the UK's blast furnace sites to electricity-based production (largely utilising scrap which is currently exported for processing). The government has reportedly offered £600m to the UK's two blast furnace sites to convert, but the risk facing the (much larger) industry co-investment required remains high if future electricity prices for steel remain uncertain and uncompetitive.

Recommendations:

11 **Consider the case for targeting electricity from the currently limited volume of a CfD-derived renewables pool to include steel production, as an integral part of a transition support package.**

This could also create a foundational framework that could naturally be extended to other industrial off-takers as the size of CfD-based electricity grows.

14: Source *Ofgem*

15: (Grubb et al., 2022)

Channelling CfD-backed electricity to priority beneficiaries can immediately address electricity prices, but not all industries will be covered. Government should, therefore, also be looking to strengthen the PPA market, to create an additional option for wider industry (and others) to directly access renewable electricity. In return, this would strengthen the non-CfD route to market for renewables, creating options for both new investment and renewables approaching the end of CfD or Renewables Obligation contracts. To do this, government should:

Recommendations:

12 **Explore options to enhance the PPA market, including mitigating the risk of off-taker payment default, for example by developing standardised, tradeable PPA contracts, or offering state guarantees.**

This would create multiple channels through which different sectors, with different characteristics, can access existing renewable energy on improved terms, and potentially co-invest in additional renewables generation (Figure 1).

Ensuring domestic and international competitiveness of UK low carbon EIIs

Demand-side policies are of equal importance to supply-side policies for industrial electrification and decarbonisation. **To justify the significant investments needed to retrofit and build new infrastructure, industry needs confidence that there will be a market for low carbon products.** Government must also mitigate the risk of carbon leakage by ensuring low carbon EIIs do not face unfair competition from higher-carbon products from abroad, including those for which little or no carbon price has been paid.

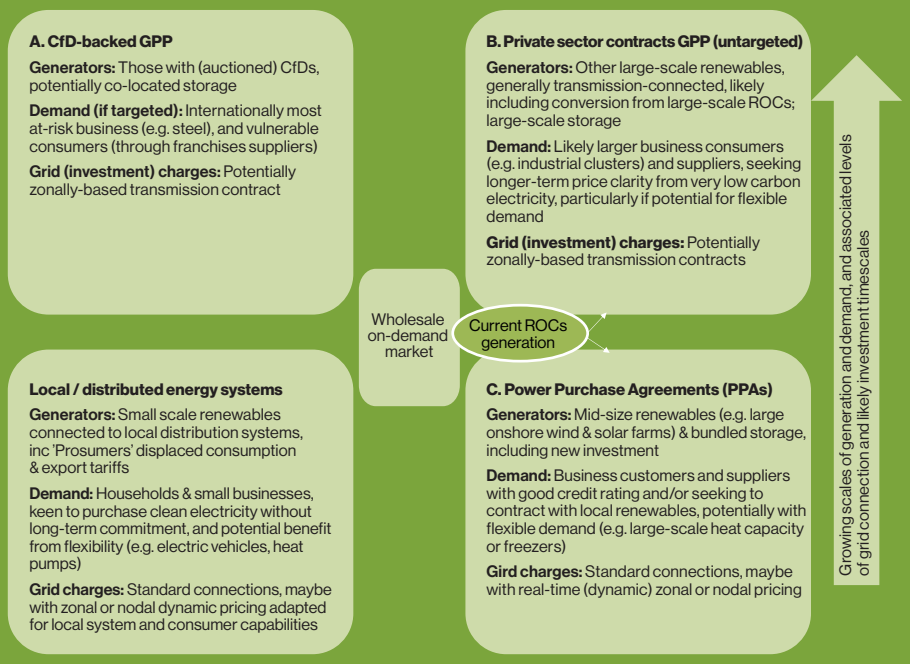
Recommendations:

13 **Set out plans for the introduction of mandatory product standards, in line with the recommendations from a recent report by Frontier Economics and the Aldersgate Group,[16] to enhance demand for low carbon products and ensure a level playing field.**

14 **To support this, an ambitious Green Public Procurement Strategy would provide a strong market signal to industry and help kick-start the market for low carbon products. The UK government spent £292bn on public procurement in 2018/19, with a large share on industrial products in the construction and defence sectors – such a significant purchasing power should be harnessed.**

15 **Review the UK Emissions Trading System so as to chart a path from the current structure of compensation and free allowances, towards a system compatible with the EU CBAM, and interactions with mandatory product standards.**

Figure 1: Potential future configurations for GB electricity market



Note: *our research did not consider in detail transmission and distribution charges, or the options for dynamic pricing at nodes or zones of the system. Indications on grid charges are therefore preliminary suggestions.*

Report Structure

The report is structured as follows:

– A one-page summary for policymakers;

– An eight-page executive summary;

The main body of the report, which is broadly split into two halves – electricity system decarbonisation, and industrial electrification;

The report also has four appendices in a separate document as follows:

– Appendix A, which summarises existing policies to support investment in industrial electrification;

– Appendix B, which summarises existing policy proposals in the literature to encourage industrial decarbonisation;

– Appendix C, which summarises current policies for alleviating industrial electricity prices

– Appendix D: A 'Green Power Pool' options for design and implementation

16: (Frontier, 2022)

1. Introduction

1.1 Industrial Decarbonisation

The need to decarbonise industry

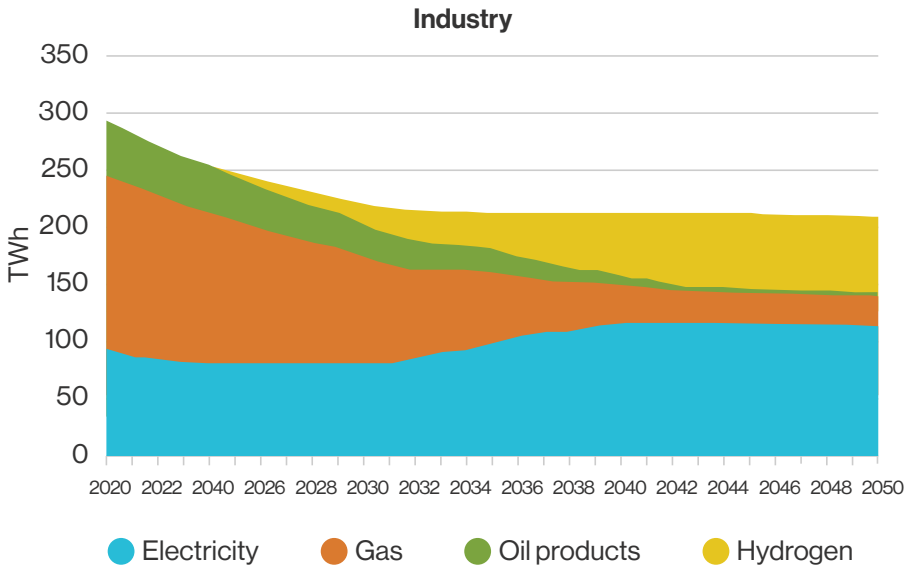
The UK has ambitious targets to decarbonise its economy in line with its legal obligation under the UK Climate Change Act and The Paris Agreement. These include a headline ambition to reach net zero economy-wide emissions by 2050, with interim targets to reduce emissions by 68% and 78% by 2030 and 2035 respectively, relative to 1990 levels.

Good progress has been made towards these targets, with UK emissions down 44% since 1990. But much of this has come from low-hanging fruit, such as energy efficiency gains and phasing out coal in the electricity mix. To maintain progress towards its climate targets, the UK will need to accelerate the decarbonisation of other sectors such as transport, buildings and industry.

In short, decarbonisation of all sectors of the economy is necessary. Under-delivery in one area would require over-delivery elsewhere to reach net zero. 'Negative emission' technologies are, as yet, unavailable at scale both technically and economically, and face obvious constraints. Ultimately there is no hiding place – all sectors must decarbonise.

Emissions from the UK's industrial sector totalled 60.4 MtCO2e in 2020, equal to roughly 15% of overall emissions that year; substantial industrial decarbonisation is an essential part of meeting the Sixth Carbon Budget (2033–37).[17] An additional incentive comes from the fact that other countries are already taking action to decarbonise their industry and moving to protect those industries from high-carbon competitors (i.e., via the EU's CBAM). If the UK fails to move quickly on industrial decarbonisation, it will lose out on the opportunity to establish itself in a growing market for low-carbon industrial products. Inaction could also see the closure of existing UK industry as companies find themselves unable to compete without innovation, especially in a market that increasingly values lower-carbon products.

Figure 2: Projected final energy demand by product for the manufacturing and construction sector under the 'Balanced Net Zero Pathway' produced by the CCC – energy use only



Source: *The Sixth Carbon Budget: The UK's Path to Net zero.*[18]
Note: *The vast majority of energy consumption is in the manufacturing sector, but remaining oil products are predominantly in the construction sector.*

Implications of industrial decarbonisation

Analysis from the Climate Change Committee (CCC) indicates that a balanced pathway to industrial decarbonisation will see overall energy use in industry (manufacturing and construction) fall due to improved overall efficiency (Figure 2). However, electricity consumption rises from 2030 while unabated fossil fuel use is largely phased out by 2050, with remaining fossil fuel consumption mostly coupled with carbon capture and storage (CCS). Low carbon hydrogen grows from the mid-2020s for use in sectors where it is difficult to fully electrify.

While hydrogen and CCS offer promising routes to decarbonise certain industrial processes, this report focuses on the role of electrification mainly due to the fact that electricity is projected to account for over half of industrial energy demand by the late 2030s (Figure 2).

17: (BEIS, 2021a)

18: (Committee on Climate Change, 2020a)

1.2 Energy Price Pressures

Pre-crisis energy price pressures on UK industry

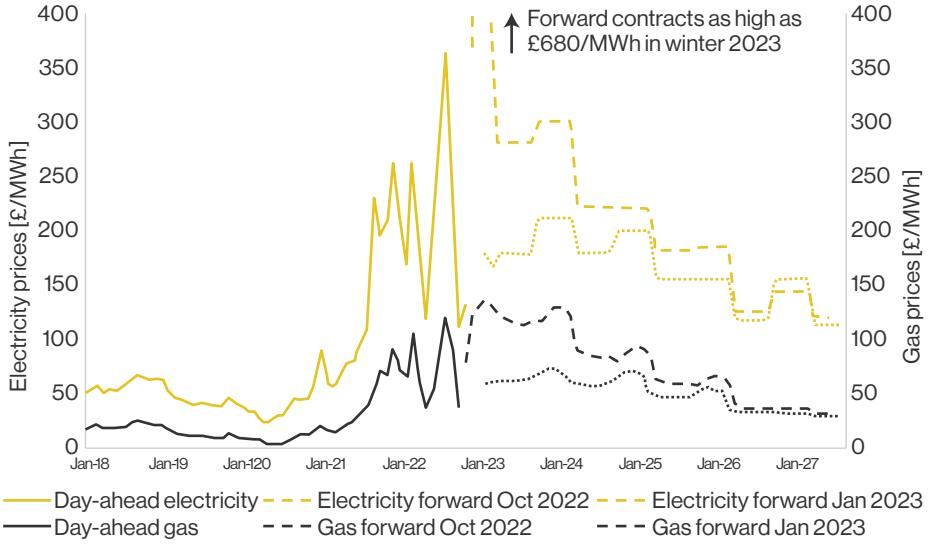
Previous reports for the Aldersgate Group explored, in depth, the level and drivers of UK industrial electricity prices before the energy crisis, finding that in 2019 GB prices were indeed higher than the European average, and specifically, much higher than in France and somewhat higher than in Germany, though generally below Italian prices.

Most of the variation was attributable to energy and supply costs, and taxes and levies (France being significantly lower in both). Variations in network costs paid by industry were relatively modest in comparison, though in the UK and Germany they still amounted to about €20/MWh, averaged across all industry, and varying considerably according to the scale and level of connection.[19] Policy costs in the UK amounted to around £25/MWh prior to compensation, and varied widely across EU countries (in part due to accounting differences).

Intensified energy price pressures due to the global energy crisis

Industrial energy price pressures have since been exacerbated by the energy price crisis and, in particular, the fact that electricity prices remain driven by the cost of gas, which in 2021 set the price of electricity 98% of the time despite being only 40% of generation. During 2023 it will become apparent that electricity also reflects the cost of forward contracts for next winter and beyond, that generators have had to sign at high prices to secure future generation, given the uncertainties and instabilities in gas markets.

Figure 3: Electricity and gas wholesale price trends in Great Britain



Sources: *Ofgem (historical: https://www.ofgem.gov.uk/energy-data-and-research/data-portal/wholesale-market-indicators, and BW (forward prices: https://www.businesswisesolutions.co.uk/energy-market-snapshot, accessed in 27 Oct 2022 and 9 Jan 2023)*

To respond to the energy crisis, governments across the continent have introduced a range of emergency measures to tackle this crisis. Strong measures have helped to cut gas demand across Europe – including sometimes by reduced industrial output – and huge sums have been spent over the summer to fill continental gas storage and procure floating platforms to convert Liquefied Natural Gas for storage. Combined with a generally mild winter across Europe, at the time of writing these measures have led to a rapid fall in the near-term wholesale gas prices.

However, even with this, European consumers are still facing retail prices far higher than just two years ago. The future of gas prices remains deeply uncertain, and forward gas contracts – companies buying ahead to ensure they can supply – remain at well over double pre-COVID levels (Figure 3, yellow lines).[20]

This is a challenge not only for domestic consumers and small businesses, but for some of our major industries. Moreover, whereas governments could previously moderate the challenges for internationally exposed industries by exempting (or reimbursing) them for some of the system charges, that is far more contentious when it comes to 'protection' against the wholesale cost of electricity itself. This could plausibly be seen as a subsidy, with potential for retaliatory trade measures by other countries under the World Trade Organisation agreement on Subsidies and Countervailing Measures.[21]

19: (Drummond et al., 2021). Overall bulk transmission costs were around €10/MWh across all the countries, with regional and local distribution adding another €20–30/MWh. The UK lagged slightly in overall network costs due to lower historical investment, offset by a larger proportion being paid by industry relative to domestic consumers. Also, the distribution of network costs between more and less electro-intensive sectors differed, reflecting in part the balance of transmission and different levels of distribution connection; network charges varied from about £10/MWh for the largest, to almost £40/MWh for small businesses. The UK approach is changing in 2023 as the system moves away from 'Triad' charges, as discussed in section 3.1.2.

20: UK Forward electricity contracts reported at the end of January 2023 for delivery in winter 2024 remained above £200 / MWh, and prices for summer 2025 remained in the range £150-200/MWh (Gordon, 2023). Pre-COVID, wholesale prices were around £50/MWh.

21: (Grubb et al., 2022)

1.3 Power Sector Decarbonisation

Electrification certainly offers promise for industrial decarbonisation, but it will only provide a credible pathway to low carbon industry if the power sector itself is decarbonised on time.

The government's headline target for the electricity sector is to reach a decarbonised system by 2035.[22] Technology-level targets exist in support of this and include a four-fold increase in offshore wind capacity by 2030, a five-fold increase in solar capacity by 2035 and a four-fold increase in nuclear capacity by 2050.[23] These targets are broadly supported by industry and experts, and are seen as compatible with the government's overarching climate goals.

The UK has performed well in decarbonising the electricity sector. Between 1990 and 2019, emissions from electricity fell 71%, and in just the last decade the share of coal in the mix has plummeted from 28% to 2% while renewables expanded from 7% to 37% of generation (about 25% being from wind and solar, the remainder mainly biomass and some hydro). This world-leading performance has been driven by a strong policy and regulatory environment, which consists of ambitious targets and an effective incentive framework.

However, the scale of the challenge to 2035 is far beyond what has been achieved so far. For example, it has taken the UK 20 years to deploy 12GW of offshore wind capacity (surpassed only by China), but it must now deploy 38GW in just 8 years to meet the 2030 target mentioned above, and more still to support a decarbonised power system by 2035. Added to that, two new technologies – CCS and low carbon hydrogen – will have to be proven at commercial scale and then rapidly deployed to replace unabated gas as the backup to variable renewable power. New grid infrastructure will also be needed to transport this additional power around the country, and flexible technologies must be scaled to manage the variability of wind and solar.

Section 2 goes into more detail on the requirements of a decarbonised power system by 2035 and the barriers that developers are currently facing. Government action to remove these barriers to power sector decarbonisation will ultimately be crucial to industrial decarbonisation via electrification. Interestingly, industrial electrification can also aid power sector decarbonisation by creating flexible demand that can respond to supply-side signals. This co-dependency is a reminder of the cross-sectoral nature of Net zero and the need for different sectors to coordinate action to ensure an orderly and timely transition.

22: Subject to security of supply. See also introduction to Section 3 for the wider political context..

23: (BEIS, 2022a)

2. A Decarbonised Electricity System by 2035

Background

It was in October 2021, in the run-up to COP26 in Glasgow, that the UK government announced its target to decarbonise the power system by 2035. The Labour Party has recently gone further, announcing that they would bring this target forward to 2030 if they were to win the next general election. In reality, the two parties are quite closely aligned on this issue, as the government stated in its 2022 British Energy Security Strategy that 95% of British electricity could be low carbon by 2030.

As of 2021, low carbon technologies (including nuclear and renewables) accounted for 54% of total electricity. This section will explore what is needed to decarbonise the remaining 46% of electricity supply by 2035 and the challenges the sector faces in achieving that goal.

2.1 The requirements of a decarbonised power system by 2035

The ambition to deliver a decarbonised power system by 2035 is more stretching than one might think, given the progress to date. Emissions from the GB electricity system may well have been slashed by over 70%, but removing the remaining emissions from the system in the next 12 years is a much more challenging feat.

There are two key reasons for this. Firstly, electricity demand and supply is forecast to increase substantially as end-use sectors such as transport, heating, and industry electrify. That in turn requires wind and solar generation to increase almost four-fold by 2035 to ensure this increased demand can be met by decarbonised power.

Second, the variability of intermittent renewables has always meant that the final 10-20% of power sector decarbonisation would be the hardest. This is because a decarbonised power system can no longer rely on unabated gas to balance the grid and meet demand in periods of low solar and wind output. Instead, low carbon, and as yet unproven at scale, dispatchable technologies such as gas with carbon capture and storage (CCS) and hydrogen will be needed. A much more flexible system, including significant scale up of both long- and short-duration storage, will also be required in order to moderate the variability of wind and solar power, and efficiently transport this power around the country.

Table 1 below gives an idea of the infrastructure deployment that will be required between now and 2035 to deliver a decarbonised power system. It is based on the 'Leading the Way' scenario from National Grid ESO's Future Energy Scenarios 2022, and suggests that something on the order of 200GW of generation and flexibility infrastructure will need to be deployed in the next 12 years to deliver a decarbonised power system.

Table 1: Low carbon generation and flexibility capacity required by 2035

Technology	Current Capacity (GW)	2035 Capacity (GW)	Buildout Required (GW)
Offshore Wind	13.1	78.9	**65.8**
Onshore Wind	13.3	35.8	**22.5**
Solar	13.2	60.2	**57**
Gas with CCS	0	3.3	**3.3**
BECCS	0	2.2	**2.2**
Hydrogen	0	7.6	**7.6**
Interconnectors	6.1	24.6	**18.5**
Storage (excl. V2G & hydrogen)	4	37.3	**33.3**
Total	**50**	**249.9**	**199.9**

Source: *National Grid ESO, Future Energy Scenarios 2022 – Leading the Way Scenario*[24]

24: (National Grid ESO, 2022a)

The transition to a decarbonised power system by 2035 can therefore be viewed primarily as an infrastructure challenge. The UK must deliver a rapid, coordinated deployment of infrastructure at a scale unprecedented in history. To enable this, government will have to work with industry to overcome several barriers which currently stand in the way of deployment at the pace required.

2.2 Barriers to delivery

2.2.1 Grid Infrastructure

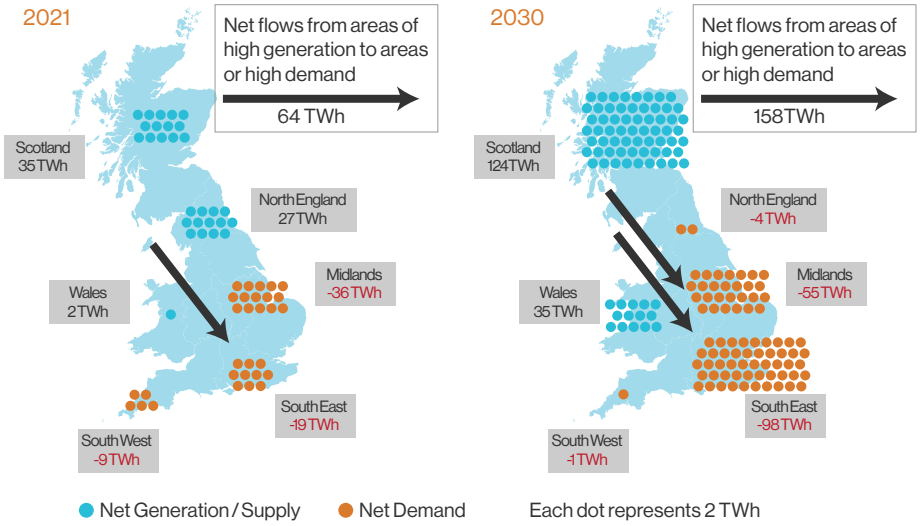
Background

The UK transmission network was developed over the past century to funnel power from a limited number of large power stations, mostly located near the coast or coal mines, one-way to the major centres of demand. The transition requires both growth and change in the nature of transmission, to accommodate a more spatially diverse renewable system mostly further from urban areas and industrial sites, and to deal with fluctuating electricity output at many different levels of the system.

The weather dependent nature of wind and solar, and constraints on land, means that capacity deployment is concentrated where conditions are more favourable. Onshore wind would be predominantly located in Scotland and offshore wind in the North Sea and Irish Sea with connections to Scotland, Northern England, the Midlands, and Wales (Figure 4). As might be expected, solar PV growth is concentrated in central and southern areas.[25]

As Figure 4 demonstrates, we currently already see sizable net power flows from the North of GB to the South, mainly a result of the relatively high wind capacities in the North, and North Sea, compared to demand which is concentrated more in the Midlands and South. Overall, National Grid foresees almost a tripling of average north-south power flows. In addition, the network will have to contend with two-way power flows – for example,

Figure 4: Average GB electricity system network flows over the year today (left) and in 2030 (right).



Source: *Future Energy Scenarios 2022*[26]

from the South West to the East and North at times of summer PV surplus, a pattern that will reverse in the dark winter months when this region will need sizeable imports.

The future GB network will have to handle large amounts of variability across time – from day-to-day through to season-to-season – and space. Indeed, with the expected rapid growth in demand for electrified heat in buildings, it is very likely we will see substantial weather driven variability on the supply and demand side contemporaneously.

Issues

The transfer capacity of the links between Scotland and England, which today are just over 6 GW, are one of the most prominent network bottlenecks across the system. National Grid ESO's Electricity Ten Year Statement 2021[27] sees their capacity doubling by 2030 and potentially more – given that 10% of annual power flows across the boundary could exceed 20GW, in an unconstrained case. Another important network constraint is around East Anglia, given current and planned offshore wind connections, the potential for Sizewell C and a new interconnector project. This is likely to lead to the need to reinforce this boundary from 3.5 GW today to over 15GW in 2030. National Grid ESO's Holistic Network Design and Ofgem's Accelerated Strategic Transmission Investment (ASTI) have made important steps forward in this area.[28,29]

The rapid growth in the UK's interconnector capacity to 2030 will also have impacts on the network by further connecting to European markets and helping to spatially diversify the supply of electricity from renewables, i.e., leveraging the fact that different locations can experience different weather at the same time.[30]

Another key issue developers are currently facing is the time it takes to connect to the electricity network, with developers recently warning that delays of up to 13 years to connect to the system are threatening investment in renewables and flexible assets. According to National Grid, there is 176GW of capacity in the pipeline for a network connection in England and Wales – whilst not all this capacity is expected to be built, and not all of it is low carbon, tackling this backlog could help

25: Figure 4 is potentially misleading in one sense, in that power flows between regions will vary strongly over time. For example, the apparent average self-sufficiency of the south-west region (net annual flow with rest of country only 1GW) by 2030 masks the fact that it is a good region for solar PV: on bright summer days it would be exporting many GW of power but would have to import power at night – and more generally, during dark winter months.

26: (National Grid ESO, 2022a)

27: (National Grid ESO, 2021)

28: (National Grid ESO, 2022b)

29: (Ofgem, 2022)

30: The treatment of emissions from imported electricity will be increasingly important as the GB electricity system approaches zero-carbon. The UK is likely to become a net exporter in future, primarily due to the rollout of offshore wind, but will still at times rely on imported electricity from neighbours with a potentially higher-carbon electricity mix. Clarity is needed on whether the UK should offset emissions associated with such imports to credibly claim a decarbonised power mix.

to meet the capacity gap set out in Table 1, and should be addressed as a matter of high priority.[31]

Under current processes, network operators are required to assess customers' applications for 'Transmission Entry Capacity' (TEC) to connect on a 'first come, first serve' basis. This, coupled with low barriers to entry, has meant that many developers secure their space in the connections pipeline, often regardless of the maturity of their proposed projects. Customers rarely remove themselves, even if they are stalled, meaning projects that are ready to connect sooner can be blocked by other projects that are not ready or able to proceed.

The ESO, working with TOs, is leading a number of reforms to the connections process. For example, supporting a TEC amnesty which will allow stalled projects the ability to voluntarily give up their space, at little or no cost. Reforms also include developing a plan for better queue management, which will introduce milestones for projects to hit on their journey to connection, as well as updating key modelling assumptions, which could also unlock capacity and enable some customers to connect sooner.

The regulatory regime – where currently, network providers must focus on minimising costs and are forbidden from undertaking anticipatory investment – is highlighted as the main issue, with grid capacity in certain regions also highlighted as barriers.

The rapidly changing demands on the GB electricity network has prompted debate around the need to introduce locational pricing as a means of ensuring efficient network usage and investment. But most energy intensive industries have very little scope to move production facilities around the country. Towns and cities by their nature will not move. There is some flexibility in where to locate new renewables, though this is also constrained by the economics of resource and land availability, as well as planning constraints and Crown Estate leasing.

Overall, the capacity for investment (in either demand or major low carbon supply) to move within the UK in response to locational signals seems quite limited, though incentives for more efficient location of renewables could clearly be improved with the use of long-term transmission contracts, as proposed by Newbery.[32]

Recommendations

The changing demands on the national transmission system points to the need for major new investment. National Grid described this as delivering 5 times as much in the next 7 years as in the last 40.[33] Ultimately, National Grid is responsible for investment in the UK's transmission infrastructure. But as a regulated monopoly, National Grid can only invest and manage transmission infrastructure in line with Ofgem's allowances. Therefore, the way that Ofgem regulates National Grid (as well as other network operators) must ensure that they are able to make necessary anticipatory investments in both grid upgrades and personnel required to meet the increased demand on the system from low carbon developers. The announcement in November 2022 of the ASTI projects is a welcome start but needs to be followed with further projects and a more collaborative approach to the supply chain.

The regulator should also work with the networks to deliver more effective queue management rules based around those proposed by National Grid ESO. These include requiring developers to meet key milestones during their connection journey, such as obtaining land rights and planning permission, as well as reaching final investment decision, otherwise they will have to make way for projects further down the queue that are ready to deploy. It would also be important to maintain an effective priority fast-track for nationally significant projects, such as the NSIP regime, to avoid bottlenecks.

Construction of the necessary infrastructure requires a significant step change compared to recent rates and will test the global supply chain's ability to ramp up. The UK is not alone in requiring additional electricity network infrastructure and extended lead times for critical equipment are already reported. Global capacity will focus on countries where it is easier to do business. Factory capacity can adjust over time, but skilled resources will take longer. Procurement patterns will need to change to make better use of key resources, with greater standardisation, less transactional project by project procurement and greater collaboration across the whole industry. Government and Ofgem need to be part of this process. Ofgem needs to relax competitive procurement rules on TOs.

It was positive to see the UK sign a Memorandum of Understanding with the North Seas Energy Cooperation group in December 2022. The North Sea will become an increasingly important northern European energy hub with the expansion of offshore wind, CCS, and hydrogen. The UK will therefore need to play an active role in this group, moving towards a North Sea grid and associated contractual arrangements, if it is to minimise the cost and reap the full benefits of rapid expansion of offshore wind energy.

Comprehensive whole-system modelling of the impact of locational pricing on system operation (including the financial impact on different actors i.e., industry, consumers), grid infrastructure, and low carbon power investment is needed before a decision can be made on its suitability – this is a reform that should not be rushed.

Summary:

1 **Accelerate reforms to the grid connection process to significantly cut connection waiting times and prioritise projects that are ready to deploy. As part of this, ensure industrial network connections/upgrades are included.**

2 **Include a commitment in the promised action plan on accelerating network development to further develop the regulatory RIIO Framework to enhance anticipatory investment in network capacity.[34]**

31: (FT, 2023a). For information on the TEC Amnesty see https://www.nationalgrideso.com/industry-information/connections/tec-amnesty

32: The annual averages then determine the long-term contract price, to be fixed on entry for a reasonable period (e.g. 15–25 years). The contract could be either firm (with compensation for non-availability of the network) or non-firm (but with a guaranteed minimum level of availability). The right of delivery at that node would be transferable directly for the same technology, but with side payments to the TSO for different technologies. At present most transmission charges are set annually adding unnecessary risk, given that generators cannot relocate if charges change and TSOs receive risk-free regulated revenue. This long-term transmission contract has the advantage that future zonal contracts can be re-estimated in the light of future scenarios without having to worry about thwarting past expectations that guided now irreversible entry decisions." (Newbery, 2021)

33: (Johnson, 2023)

34: RIIO: allowable Revenues to network companies related to Investment, Innovation and Outputs.

3 **Treat construction of the necessary grid infrastructure as a national endeavour, requiring collaboration with supply chains to make best use of scarce resources.**

2.2.2 Planning Regime

Background

In the UK, as in most countries, planning permission is required before a developer can begin physical construction of a project. In England and Wales, smaller projects (<50MW) are covered by the Town and Country Planning Act 1990, while larger projects and electricity network projects are covered by the Planning Act 2008 and the Electricity Act 1989. Planning is covered by a different regime in Scotland due to devolved powers – the Scottish Parliament recently approved and adopted a significant update to its National Planning Framework, which is designed to enable more renewable energy generation and support other low carbon technologies.

The planning system is important in determining that a development occurs in the right place, at the right time, and benefits communities and the broader economy while protecting the nation's heritage and natural environment. Developers must undertake a series of environmental assessments as part of the planning application, which is then submitted to either the local authority or Planning Inspectorate.

Issues

Low carbon power, flexibility and network infrastructure developers have long been concerned about the impact of planning application delays on project timelines. The time it takes to secure planning permission can be far longer than project construction, with delays of 10+ years reported by wind farms that would take just 1 year to construct. In a similar manner to grid connection delays, bureaucratic inefficiencies currently present a genuine barrier to achieving the goal of a decarbonised power system by 2035.

Developers point to disproportionately burdensome processes, under-resourced planning authorities and punitive regulations. Meanwhile other nations are moving to reduce planning and permitting barriers for low carbon projects, with the European Parliament recently voting in favour of faster approval deadlines for renewables projects. Without action, lengthy planning timescales in the UK could genuinely trigger capital flight to neighbouring countries where projects would be able to reach commissioning more quickly.

Recommendations

Planning application timelines must be significantly reduced if the government stands any chance of meeting its goal of a decarbonised power system by 2035. Therefore, we propose that government works with the relevant authorities to overhaul the planning regime so that net zero aligned projects receive preferential treatment reflecting the importance of meeting net zero targets. Government and relevant authorities should also ensure that adequate resourcing is available in the planning and permitting system to ensure applications are assessed as quickly as possible. Government could also consider creating a priority fast-track for significant projects such as key electricity network upgrades and larger electricity generation projects.

Summary:

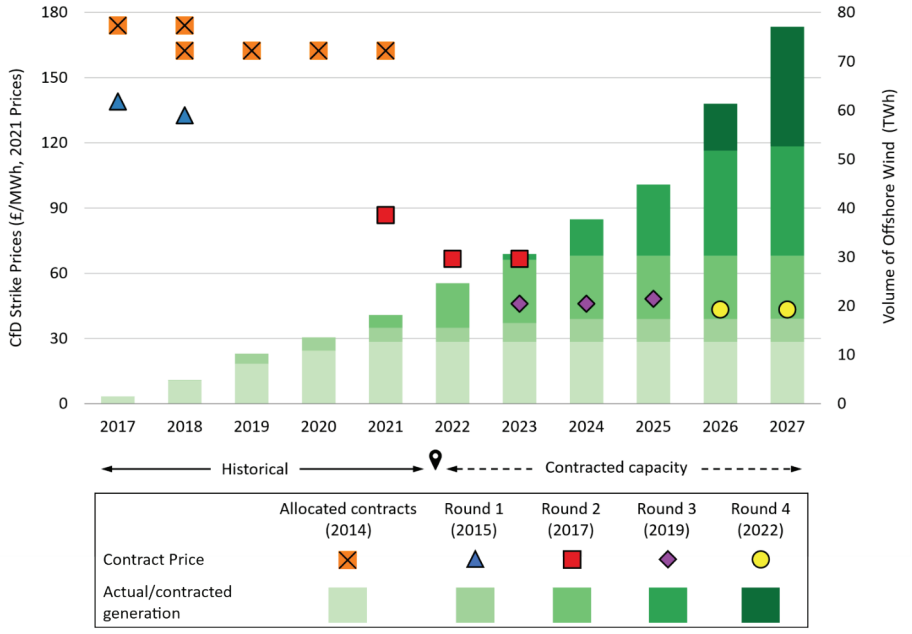
4 **Streamline the planning process for low carbon and network infrastructure by installing a presumption in favour of net zero aligned projects, creating a priority fast-track for significant projects, and scaling up personnel at national and local level to manage the increased demand on these bodies.**

2.2.3 Low carbon investment support

Background

Electricity Market Reform (2013) is the prevailing incentive framework for decarbonisation of electricity supply and consists of the Contracts for Difference (CfD) Scheme, the Capacity Market, the Carbon Price Support, and the Emissions Performance Standard. Together, these policies work to incentivise the switch from fossil fuel to low carbon electricity while maintaining system security.

Figure 5: Offshore wind Contracts for Difference (CfD) Strike Prices (2022 prices), and historic and projected annual generation.



Source: *Authors, with data from the Low Carbon Contracts Company (LCCC).*

Notes: *'Negotiated Contracts' were those initially directly allocated, while subsequent rounds were subject to auctions. Years in parentheses are years the allocation/auction rounds took place. Round 4 generation assumes three awarded contracts begin generating in 2026 (Inch Cape P1, EA3 P1, Moray West) and two begin in 2027 (Norfolk Boreas, Hornsea P3), with average capacity factors of 40%.*

The CfD scheme is the lead policy for bringing forward new low carbon electricity capacity and offers a government-backed contract (typically 15-year) with a guaranteed strike price, thereby insulating the generator from market volatility, which in turn reduces the cost of capital. This is seen as a crucial development in low carbon policy as it allowed technologies with a high-capex cost profile to access low-cost financing, which in turn led to a rapid increase in the size and number of projects delivered. Together, this mass deployment, and the competitive nature of the CfD auctions, fostered major cost reductions with offshore wind falling from £180/MWh in 2014 to below £50/MWh in 2022 just eight years later (Figure 5).

Issues

The result of this policy success is that new renewable electricity offers the lowest cost power available on the market. That creates a new challenge for policymakers in terms of how to ensure the full benefits of this cheap power are being realised and whether it should be channelled to parts of society most vulnerable to energy price fluctuations, such as vulnerable industries and the fuel poor (explored further in section 3.1.2). Others suggest that renewable power is now so cheap that it should no longer require government-backed contracts and should instead rely on private-backed Power Purchase Agreements (PPAs).

These questions are being actively considered by government via annual consultations on CfD reform and the landmark REMA process. The threat to the CfD scheme has created significant concern among large-scale renewables developers around the investibility of the GB market without CfDs. These organisations suggest that the higher cost of capital associated with merchant renewables projects, and future concerns around wind capture price cannibalisation,[35] would mean GB projects would no longer be investible, especially at scale. In this scenario, capital set aside for the GB market would likely be re-directed to neighbouring markets that continue to offer CfDs or similar government-backed schemes. The UK cannot afford to lose ground in this competition for low carbon capital, especially given recent research from the CBI which has shown that the UK is already falling behind the US and Europe in terms of green technology market share.[36]

Recommendation

Meeting the goal of decarbonised power by 2035 will be heavily reliant on the rapid deployment of variable renewables with forecasts suggesting wind and solar power will make up at least 70% of electricity generation by the mid-2030s.[37] There is currently no evidence that the pace of deployment required for this can be delivered by the private market alone – data on PPAs is opaque but the proportion of renewables supported solely by PPAs is certainly less than 10%.[38] For an idea of scale, between 2019 and 2021 only 1.3GW of subsidy-free PPA capacity was signed in the GB market.[39] This deployment rate falls a long way short of what is required for a decarbonised system by 2035 (renewables deployment needs to be on the order of 10GW/year). And while removing CfDs would likely lead to increased use of PPAs, the consensus is that such a move would trigger capital flight to other regions with attractive financial instruments for renewables development.

As a result, we strongly recommend that the government does not remove CfD support until there is a clear alternative that can support the scale of renewables deployment required for a decarbonised power system by 2035. Adjustments to the CfD system will be required as the growing capacity increases the importance of location and output profiles. But government should preserve the essential feature of underwriting the investor risks associated with highly uncertain wholesale market prices, and ensure that increases in input costs due to inflation and global supply chain pressures are reflected in allocation round budgets and administrative strike prices. The overriding lesson from EMR is that well-designed, stable policy delivers good results. Following this example will stand the government in good stead as it endeavours to eliminate the remaining emissions from the power sector.

Summary:

5 Extend the Contracts for Difference (CfD) scheme while developing it to support greater locational diversity (e.g., through some weighting / differentiation by zones) and exploring incremental reforms to improve operational signals.

2.2.4 Electricity Market Design

Background

At the heart of electricity economics across Europe is a short-run 'spot' market – typically, focused around offers and bids for electricity generation and purchases a day ahead. In this system, the 'marginal' generator – the most expensive operating plant required to meet the demand – effectively sets the price, and this in turn becomes a reference point for most other contracts in the market.

In effect, a general economic idea of pricing 'at the margin', based on quite simple (and simplistic) economic ideas, has become translated into a more general structure of short-run-marginal-cost-on-all – a structure which also does not take into account the technological revolution underway in electricity systems.[40]

One common myth is that huge profits simply reflect monopolies dominating in uncompetitive markets. In electricity, almost the reverse is true in the short run. Increases in electricity prices have been particularly dramatic in competitive electricity markets because they respond rapidly and with few constraints to the principle of marginal cost pricing (MCP).

Underlying the economic theory of MCP is an idea of equilibrium – a long-run stable situation, with pricing providing market incentives to move towards such a state. MCP is indeed a very important incentive to operate existing systems

35: Wind capture price cannibalisation is the phenomenon whereby the price received by wind generators in the wholesale market is depressed towards zero at high levels of wind generation. This is due to the very low running costs of wind and exacerbated by subsidy schemes – wind generators will bid close to zero (and sometimes negative) to ensure they receive their subsidy. Plants without a subsidy face difficulty covering their running costs at very low or even negative wholesale capture prices.

36: (CBI, 2021)

37: National Grid, Future Energy Scenarios (2022) – Forecasts for wind and solar as a proportion of overall electricity in 2035 range from 72% (Falling Short scenario) to 82% (Leading the Way scenario).

38: (SPglobal, 2021)

39: (Cornwall Insight, 2021)

40: We cover this application of simple economic ideas in detail in Box 1 – (Grubb et al., 2022)

efficiently. It ensures that the cheapest-to-operate plants are used as much as possible, with more expensive ones only called on when needed. The theory is that such pricing is efficient, and includes the incentive to construct new, low-cost plants, which can use their operating profits to recoup the cost-of-capital and which (it is typically assumed in the standard theory) are more expensive to build than fossil fuel plants.

Issues

A recent empirical study of electricity price-setting across nine major European countries confirms the implications, as summarised in Table 2.[41]

In most of those countries, although non-fossil sources and (for some) electricity imports accounted for over half the generation, fossil fuel generators set the price for more than 70% of the time. In Britain, natural gas accounted for around 40% of generation but set the price for 98% of the time (up from 84% in 2019). Non-fossil sources set the price 2% of the time, though they generated about half of the GB's electricity in that year (wind and solar being about 25%).[42]

Consequently, after several years of relative stability, the wholesale price of electricity across Europe has followed the price of fossil fuels, and in Britain, specifically, natural gas. The result has been the dramatic, four-fold increase in wholesale prices shown in Figure 3. Combined with the cost of direct gas consumption, the crisis in the fossil fuel markets has largely driven the wider inflationary and cost-of-living crisis – and, for much of industry, a crisis in international competitiveness.

Along with this, concerns arise about windfall profits. Beyond the fossil fuel producers themselves, the price paid to electricity generators in the wholesale market has increased dramatically, but the cost of generation for low carbon and other 'inframarginal' generators has not changed. The profits to those that sell into the wholesale market have consequently mushroomed (except for those on CfDs, who pay back revenues obtained above the 'strike price').

Table 2: Percentage of time for which electricity prices were set by different sources in 9 major European countries (2021)

Country	Fossil fuel	Non-fossil	Imports
Germany (DE)	72%	11%	17%
Denmark (DK)	31%	12%	57%
Spain (ES)	65%	32%	4%
France (FR)	7%	93%	0%
Ireland (IE)a	72%	2%	26%
Italy (IT)	82%	14%	4%
Greece (GR)	91%	9%	0%
Portugal (PT)	40%	60%	0%
Great Britain (GB)	98%	2%	0%

Source: *(Zakeri et al., 2022), Table 2*

41: (Zakeri and Staffell, 2022)

42: Non-fossil generation in Great Britain in 2021 totaled just over 50% of generation, comprising wind 19.4%, solar 3.6%, nuclear 13.8%, biomass 12%, hydro 1.6%, plus 7.4% imports from interconnectors which were primarily from nuclear power in France.

This cost escalation has indeed occurred alongside the substantial reductions in renewable energy costs already noted, leading to a dramatic 'cost inversion' in the system – the sources that a decade ago required generous subsidies to launch the industries at scale, are now far cheaper than generation from fossil fuels.

In economic theory, this combination should induce far more private investment in such renewable sources – if they could be built quickly, did not face other obstacles (such as planning or grid connection delays), and the investors were confident that profits in the wholesale market would be maintained.

In practice, the combination led to the 'windfall tax' introduced in January 2023 – in the form of a 45% levy on electricity sold at prices above £75/MWh. This precedent of course injects a different element of future uncertainty, and itself does nothing to reduce the burden faced by energy consumers, whether domestic or business.

Unsurprisingly therefore, the companies we interviewed were uniformly interested in whether and how the market itself could be reformed, including proposals for separating markets between what is now clearly two fundamentally different types of generation – with one designed to give direct access to renewables through a 'green power pool.'

Recommendations

In 2018, in the context of work examining the drivers behind the high electricity prices faced by UK industry compared to key European competitors,[43] we first outlined an approach which would enable consumers to access cheap renewable energy through a 'Green Power Pool' (GPP).

This can most generally be conceived as a combined volume of electricity from many renewable generators, with matching volumes made available to consumers directly rather than through the current wholesale market. This approach would establish a 'dual market' system, with the wholesale market operating in parallel to the GPP. A GPP emerged as key option for wholesale market reform under the government's REMA consultation launched in July 2022.

43: (Grubb and Drummond, 2018)

In November 2022, we published a working paper that develops specific options for the design and implementation of a GPP in Great Britain.[44] Set out in detail in Annex D, a GPP could potentially address some suggested guiding principles for market reform, whilst preserving security of supply and enhancing conditions for low carbon investment and efficient operation of an expanding electricity system.

Creating a GPP alongside the wholesale market would allow consumers to access the real cost of cheap renewable power. Over time, this could create a market based on long-run marginal cost – presenting a more investible proposition for developers than the current wholesale market, and opening the possibility to move away from government-backed contracts in the long-run – and would reveal the true backup and balancing costs of variable renewables. This is a crucial step in transitioning from a market designed around fossil fuels and commodity-based economics (short-term focused), to one designed around variable renewables and asset-based economics (long-term focused).

The GPP also presents the opportunity to target cheap, clean renewable power to primary beneficiaries such as fuel poor consumers and EIIs. We explore this more in Section 3, but the key takeaway is that a GPP could create a structural solution that would reduce the exposure of the taxpayer to supporting vulnerable groups via fiscal intervention in future energy crises. Taxpayer support on energy costs through the recent crisis is estimated to have totalled over £50bn for domestic household support and £18bn for support to industry and business.[45] For a sense of scale, this is roughly equivalent to the UK Government's annual spend on defence.

Finally, it is important to note that private sector Power Purchase Agreements do provide a complementary route and may be well suited to some smaller-scale renewables investment, especially if and as other obstacles are removed. There may be options through which government could enhance the role of PPAs (discussed further in section 3.1.2). We were not able to explore such options in detail in the course of this project, but as noted, we see no evidence that the pace of renewables deployment required can be delivered solely through private PPAs (between 2019 and 2021 only 1.3GW of subsidy-free PPA capacity was signed in the GB market, contrasting with the need for 10GW/yr or more average over the next decade).

Summary:

6 Continue to explore the REMA option of transitioning to a dual-market approach,[48] creating a Green Power Pool alongside the wholesale market to allow consumers to directly access reliable and increasingly cheap renewable electricity.

2.3 Summary of Recommendations: Policy priorities to deliver a decarbonised power system by 2035

1.	Accelerate reforms to the grid connection process to significantly cut connection waiting times and prioritise projects that are ready to deploy. As part of this, ensure industrial network connections/upgrades are included.
2.	Include a commitment in the promised action plan on accelerating network development to further develop the regulatory RIIO Framework to enhance anticipatory investment in network capacity.[46]
3.	Treat construction of the necessary grid infrastructure as a national endeavour, requiring collaboration with supply chains to make best use of scarce resources.
4.	Streamline the planning process for low carbon and network infrastructure by installing a presumption in favour of net zero aligned projects, creating a priority fast-track for significant projects, and scaling up personnel at national and local level to manage the increased demand on these bodies.
5.	Extend the Contracts for Difference (CfD) scheme while developing it to support greater locational diversity (e.g., through some weighting / differentiation by zones) and exploring incremental reforms to improve operational signals.
6.	Continue to explore the REMA option of transitioning to a dual-market approach,[47] creating a Green Power Pool alongside the wholesale market to allow consumers to directly access reliable and increasingly cheap renewable electricity.

44: (Grubb et al., 2022)

45: (Commons Library, 2023) (HM Treasury, 2023)

46: RIIO: allowable Revenues to network companies related to Investment, Innovation and Outputs.

47: REMA refers to the Government's Review of Electricity Market Arrangements.

48: REMA refers to the Government's Review of Electricity Market Arrangements.

3. Supporting Industrial Electrification

Background

Electricity is forecast to supply over half of industrial energy demand by the mid-2030s and is a leading decarbonisation option for some of the most carbon-intensive sectors, such as steel. For these reasons, this report is primarily focused on electrification as a means of decarbonising industry (although we do note that other technologies will play a role, especially for sectors like ceramics, which cannot easily electrify or interrupt their energy use in a flexible manner).

However, the extent and ease with which manufacturing processes can be electrified varies significantly by sub-sector, and conversion also has regional implications. These are summarised below:

Steel: At present, two sites produce around 80% of UK steel from iron ore, using blast furnaces with coking coal. The remaining 20% of UK steel is produced with scrap steel at four other sites using electric arc furnaces (EAFs), which apply a very high electrical current through the scrap to melt it. Some gas is used with oxygen burners to reform this into new steel products, but steel produced using EAF involves around one-sixth of the emissions compared to blast furnaces. Transitioning the remaining blast furnace capacity to EAF production is one of the key options for decarbonising steel production in the UK, with low carbon hydrogen also playing a role to displace the remaining natural gas demand.[49]

Chemicals: Options available for decarbonisation are substantially more varied in the chemicals sector. Electrification remains key, including to replace dryers used in chemical production, for relatively low-temperature heating, and for on-site production of green hydrogen for use as both a fuel and feedstock (i.e., replacing natural gas used to generate steam or high temperature direct heat; and to displace hydrogen currently produced from natural gas, coal, and oil). CCS may play a significant role in processes for which there are currently no clear options to move away from fossil fuels,[50] but operating CCS units will, in turn, further increase electricity demand. Some chemical industries are geographically concentrated (e.g., in the Merseyside industrial cluster), but others are much more dispersed.

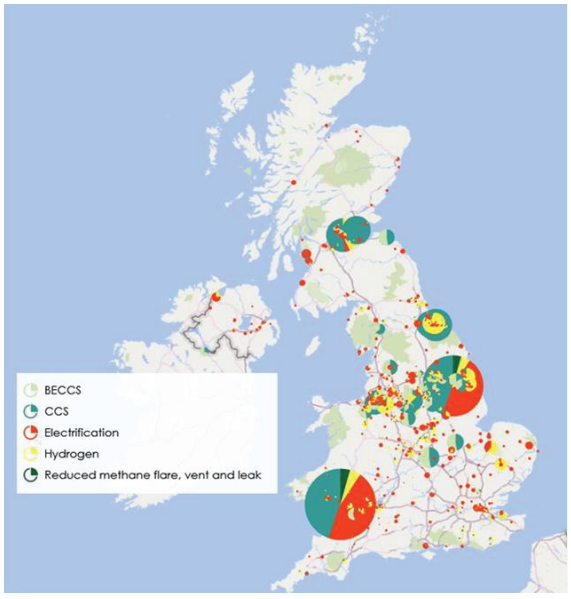
Cement: Due to high temperature heat requirements, further direct electrification may play a limited role in cement compared to fuels such as biomass and low carbon hydrogen, along with CCS. High uncertainty surrounds more radical options for new cement technologies (e.g., Plasma) or alternative construction materials which may change this in the longer term. Some projections suggest electricity demand in the sector could double from current levels.[51]

Due to their proximity to raw materials and high transport costs, cement plants are quite geographically dispersed.

Future industrial electricity demand

Figure 6 summarises the rough geographic spread of different decarbonisation options in the manufacturing sectors in the UK. Expanding direct electrification is a key solution in industrial clusters, but possibly even more so in dispersed sites. The adoption of CCS and production of green hydrogen (for use in industry and elsewhere) will also create an increased demand for low carbon electricity. This, alongside increasing demand for electricity in other areas of the economy, will necessitate large, rapid changes in the capacity and profile of electricity generation, and electricity networks (explored in more detail in Section 2).

Figure 6: Map of deep decarbonisation measures in the manufacturing and construction sectors in the 'Balanced Net Zero Pathway' in 2050



Source: *The Sixth Carbon Budget: Manufacturing and Construction Sector Summary.*[52]

Note: *The individual pies represent emissions within a certain geographical radius and may include more than one site. Map excludes small sites where geographical data was not available, which includes all industrial off-road mobile machinery. Map does not include abatement of emissions from electricity generation, fuel supply or waste, or from resource efficiency or energy efficiency measures.*

49: (UK Steel, 2022)

50: (Frontier, 2021)

51: (MPA, 2020).

52: (Committee on Climate Change, 2020b)

3.1 Requirements for Industrial Electrification

We now turn to the barriers to industrial electrification and various actions government should take to support these companies in transition. There is a clear case for government action in three key areas: (1) Investment support for the infrastructure overhauls that will be required to electrify industrial processes, (2) Action on electricity prices to ensure that electrified industries can access cheap, renewable electricity, and (3) The creation of markets for low carbon industrial products and protecting against undercutting by higher-carbon industry.

In preparation for this report, we interviewed a range of industrial sector stakeholders to get real-world input as to the capacity for different sub-sectors to invest in industrial decarbonisation, the barriers to investment, and the government assistance required to overcome these barriers.

3.1.1 Low Carbon Investment Support

Background

Although largely proven in concept, the technologies to electrify some industrial processes, including in the chemicals sector, remain expensive, inefficient and with uncertainties associated with deployment at scale. Appendix A summarises some of the funds in place to support innovation and investment in electrification, which can help to improve these technologies and reduce uncertainties. The key takeaway is that, aside from the recent government decision to extend the IETF by £185m from 2024, there is currently no additional UK government funding available to support industrial electrification.

In many sectors – including steel and cement production – the technologies with which to electrify key processes are already known and broadly available. The main challenge is driving the large capital investments for their deployment. The capacity to invest depends on a combination of a sector's own resources, and its attractiveness to capital markets. There is an important interaction with electricity options, as greater clarity and confidence about electricity prices will reduce the uncertainties, and hence perceived risks and cost of capital, for capital markets. The chemicals sector broadly has access to sufficient resources to invest in electrification and other decarbonisation technologies, should the wider policy framework tackle prohibitively high electricity prices and support the required grid upgrades. However, this is not the case in all sectors – the steel sector in particular stands out.

Issues highlighted by industry

The trade body UK Steel estimates that to convert the remaining blast furnace steel making capacity to EAF-based production, around £3.6 billion in capital investment would be needed.[53] It has been widely reported that steel producers in the UK are operating with very tight margins, or even at a loss, due a combination of international competition and high UK production costs, as a result of high energy prices.[54] Steel producers themselves do not have sufficient capital to deliver this investment, and where international parent companies may have such resources, they tend to be channelled to sites in other countries with greater comparative advantage. Steel producers in the UK are also unlikely to receive any substantial finance from any other private source. Public resources are therefore likely to be necessary, if the UK is to retain and transition its steel industry.

The main source of proposed funding for steel sector decarbonisation in the UK is the Clean Steel Fund, announced in 2019, which promised £250 million to the industry from 2023. However, the level of funding is far below what is needed (with industry stakeholders suggesting at least £1 billion is required), and there has been little discussion of the fund by Government since mid-2021, with some industry stakeholders now of the view that it is unlikely to happen (the Fund no longer appears in government funding spreadsheets). Compared with similar funds in other countries,[55] stakeholders believe that this places the UK steel sector at an even greater structural disadvantage – particularly if they are outside the European Carbon Border Adjustment Mechanism (CBAM) (discussed further in 4.1.3).

Industry stakeholders were also largely united in their belief that existing policy measures and processes broadly fail to address second-order issues of importance to industrial electrification, such as planning for and appropriately funding significant upgraded electricity network and connection capacities, and the availability of scrap steel for use in EAF steel making processes. Although around 96% of steel used in the UK is recovered and recycled, around three quarters is currently exported (and often converted into new steel products before being re-imported), as production costs are too high in the UK due to industrial electricity prices.[56] Potentially this scrap could be used to help to decarbonise UK steel production, but only if conversion of blast furnaces to EAF is viable.

Beyond the presence or absence of suitable individual measures, a commonly reported issue was a general lack of policy coherence, stability, and longevity. Industry stakeholders felt that for individual funds to directly support electrification, application windows and the time in which the projects that receive funding must take place are often too short, and often do not facilitate sequentiality between R&D, demonstration, and deployment (including because not participating in one mechanism sometimes precludes a firm from participating in a subsequent mechanism).

More broadly, they felt the current policy framework is often a patchwork of complex individual measures that fail to act as a coherent whole. This is evident in the various overlapping funds set out in Appendix A. And despite the publication of the Industrial Decarbonisation Strategy in 2021, some stakeholders felt that these issues are symptomatic of a lack of sufficient commitment among policymakers to a serious, long-term industrial strategy that includes energy-intensive manufacturing industries. They point to the historical collaborative creation of sector-specific decarbonisation roadmaps in which the needs of individual sectors (including chemicals and cement[57,58]) to facilitate decarbonisation were laid out, but to which governments have not subsequently acted upon as a further example.

Recommendations

Chemical industry stakeholders were supportive of further funding and engagement for demonstrator projects for the electrification and wider decarbonisation of key processes, and although they would welcome public funds to

53: (UK Steel, 2021)

54: (Hutton, 2021)

55: Some examples of this: the French Government support EAF investment with £1.4bn, and the Canadian Government investing £650 million in Arcelor Mittal and Algoma steel plants.

56: (UK Steel, 2022)

57: (BEIS & CGP, 2017)

58: (MPA, 2020)

help with deployment of low carbon technology, they highlighted that sufficient funds were already available in the industry. The barrier to using such funds was simply a lack of incentive and appropriate business case.

However, cement – and particularly steel – sector stakeholders emphasised the need for greater focus on funding for clean technology deployment. For the steel sector, confirming the Clean Steel Fund to start in 2023, and with much increased funding, was viewed as critical to decarbonising and maintaining long-term competitiveness in the UK. UK Steel have also proposed the creation of a Clean Steel Innovation fund, focusing on three core themes, and including helping to improve the product capability of EAF-produced steel.[59] An equivalent to such Clean Steel Funds would be welcomed by the cement sector, although the MPA/UK Concrete state that such financial support should focus on developing and deploying biomass and CCS technologies. Long-term investment from Government will be required to support decarbonisation in these sectors.

Stakeholders from all sectors held a broadly common view on three points. Firstly, that application and project execution windows should be more closely aligned to projects seeking funds from instruments under this category (potentially with rolling applications), simplified to promote wider access,[60] and allow for appropriate sequencing along the innovation chain (from R&D to deployment). Access for firms that have not drawn on public funds for a previous step in the chain should also be facilitated.

Secondly, plans for public investment in the requisite electricity network capacity should be put in place to facilitate rapid electrification of production processes that the current funds and proposals largely focus on. Thirdly, loan guarantees are likely to provide relatively little value or additionality. In the chemicals sector, for example, this is because funds (or access to finance) for investments in electrification are likely to be already available if wider incentives are in place. In the steel sector, however, stakeholders were clear that only substantial public investment in new capital stock would be sufficient to achieve further electrification and wider decarbonisation of production processes.

Carbon contracts-for-difference (CCfDs), through which governments can guarantee investors a fixed carbon price that rewards actions to reduce CO2 emissions, have the potential to encourage capital-intensive, low carbon investment where current or projected carbon prices, or their uncertainty, would otherwise prevent the investment. The EU plans to deploy CCfDs for hydrogen electrolysers, sufficient to deliver 1.4 million tonnes of low carbon hydrogen to the steel sector by 2030, which would lead to a 30% reduction in emissions from EU primary steel production.[61]

Discussions regarding the use of CCfDs for low carbon hydrogen production and industrial CCUS (alongside power sector CCS) in the UK are ongoing. However, there has been little discussion about the use of CCfDs for investment in electrification, or direct investment in low carbon technologies that make use of low carbon hydrogen, for example. Industrial stakeholders indicated that their use for this purpose may be of interest, but it would depend on their specific design.

There is a significant body of literature on the government support required to create an environment where EIIs are incentivised to invest in industrial electrification and broader decarbonisation. This is summarised in Appendix B (Table 3) and correlates with many of the findings from our interviews with key industry stakeholders. Radical new thinking is not required to stimulate investment in electrification, rather, government should focus on implementing the proposals below. Our overriding recommendation is for government to work with industry to ensure coherence across the range of measures so that EIIs are presented with a logical and investible support framework.

Recommendation:

7 A bold support fund for industrial decarbonisation is required to secure private co-investment in innovation and deployment of new low carbon production technologies at the scale required.

3.1.2 Addressing Electricity Prices

Previous reports for the Aldersgate Group explored in depth the level and drivers of UK industrial electricity prices before the energy crisis, finding that, in 2019, GB prices were indeed higher than the European average, much higher than in France and somewhat higher than in Germany, though generally below Italian prices.[62] Of course, the situation is now significantly more acute due to soaring gas and electricity prices as a result of the global energy crisis and the uncertainty around government support.

Industrial electricity prices pose challenges for both industrial competitiveness and decarbonisation. This is due to the fact that EIIs require substantial electricity to power their processes and are therefore particularly exposed to electricity prices. If EIIs face higher electricity prices than competitors in the UK and abroad, they will either lose market share or profit margin, and if electricity prices are higher than alternative energy sources, EIIs are discouraged from investing in electrification. If the government wants to incentivise industry to invest in electrification, then it is crucial that it takes steps to provide access to predictable, low-cost electricity.

Background

The three sectors examined vary significantly in their specific arrangements for procuring electricity. The UK's two integrated blast furnace steel plants generate some electricity from waste gases for their own consumption, and there is widespread use of combined heat and power generation in the chemicals sector, but very little 'autogeneration' in the cement sector. The chemicals sector procures much of its electricity through long-term PPAs, though stakeholders suggested only a limited portion of these are based on renewable energy, due to very high power demand. Few PPAs currently exist in the steel sector, in part because uncertainty about future plant viability precludes long-term contracts. There are relatively few PPAs in the cement sector, with most power bought directly from the wholesale spot markets or procured from suppliers, often through 'green tariffs', backed by REGOs.

59: As part of a theme focused on 'Transforming Primary Production'. The other two themes are 'Energy Efficiency and Downstream Steam Processes' and 'Steel Supply for a low carbon world'. (UK Steel, 2022)

60: (Frontier, 2021)

61: (European Commission, 2022a)

62: (Drummond et al., 2021).

The steel, cement and chemicals sectors are all participants under the UK's Emissions Trading System (UK ETS).[63] The carbon price it imposes should help to incentivise the adoption of lower-carbon processes, including electrification, where feasible and where the carbon price is high enough. However, for a sector that must compete with international markets that do not face any carbon costs, such carbon pricing will only be effective (and avoid carbon leakage) when applied in tandem with a CBAM or some other form of mechanism to address unfair competition from high-carbon sources. For carbon costs to act as an effective market signal for heavy industry, these costs need to be part of a broader policy framework which accelerate the development of affordable low carbon technologies and which support industries against any unintended consequences during the transition to low carbon technologies.

Since the UK ETS began operating in 2021, its prices have largely tracked the EU ETS, but in some periods the price has risen higher. While this increases the potential revenue to any installations with excess free allowances, for the majority of installations that fall below their benchmark, divergence above the EU ETS price raises their costs compared to European competitors.

The most prominent issue highlighted is the high price of electricity faced by industry, particularly vis-à-vis competitors in European countries, but also relative to other energy carriers (e.g., natural gas). As indicated, this is a long-standing issue, which has been exacerbated by the recent energy crisis given the higher gas-dependency of British electricity.[64] This places strong competitive pressures on electro-intensive industries and facilities, and impedes further efforts to decarbonise through electrification (such as enhancing the use of Electric Arc Furnace steel manufacturing, and indeed the cost of running carbon capture and storage).

A further issue highlighted is that many industries have electricity network connections that would require upgrading if they were to electrify their operations and thus increase their load on the electricity system. Companies that have attempted to explore such upgrades report receiving long timelines for network connection upgrades, and that this has disincentivised them from pursuing electrification. This issue is clearly related to the delays faced by renewables developers (discussed in section 2.2.1) and therefore we urge National Grid and the other involved parties to ensure industrial electricity network connections are included in the ongoing reforms to improve the process.

Existing Proposals and Recommendations

Britain already has several policies in place to moderate industrial electricity prices, as indicated in Appendix C. However, recent publications and our stakeholder interviews revealed a range of insufficiencies with this landscape – some common across sectors, and some more sector-specific.[65]

Appendix B (Table 4) summarises proposals in the literature to moderate industrial electricity prices. The first two mechanisms are designed to reduce electricity prices to electro-intensive industries that are exposed to international competition. Of the three sectors analysed only the steel sector qualifies for both measures (something steel industry stakeholders highlighted as crucial), as the steel industry is more electro-intensive than other manufacturers. All three sectors qualify for renewable levy exemptions, but only some chemicals sites receive indirect carbon cost compensation (i.e., for the impact of the UK ETS on electricity prices). For complexities around such compensation, see our previous Aldersgate report (Grubb and Drummond, 2018).

The cement sector and parts of the steel industry receive an automatic discount on the Climate Change Levy (CCL) through mineralogical and metallurgical exemptions. Most sites in the steel and chemicals sectors receive a discount through application of a Climate Change Agreement (CCA), though not all.[66]

Network charges have historically formed a significant component of electricity prices for industry, particularly the smaller plants connected at distribution level. For large industrial consumers, annual network charges have historically been largely determined by consumption during three 'Triad' periods of national peak electricity demand, which allowed industrial users to access lower network charges by shifting demand away from these periods.[67]

However, cost-avoidance via the Triad system will end in March 2023, to be replaced in large part by fixed network charges based on voltage and capacity of connection. This will mean that industrial consumers who currently adopt Triad avoidance strategies will see their network tariffs increase,[68] although those that do not (or cannot) avoid Triad periods will see their costs reduce.

Network charges reflect location and usage, but the purpose needs to be clear. Whilst each sector is different, none have much scope to move location, for example, in response to fixed transmission charges. All six steel plants represent major capital investment and bring local employment and value chains. Cement plants are located where they can access raw materials. A few chemical industries might be more mobile, but much of the industry is embedded in established industrial clusters, or only part way through the life of its embedded assets (which can be sustained for 20 years or more in some cases).

However, each sector does have significant ability to schedule and flex the timing of their production in response to time-varying signals. An implication is that locational signals in electricity prices may be valuable not because industries can relocate around the UK, but because they can respond to dynamic pricing. In other words, industries could capitalise on cheap renewables output at times of high output, if the market and networks facilitate access.

The case for shifting policy costs from electricity to gas rests on the current imbalance of policy costs placed on these vectors and the need to incentivise electrification. Placing a higher proportion of policy costs on electricity distorts the incentive for end-users to electrify by damaging the economics of electricity versus gas, for example.

63: Although, some sub-sectors and smaller installations are excluded.

64: As of 2021, about 40% of electricity in Britain was generated by natural gas, compared to around 20% averaged across the EU.

65: The interviews and analysis took place before the Energy Bill Relief Scheme was announced.

66: One steel sector stakeholder interviewed has opted to leave a CCA and instead pay the full CCL rate, concluding that the targets negotiated under the CCA were too difficult to meet, and the penalty for failing to do so exceeded the full CCL rate.

67: Triad periods are the three half-hourly settlement periods with highest electricity system demand between November and February (separated by at least ten days and determined ex-post).

68: UK Steel estimate that some steel producers will see an increase of 200–300% in network charges (UK Steel, 2021)

Given the current gas-price crisis, the proposal to reduce electricity prices by shifting policy costs onto gas may seem inconceivable at present, but since electricity wholesale costs are also driven by gas, the underlying principle remains relevant.

Government has recently committed to 'rebalancing' electricity and gas prices following recommendations made in Chris Skidmore MP's Mission Zero report, and is expected to outline its approach by the end of 2023/4 and make significant progress affecting relative prices by the end of 2024. The disparity between the cost of fuels is one of the biggest barriers to the decarbonisation of industry, and does not reflect the extent to which electricity generation has decarbonised in the last decade. As things stand, around 12% of electricity bills are made up of 'environmental and social levies', compared to just 3.4% of gas bills.[69] 'Rebalancing' these policy costs would significantly reduce the cost of electrification for domestic and industrial consumers. As such, this is a positive move helping shift incentives in favour of electrification although it will need to be executed with care to anticipate and address any unintended consequences for those industries that current rely heavily on gas and where the switch to electricity is either currently not possible or may only become possible over a transition period (e.g. ceramics).

There are a number of options for moving policy costs from electricity to gas bills. Foremost is directly moving some of the levies onto gas bills, leaving overall dual fuel bills unchanged. This could include the Renewables Obligation, an environmental levy introduced to support early renewables projects when costs were higher than they are now. This could be accompanied by moving the Feed-In Tariff to gas bills. Such a move would send a strong message to investors that electrification is the direction of travel.

However, we caution that such a move would create additional cost for industries, such as ceramics, glass and cement, whose processes cannot be currently or quickly electrified (and will therefore need support to transition to non-fossil gases and appropriate exemptions until options to decarbonise are available). Furthermore, for other industries where electrification is the lead option, rebalancing electricity costs must come as part of a broader policy framework to make electrification more technologically and economically accessible to industry. Without a comprehensive approach which both rebalances cost and makes electrification genuinely feasible, rebalancing prices by itself will simply add further cost to fossil-based UK industry that lacks the ability to electrify.

The largest component of environmental levies concerns the cost of legacy Renewables Obligation certificates, which were signed for 20 years. To the extent that these generators could be persuaded to move to CfD-like contracts instead, with the benefit of more secure future prices, this could reduce the levy costs for all.

Further proposals in Table 4 (Appendix B) aim to increase the degree of exemption from environment-related measures, namely the costs of renewable supports (overwhelmingly, the historical costs of the Renewables Obligation scheme) and the carbon cost paid by generators. An additional proposal would be to exempt industry from the cost of payments under the Capacity Market.

Overall, this brief overview of major industrial sectors already indicates some general observations. Despite a general GB philosophy to minimise intervention in markets, in practice, the government and regulator are already significantly involved in determining electricity prices for different groups. Interventions are unavoidably complex, but necessary. Moreover, the sectors are different, and have different needs. These general observations inform our recommendations.

Summary:

8 **We welcome the commitment from government to 'rebalance' electricity and gas prices, shifting policy costs currently levied on electricity bills to gas bills in order to incentivise investment in electrification. However, this change should be implemented as part of the broader policy framework that makes electrification more technologically and economically accessible to heavy industries, along with targeted, time-limited exemptions for industries without viable electrification options.**

9 **Government should consider both expanding existing exemptions from policy and carbon costs across Energy Intensive Industries and introducing a new exemption for capacity market costs.**

New proposals and recommendations

Almost all the participants in the survey expressed consternation about the underlying structure of the electricity market, and correspondingly expressed interest in proposals to disentangle the cost of fossil-fuel-based electricity from the now-cheaper cost of renewables.

As set out in section 2.2.4, our previous reports proposed the creation of a 'Green Power Pool' (GPP) to facilitate direct industrial access to cheap, clean electricity, given that the cost of recently-contracted renewable electricity was already cheaper than wholesale electricity costs before the energy crisis, and by 2021 was much cheaper.[70] Research for this project, captured in a series of working papers, underlines the potential value of making different pools of renewable energy available to different consumer groups, and details of the design and operation of a GPP given the variable nature of renewables output.[71]

One form of GPP could be based on renewables contracted through government CfDs at prices which are transparent and much cheaper than wholesale electricity. Moreover, the average cost of electricity from the existing pool of CfDs will decline sharply over the coming years as generation from more recent contracts (mainly for offshore wind) comes online.

However, not all industries are the same. The strategically important steel sector is the biggest emitter and faces the most immediate threat to international competitiveness. We identify four reasons for steel production to be a priority beneficiary from a GPP based on the existing pool of CfD-backed electricity generation: strategic economic and environmental importance combined with imminent risk of closure and large-scale job losses; its inability to strike direct long-term contracts with low carbon generators (i.e., via PPAs), given these uncertainties; the flexibility of electric arc production to respond efficiently to varying renewables outputs; and proximity (at least of the current blast furnaces) to existing or potential offshore renewables generation.

69: Source *Ofgem*

70: (Grubb and Drummond, 2018), UK Industrial Electricity Prices: Competitiveness in a low carbon world; and (Drummond et al., 2021), 'Delivering competitive industrial electricity prices in an era of transition', both available at https://www.aldersgategroup.org.uk/publication/type/reports-and-briefings/

71: (Grubb et al., 2022)

The most obvious priority for its decarbonisation is to convert one or both of the UK's blast furnace sites to electricity-based production (largely utilising scrap which is currently exported for processing). The government has reportedly offered £600m to the UK's two blast furnace sites to convert, but the risk facing the (much larger) industry co-investment required remains high if future electricity prices for steel remain uncertain and uncompetitive.

This could also create a foundational framework that could naturally be extended to other industrial off-takers as the size of CfD-based electricity grows.

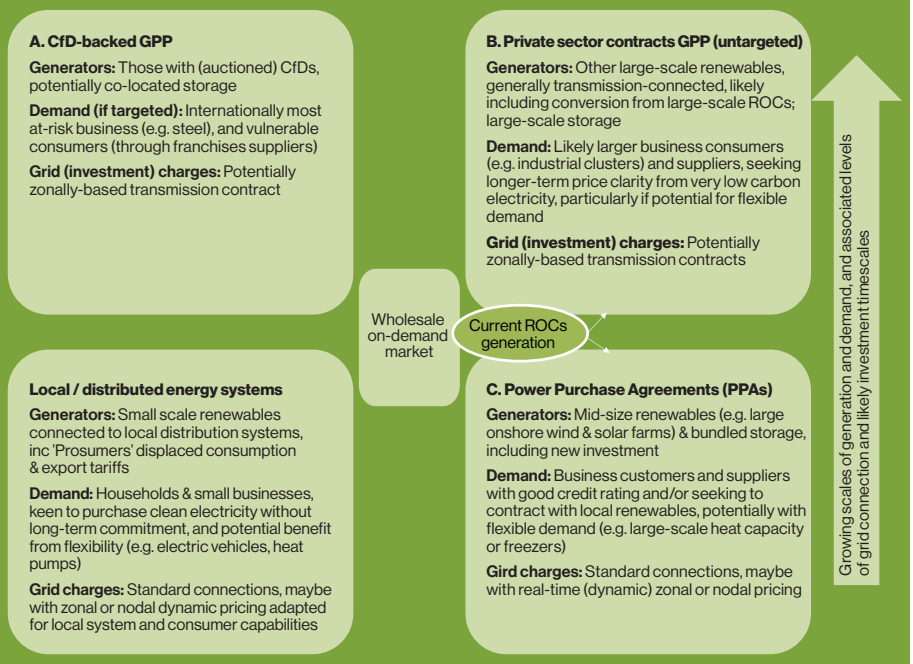
Channelling CfD-backed electricity to priority beneficiaries can immediately address electricity prices, but not all industries will be covered. Government should, therefore, also be looking to strengthen the PPA market to create an additional option for wider industry (and others) to directly access renewable electricity. In return, this would strengthen the non-CfD route to market for renewables, creating options for both new investment and post-CfD contract renewables. To this end, we believe government should explore options to enhance the PPA market, including mitigating the risk of off-taker payment default, for example by developing standardised, tradeable PPA contracts, or offering state guarantees.

Figure 7 outlines a potential configuration of future electricity markets consistent with the combined needs we have explored in our research. This includes the need for most renewables-based markets to interact with the wholesale market for balancing and backup. This would retain roughly its current design, but increasingly become a market for providing these capabilities, including some forms of "on-demand" low carbon generators, and various forms of storage connected directly to the national network. Government should consider the case for targeting electricity from the currently limited volume of a CfD-derived renewables pool to a combination of steel production and fuel poor households.

Summary:

10 **Explore the possibility of facilitating industrial access to cheap, predictably priced low carbon electricity via Green /] Power Pool(s).**

Figure 7: Potential future configurations for GB electricity market



Note: *our research did not consider in detail transmission and distribution charges, or the options for dynamic pricing at nodes or zones of the system. Indications on grid charges are therefore preliminary suggestions.*

11 **Consider the case for targeting electricity from the currently limited volume of a CfD-derived renewables pool to include steel production, as an integral part of a transition support package.**

12 **Explore options to enhance the PPA market, including mitigating the risk of off-taker payment default, for example by developing standardised, tradeable PPA contracts, or offering state guarantees.**

3.1.3 Markets for Green Industrial Products

Background

Supply-side policy support for industrial decarbonisation tends to receive significant attention due to the scale of capital required and the immediate impact such investments will have on emissions. But it is demand-side policy that will ensure the long-term competitiveness of low carbon industry by creating an enduring market for its products. Line of sight of such a market would also create longer-term certainty for the industrial sector, providing the confidence for private capital to invest, alongside the public funding set out above, in advancing industrial electrification and decarbonisation.

Policies that can help to create a market for low carbon industrial products include CBAM, product standards, procurement agreements and tax systems. A range of measures, summarised in Appendix B (Table 5), could help to establish a market for low carbon industrial products and improve competitiveness.

Recommendations

Standards for public procurement of low carbon industrial products, based on lifecycle emissions, are frequently proposed as a potentially important measure to catalyse a market for low carbon industrial products. Stakeholders in the steel and cement sectors suggested that such standards may indeed be very helpful,[72] but would likely

72: (Frontier, 2022)

have limited impact in isolation.[73] Mandatory product standards must therefore form part of a suite of policies including a CBAM and Green Public Procurement, aimed at growing markets for low carbon goods and supporting the competitiveness of low carbon industry (see the below section for more information).

Product standards that mandate maximum levels of lifecycle emissions for products that may be placed on the market (by domestic or international producers), are proposed for potential introduction in the mid-to late-2020s by the Industrial Decarbonisation Strategy.[74] The government confirmed in July 2022 that it intends to consult on their design and introduction.[75] Although the public sector is a substantial consumer of steel and cement products,[76] much of its procurement continues to be sourced from other countries, so public standards on 'embodied carbon' would need to be applied equally to imports.[77]

Both mandatory product standards and green public procurement will help to create a robust market for low carbon industrial products. In turn, this will deliver confidence to industrial companies to invest in the electrification of their operations, as they will have confidence over the demand for their products, and thus return on their capital investment. A recent report for the Aldersgate Group, developed with extensive engagement with industry, has detailed steps that government should take for successful implementation of mandatory product standards.[78]

Stakeholders in steel and cement were clear that the introduction of any measures to create a market for low carbon products must follow, or at minimum be introduced in parallel with, strengthened measures in investment support and international competitiveness. Otherwise, the market may turn to imports of low carbon products where they outcompete, or cannot be satisfied by, domestic producers – exacerbating existing pressures. The introduction of mandatory labels and requirements for domestic products alone may also unfairly disadvantage domestic producers if they were not also applied to imports.

Following agreement between the EU's Commission, Council and Parliament in December 2022, the EU is due to introduce a CBAM from 2026, following a transitional 'reporting' phase starting in October 2023. The CBAM will require EU importers to purchase certificates equivalent to the weekly-average carbon price under the EU ETS, for qualifying products. The objective is to reduce the risk of 'carbon leakage' by levelling the carbon price applied to the production processes of all covered products used or consumed in the EU, regardless of where they were produced.

The CBAM will initially cover imports of cement, iron and steel, aluminium, fertilisers, and electricity, with expansion thereafter.[79] It will replace the current system of free allocation of a significant proportion of the emission allowances that EU industry (including electricity generators) are required to surrender for their emissions covered by the EU ETS.[80]

Under current proposals, there will be three channels through which industries in a country exporting regulated products to the EU can avoid a charge applied at the border: (1) having a domestic carbon pricing mechanism linked to the EU ETS (or participating in the EU ETS itself, as with non-EU, EEA countries), (2) having a carbon price applied to the production of regulated products at least equal to that of the EU ETS, or (3) coming to a bespoke agreement with the EU. Of course, in theory there is also a fourth channel – producing industrial products without emissions.

Given its proximity to the EU and resulting levels of trade and interconnectedness in heavy industry, the UK is potentially one of the most exposed countries to an EU CBAM – particularly exports of iron, steel, and aluminium.[81] Directly linking the UK ETS with the EU ETS, as stated as an option in the UK-EU Trade and Cooperation Agreement, would both avoid application of the EU CBAM to UK industry (and the regulatory burden that would place on UK industry), and remove any carbon price differential.[82] If the UK ETS remains unlinked to the EU ETS, then the UK must introduce measures to ensure the UK ETS imposes a carbon price on industry that remains at least equivalent to the EU ETS price over time, to avoid paying additional charges. This, in turn, would require the UK to implement measures to prevent carbon leakage, other than the continued free allocation of permits (which effectively disapply, to a significant degree, the carbon price to industries in receipt).

One such measure would be the introduction of a UK CBAM. Stakeholders from all three sectors were unanimous in their desire to see a CBAM introduced for sectors and firms that participate in the UK ETS and will be regulated under the EU ETS, to both: (a) prevent exacerbating competitiveness concerns with respect to continental producers, and (b) prevent 'dumping' of carbon-intensive products that may otherwise have been destined for the EU market to the UK market, further undercutting UK producers for domestic consumption. A CBAM would also remove the need for free permit allocation, removing the perverse incentives they currently impose.[83] The UK government confirmed in July 2022 that it will consult on the design and implementation of a UK CBAM.[84]

73: The UK government has issued guidance for procurement of steel in major public projects, designed to create a 'level playing field for UK steel producers' in public procurement, although such guidance offers no specific criteria on emissions (See 'Procurement policy note 11/16: procuring steel in major projects – revised guidance').

74: (BEIS, 2021b)

75: (BEIS, 2022b)

76: Around 10% of the UK's steel demand is from the public sector (central government, devolved administrations and local authorities combined) (UK Steel, 2022)

77: In 2020/21, of the 94 major public projects reported, a total of £640 million was spent on procurement of steel products. Of the £460 million with sources specified, just £260 million was sourced from UK producers (BEIS, 2022b)

78: (Frontier, 2022)

79: "CBAM will initially cover several specific products in some of the most carbon-intensive sectors at risk of "carbon leakage": iron and steel (including some downstream products such as nuts and bolts), cement, fertilizers, aluminium, electricity and hydrogen (which was recently added because it is mainly produced with coal in non-EU countries). The European Parliament also signalled a clear intention to include plastics and chemicals by 2026 and all sectors covered by the EU Emissions Trading System (ETS) by 2030. At this point, finished or semi-finished products such as cars could also be included. In addition, indirect emissions (those caused by the production of the energy used in the manufacturing process) will also be included in calculating the carbon content of an imported product "under certain circumstances" (as stated by World Economic Forum, https://www.weforum.org/agenda/2022/12/cbam-the-new-eu-decarbonization-incentive-and-what-you-need-to-know/)

80: (European Commission, 2021, 2022b)

81: For estimates of potential UK liabilities per sector, see: (Burke et al., 2021)

82: Explicitly recommended by (UK Steel, 2021)

83: If the current system of free allocation of permits is maintained, UK Steel propose that businesses reducing emissions retain their full free allowances as a result of CO2 reduction measures if moving between product benchmarks but still producing the same output product. (UK Steel, 2022)

84: (BEIS, 2022b)

Summary:

13 **Set out plans for the introduction of mandatory product standards, in line with the recommendations from a recent report by Frontier Economics and the Aldersgate Group,[85] to enhance demand for low carbon products and ensure a level playing field.**

14 **To support this, an ambitious Green Public Procurement Strategy would provide a strong market signal to industry and help kick-start the market for low carbon products. The UK government spent £292bn on public procurement in 2018/19, with a large share on industrial products in the construction and defence sectors – such a significant purchasing power should be harnessed.**

15 **Review the UK Emissions Trading System so as to chart a path from the current structure of compensation and free allowances, towards a system compatible with the EU CBAM, and interactions with mandatory product standards.**

3.2 Summary of Recommendations: Policy priorities to deliver industrial decarbonisation

7. A bold support fund for industrial decarbonisation is required to secure private co-investment in innovation and deployment of new low carbon production technologies at the scale required.

8. We welcome the commitment from government to 'rebalance' electricity and gas prices, shifting policy costs currently levied on electricity bills to gas bills in order to incentivise investment in electrification. However, this change should be implemented as part of the broader policy framework that makes electrification more technologically and economically accessible to heavy industries, along with targeted, time-limited exemptions for industries without viable electrification options.

9. Government should consider both expanding existing exemptions from policy and carbon costs across Energy Intensive Industries and introducing a new exemption for capacity market costs.

10. Explore the possibility of facilitating industrial access to cheap, predictably priced low carbon electricity via Green Power Pool(s).

11. Consider the case for targeting electricity from the currently limited volume of a CfD-derived renewables pool to include steel production, as an integral part of a transition support package.

12. Explore options to enhance the PPA market, including mitigating the risk of off-taker payment default, for example by developing standardised, tradeable PPA contracts, or offering state guarantees.

13. Set out plans for the introduction of mandatory product standards, in line with the recommendations from a recent report by Frontier Economics and the Aldersgate Group,[86] to enhance demand for low carbon products and ensure a level playing field.

14. To support this, an ambitious Green Public Procurement Strategy would provide a strong market signal to industry and help kick-start the market for low carbon products.

15. Review the UK Emissions Trading System so as to chart a path from the current structure of compensation and free allowances, towards a system compatible with the EU CBAM, and interactions with mandatory product standards.

85: (Frontier, 2022)

86: (Frontier, 2022)

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