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Discussion Paper

Green growth, price pressures and productivity

Summary

'Green growth' through the net zero transition is possible, and could deliver many benefits across multiple sectors, and the wider economy, to offset the costs of decarbonisation. Nonetheless, 'green growth' is like any other form of economic expansion: where opportunities need to be exploited particularly in the context of constrained labour markets, producer costs and the Consumer Price Index (CPI) should be expected to increase, even where we enjoy net gains in GDP, investment, and employment. This type of pressure adds to but is different to the challenge of how decarbonisation costs may be recovered through the prices of goods/services, energy bills and/or taxation. In either case, a crucial key to unlocking more affordable routes to delivering net zero lies in identifying and delivering on sources of productivity and efficiency gains both in how we produce the goods and services that peoples' lives and businesses rely on, and in how we use them. This is a key focus for debate and decision making going forward, alongside building recognition and understanding that 'net zero' is ultimately a societal and public policy challenge more than it is a technological one.

Our research, conducted over the last seven years, has involved economy-wide scenario simulations for different types of net zero actions, including increasing residential energy efficiency, enabling the electric vehicle (EV) roll-out, and deploying carbon capture and storage, involving applied examples for the UK national and/or devolved and regional economies. In interrogating this wide range of decarbonisation efforts, our work is guided by five fundamental net zero principles around (1) understanding of who really pays and gains, (2) identifying pathways that deliver growing and equitable prosperity, (3) assessing which actions can deliver near-term economic returns, (4) determining how outcomes that simply involve 'offshoring' of emissions, jobs and gross domestic product can be avoided and (5) seeking to frame net zero as a public policy rather than a technological challenge.

Three recurring findings emerge from our research:

1. **Reducing carbon emissions to meet net zero targets will inevitably involve new costs that must be recovered and/or which will feed through to higher prices of goods and services, though impacts can be mitigated by enabling efficiency gains, and developing sources of early mover competitive advantage**. For example, where the UK 'moves first' on large-scale industrial decarbonisation systems such as CCS, this could bring challenges such as competitiveness loss in international markets and import substitution/offshoring of activity, as well broader 'carbon poverty' and cost of living issues. Improved efficiency in operational carbon capture is crucial in overcoming these.

2. **'Green growth' opportunities do exist and can help offset and redistribute the impacts of new decarbonisation costs, but, like any expansionary process, bring price pressures of their own and a risk of potentially overheating the economy.** For example, the UK, like many economies, is challenged by constraints on total labour supply. Thus, any expansion will bring labour cost and other price pressures (including, but not limited to, energy bills) that feed through to the CPI and to the international competitiveness of many sectors of the economy, with potential distributional issues and tensions in different regions.

3. **Green growth opportunities can be maximised where productivity gains can be realised in production and/or where people and businesses can learn to use new technologies more efficiently.** This applies both in terms of how households use energy and other resources to deliver the heating, transport, and other services they use every day, and in industries, where even early mover costs in adopting new emissions reducing technologies can ultimately be offset where 'learning by doing' delivers sources of competitive advantage in emerging global markets for low carbon commodities, products, and services.

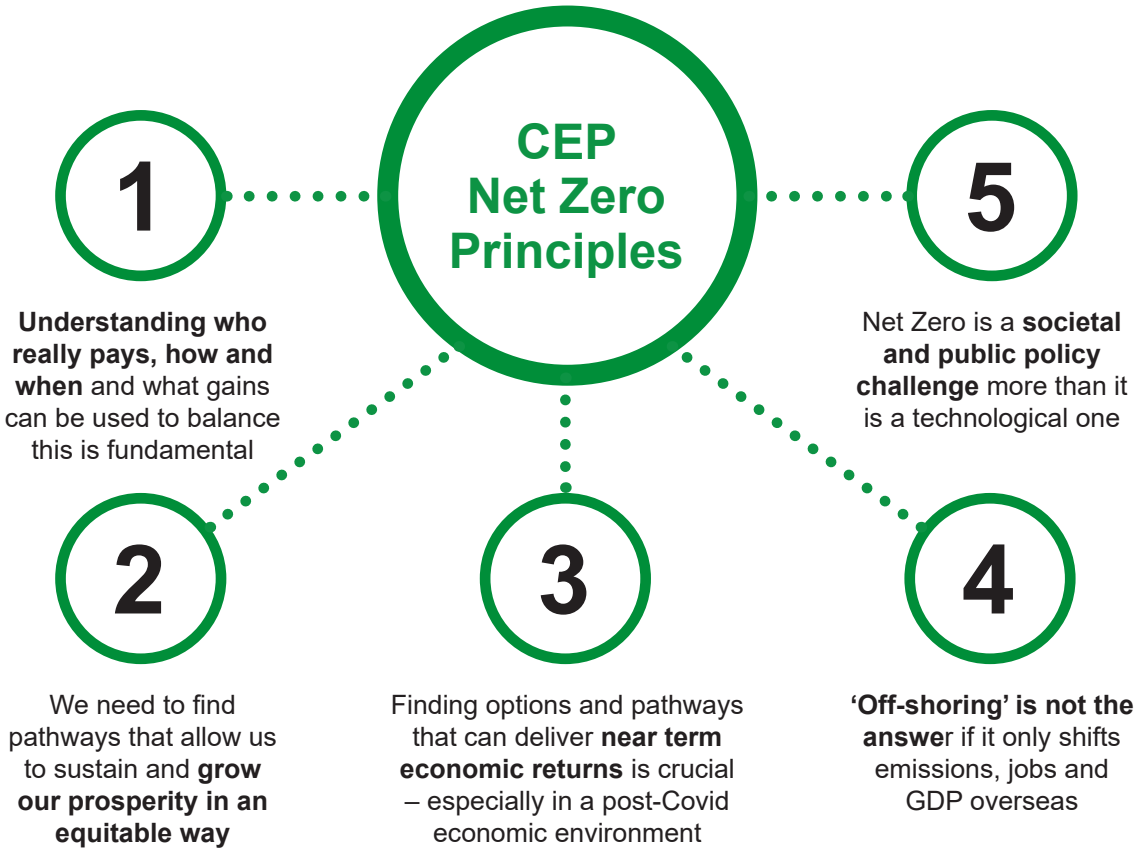
Thus, there is a real need for informed and inclusive conversations around the role of wider, and potentially innovative, public policy interventions aimed at ensuring preferable outcomes ultimately emerge for an economy like the UK in taking important, and often world-leading steps in addressing the climate change challenge, and for the people and businesses living and operating therein. Our research suggests that this should include focusing on the role and timing of different types of policy intervention to enable the exploitation of green growth opportunities as a central route to overcoming the impacts of cost-price pressures, while managing distributional challenges and tensions emerging between decarbonisation, 'green growth', 'just transition' and regional 'levelling up' policy agendas.

1. Introduction

Our research involves simulating scenarios for a range of actual or potential net zero actions using a multi-sector economy-wide modelling framework, generally involving applied examples for the UK national and/or devolved and regional economies.[1] This paper summarises insights emerging from our scenario simulation work regarding the particular challenge of how price pressures associated with net zero actions inevitably effect outcomes of concern for policy makers, businesses and citizens, both now and in the future as we transition towards net zero, but also realising how efficiency and productivity gains could affect these outcomes for the better. Our aim is to stimulate discussion and debate around an innovative and effective public policy approach to achieving net zero ambitions. We note that this approach should recognise and address what may be termed 'green inflation pressures' and consider how 'green growth' pathways can be designed to mitigate the negative effects of cost pressures, while retaining key gains, such as increasing real wage rates.

We focus on explaining three recurring findings emerging from our scenario simulation scenarios around how producer costs and the consumer price index (CPI) are likely to increase as a result of: (1) decarbonisation costs being passed onto different actors; (2) 'green growth' opportunities being exploited in a wider economy context, where labour and other supply constraints exist and persist through transition timeframes; (3) the impacts of gains in productivity and efficiency across a range of production and consumption processes. We consider how these three key drivers of outcomes may evolve and interact over time, on the one hand with the risk that approaches to resolve challenges arising under driver (1) acting to exacerbate (2), while actions to support the realisation of (3) can act to limit price increases and/or mitigate the impacts thereof, while enabling the realisation of greater societal and economic benefits of the net zero transition.

We summarise insights emerging in terms of five fundamental 'Net Zero Principles' of concern in a public policy context that have emerged from our analysis of actions such as retrofitting homes to increase residential energy efficiency, investing in infrastructure required to support the electric vehicle (EV) rollout, and deploying carbon capture and storage. While our applied analyses generally focus on UK examples, generic insights emerge that will resonate in a wide range of national and international contexts. For example, our emerging Net Zero Principles Framework (NZPF) is set out in a paper published (open access) in the journal Local Economy in 2020[2], with the five principles stated as follows:



2. CPI pressures are both a driver and an outcome of the 'who pays' model applied

Net Zero Principle #1: Understanding who really pays for any given action/ pathway or combination thereof, how and when, and what gains can be used to balance this is fundamental.

The question of 'who ultimately pays' is perhaps the most obvious challenge when considering the challenge of consumer price pressures arising through the net zero transition. This is because increases in the wider cost of living and/or doing business (where jobs and people's ability to earn a living) could generate more complex poverty concerns than the familiar energy or fuel poverty measure most directly linked to climate/energy policy actions. Crucially, this is associated with a narrower set of prices faced by households.

However, where the drivers of price pressures are complex and interdependent, avoiding negative outcomes – such as possible broader 'carbon poverty' challenges arising as we enact and pay for the transition – will itself be a complex challenge.

One crucial insight emerging from our wider economy scenario analyses across multiple potential net zero actions is that the actors directly identified as paying – e.g., under 'polluter pays' – are unlikely to be the only ones who ultimately pay because of how costs are transmitted across the economy.

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Case study - CO_2 Transport and Storage

Take for example, the findings of our recent work exploring the impacts of the UK being a first mover rolling out a potential CO2 transport and storage (T&S) industry.[3] We find that if energy- and emissions-intensive firms operating in the UK's largest regional industry clusters (i.e., the likely users of a T&S network that services industrial carbon capture) are required to pay to support the rollout of the T&S industry,[4] this may trigger (from the outset) an industry and wider economy contraction driven by international competitiveness loss. These contractionary pressures persist for as long as UK industries find themselves at a competitive disadvantage where they bear and attempt to pass on first mover CCS costs through commodity and/or product prices.

The key consequences of policy concern are likely to be job losses concentrated not only within the regional cluster industries, as export demands for those industries fall (crucially equating to effective offshoring as domestic downstream users switch to less costly imports), but also in those sectors where workers who have lost jobs and/or income from employment spend their earnings. Depending on the residence of workers relative to workplaces, the latter (secondary) source of contraction may largely impact within the host region.

Our research shows that the consequent wider economy contraction, reflected in falling UK GDP and total employment, is associated with an increase in the CPI, which reduces only if greater international trade responses/offshoring pressure causes the economy to contract further. Thus, there is a 'double hit' on UK household spending, from income loss and the rising cost of living.

If, on the other hand, government opts to socialise the costs of supporting the rollout of the new T&S industry by somehow transferring the costs to taxpayers/ UK households, our research suggests that the resulting loss of real disposable income will still have negative impacts on particularly those service sectors where people do much of their spending.

Case study - CO_2 Transport and Storage

However, our findings suggest that contractions will be smaller and less regionally concentrated than under an 'industry pays' approach given that the risks of offshoring and job losses in (relatively high wage) industry cluster activities are removed, coupled with employment gains in the new T&S industry and its supply chain. In terms of the CPI, some upward CPI pressure does emerge under household pays, but this could be associated with limited net expansion in the economy given the gains linked to the new industry rollout.

CPI pressure linked to 'green growth' is most evident in scenarios where we assume that that decarbonisation costs, in the form of delivering demand for T&S, does not require an increase in the price of any other consumption. This may happen where, for example, if government can directly fund through deficit finance or an external/export demand base emerges for T&S services.

This means that CPI pressures associated with passing on decarbonisation costs are limited, but the 'green growth' opportunity plays out in the context of labour supply constraints, with new industry activity driving up not only real wage rates but the nominal cost of labour faced by producers in all sectors of the economy.

However, our scenario simulation results show that the combination of jobs and real wage gains can enable a net increase in spending by UK households. On the other hand, price pressures driven by rising labour costs lead to some competitiveness loss and reduction in export demand for the outputs of other sectors in the economy so that gross gains are still associated with some negative distributional impacts, with offshoring pressure now arising via import substitution.

“The emerging picture is one of trade-offs. For policy makers to assess these and to make decisions, it is necessary to understand where, how and what types of jobs/real income gains and losses may emerge under alternative funding options for a decarbonisation action.”

Thus, the emerging picture is one of trade-offs. For policy makers to assess these and to make decisions, it is necessary to understand where, how and what types of jobs/real income gains and losses may emerge under alternative funding options for a decarbonisation action like rolling out T&S industry capacity/service provision. Particularly if interventions to mitigate negative impacts and/or manage distributional consequences are to be made, this must be coupled with understanding a range of outcomes, including what the public budget implications may be (where wider economy expansion/contraction increases/reduces tax revenues) and the timing and nature of impacts on the cost of living as reflected in the CPI.

3. How might cost of living challenges impact the building of consensus around required actions?

Net zero principle #2: Policymakers and stakeholder communities need to find and build consensus around pathways that allow regions and nations to sustain and grow the prosperity of populations in an equitable way

The potential tension between decarbonisation, 'green growth', just transition and regional 'levelling up' public policy agendas is also likely to be challenging in terms of building societal consensus around actions required to deliver mid-century net zero transition agendas, where the cost of living is impacted and/or, as outlined above, competitiveness loss in UK industry brings risks to jobs through offshoring of production and/or greater reliance on imports. Building consensus around solutions and pathways across UK society is necessary for the transition to remain politically feasible. This is the essence of the just transition challenge: if people feel that outcomes are likely to be inequitable or unjust for them as individuals, the socio-economic and/or geographical groups that they belong to and/or the areas of industrial activity their jobs and/or communities rely on, they are likely to resist the need to change their own behaviour and/or to countenance policy actions proposed.

In this regard, it is important to understand how different types of costs and gains may be distributed, and just how they may transmit to different types of impacts for specific groups in society. For example, our research on how energy efficiency programmes aimed at reducing the physical energy required to run UK homes can trigger sustained wider economy expansions as households enjoy lower energy bills and increased real disposable income for other types of spending.[5] However, again, one trade-off is CPI pressure, driven particularly by increased labour costs in constrained UK labour markets. Thus, one crucial challenge emerging is the weight of real income and spending power gains set against the increased cost of living for different household income groups.

Here, our scenario simulations for the UK suggest that in the case of households on the lowest incomes – those with whom policymakers challenged to address 'energy poverty' issues may be most concerned with in designing energy efficiency programmes – the bulk (around 80%) of sustained real income gains resulting from energy efficiency actions will be direct reductions in energy bills rather than the resulting wider economy expansion.

The central issue is that lower income households tend to source a smaller share of more limited absolute weekly, monthly, and annual incomes from employment, ownership of capital etc. Thus, when the economy grows, lower income households extract limited gains but will still face a rising cost of living when the CPI increases coupled with a very limited share of wider GDP, investment, and employment gains. This will act to offset real savings as energy bills fall unless other sources of income – particularly transfers from government – rise in line with CPI pressures.

However, even if previous levels of spending power are maintained for low-income households, potentially augmented through reduced energy bills and associated alleviation of energy poverty, the key point is that they may still not share in the wider gains of 'green growth' that can clearly be delivered by regional and/or national programmes aimed at increasing the energy efficiency of our housing stock.[6] This may be challenging in terms of net zero narratives built around ideas of 'shared prosperity' and/or increased equity in considering the nature of a 'just transition'.

Moreover, energy efficiency is only one element of the (at least initially) costly activities that households will be required to undertake via the wider challenges of decarbonising heat and transport. Our research demonstrates that the impacts of actions to address these wider challenges for low income households in particular will be crucially affected by: (a) how energy prices are affected for extended periods by current approaches to recovering decarbonisation costs incurred in the energy supply industry through consumer bills; (b) CPI pressures associated with 'green growth' associated with the switch from import-intensive petrol and diesel to domestically produced electricity to run EVs, which may remain unaffordable to low income households.[7]

Generally, our research on the impacts of the EV roll-out shows that the potential for greater reliance on domestic and higher average wage supply chain in fuelling cars from electricity rather than diesel/petrol, and from likely efficiency gains per mile travelled, can ultimatley lead to growth in the economy. However, particularly in the absence of productivity growth in generating, distributing, and supplying electricity, price pressures from both passing on decarbonisation costs to residential and commercial consumers combined with those associated with supply constrained economic expansion will affect the magnitude and distribution of green growth outcomes.[8]

> "When the economy grows, lower income households extract limited gains but will still face a rising cost of living when the CPI increases, coupled with a very limited share of wider GDP, investment, and employment gains."

4. CPI challenges in enabling delivery of near-term economic returns

Net zero principle #3: Not least in contexts where economic conditions are currently challenging, finding options and pathways that can deliver near term economic returns is crucial

Perceived equity and justice over the longer term of the net zero transition is not likely to be the only, and perhaps not even the primary concern in building wider public, business, and political consensus around the need to take action on climate change. Rather, if we are asking people to make changes and potentially pay NOW in acting to prevent climate change impacts that may still seem 'far off' (despite recent weather events across the globe), there may be a need to demonstrate near term economic (and other) returns. This need may be exacerbated in the context of recovery from the COVID crisis in a landscape currently characterised by a range of cost and price pressures, where people already feel their ability to earn/generate real income and maintain spending power, and businesses are concerned about maintaining competitive business models.

Generally, our research shows that the timing of economic returns to different actors depends not only on the timing of action, but how it is paid for in different timeframes. In some contexts, this will motivate attention to analysis and arguments such as those set out by Lord Stern (2021) regarding the potential need for public spending to focus on front-loading and incentivising investment in the assets our economy needs moving forward. In others, and more generally, there may simply be an argument to delay recovery of costs from taxpayers, for example through targeted deficit financing made possible by the UK Government's new Sovereign Green Bond issue (HMT/DMO, 2021).

For example, returning to the example of residential energy efficiency, we recently undertook a study considering the extent and timing of wider economy impacts associated with delivering on the UK Government's Clean Growth Strategy aspiration for as many homes as possible to reach EPC Band C by 2035.[9] Our results show that long-term net positive impacts on UK GDP, employment, household spending and the public budget - and the extent of CPI impacts associated with this particular source of 'green growth' - are less, if at all, affected by the funding model adopted. Rather, longer term outcomes are largely driven by wider economy expansion triggered by real spending power gains to more energy efficient households.

Crucially, however, this is in a timeframe (beyond 2035) where all decarbonisation costs have been paid (except where longer term household loan finance is involved) so that observed increases in the UK CPI are entirely driven by 'green growth' powered by more efficiency use of energy. [Note, however, that this 'green growth' is set in the context of constrained UK labour markets, with rising labour costs leading to sustained gross losses in activity and employment in some more export-intensive sectors of the economy.]

In the nearer term, our scenario simulation results show that near term net gains in the real incomes and spending power of UK households could be delivered through a combination of employment and real wage gains associated with transitory economic expansion associated with retrofitting programmes. Crucially, near term gains from 'greener homes' programmes are maximised where retrofitting programmes enable rapid realisation of energy efficiency gains in those households receiving retrofits in the earlier phases, and that this frees up real income and spending power directed at other goods and services produced across the economy.

However, this also requires that the timing of household contributions be delayed (e.g., through low/zero income loan finance) or for grants to be provided to remove the cost burden on households all together. Moreover, as noted above, policy attention must focus on the distributional implications in all timeframes, not least because near-term gains through 'green growth' will again bring producer cost and CPI pressures where labour and capital markets are constrained in timeframes where there is a substantial increase in investment activity.

"Crucially, near term gains from 'greener homes' programmes are maximised where retrofitting programmes enable rapid realisation of energy efficiency gains in those households receiving retrofits in the earlier phases, and that this frees up real income and spending power directed at other goods and services produced across the economy."

5. Offshoring risks losses in GDP and jobs combined with increases in the cost of living

Net zero principle #4: 'Offshoring' is not the answer in regional/national or global contexts if it only shifts emissions, jobs, and GDP overseas

In balancing the challenge of 'who pays' across the net zero policy landscape, the challenges of requiring households/citizens to bear costs on major challenges such as decarbonising heat and transport naturally focusses attention on identifying how the direct cost burden could be directed elsewhere. However, as already discussed in Section 2, the central challenge is that costs will inevitably fall on end consumers, even where another group – such as industrial polluters – are identified as those 'who should pay'. One potentially unanticipated but particularly damaging (for climate as well as economic ambitions and aims) is offshoring of currently emitting industries to production locations in other countries and/or where we import more of the commodities, goods and services required to meet our consumption requirements.

For example, the 'polluters pay' or 'industry pays' challenges identified in Section 2 via the example of CCS to enable industrial decarbonisation in the UK's regional clusters are exacerbated if we turn our attention to the implications of requiring firms to install and operate carbon capture equipment. Here, particularly in the absence of new industry activity to service carbon capture needs, our research demonstrates the risk to specific sectors, regions, and groups in society, as well as to the prosperity of the UK economy overall. The crucial driver is the imposition of relatively high 'first mover' decarbonisation costs on industry that involve losses in capital efficiency and associated returns to the use of that capital. This will trigger competitiveness loss in international markets and is a risk that will persist across extended timeframes unless capture firms are supported in building and delivering efficiency gains in how they operate new technology/equipment in the early mover stage.[10]

What is the solution to offshoring, and can it alleviate the CPI/cost of living challenges of how decarbonisation costs are passed on, particularly in 'first mover' contexts on large scale solutions such as CCS? Crucially, we find that commonly discussed and lobbied for, border tax adjustments may not be the answer: our scenario simulations suggest that this may in fact worsen industry and wider economy outcomes if UK production and consumption is directly and/or indirectly intensive in imports of the commodity in question (e.g., petrochemicals, which is present in the supply chains of a multitude of everyday goods and services, and of many renewable energy solutions).

However, our research shows that the solution may lie in using periods where policy support is provided to prevent competitiveness loss to improve the efficiency of solutions like carbon capture. For example, our research demonstrates that gaining some competitive advantage in moving early on the adoption of carbon capture could, over time, enable recovery of industry even under a 'polluters pay' model, potentially to the extent that 'onshoring' of activity will occur as UK regional clusters become more carbon efficient locations for global production. Nonetheless, across the wider economy, net negative impacts on GDP, total employment and real household spending should be expected to persist even under the most optimistic scenarios, and this is primarily to the CPI effects of 'green pricing' (i.e. passing on decarbonisation costs).

This latter point raises a more general issue. If moving to net zero inherently involves higher pricing of production and consumption in our economy, there will be CPI effects and our concerns over 'energy poverty' could extend to a broader 'carbon poverty' challenge, where those on the lowest incomes/least able to pay will suffer most from increased cost of living, particularly where prices rise on a range of essential goods and services. Where the UK opts to be a first mover in actions where other nations do not yet follow, households and businesses will act to offset the impacts of increases in UK prices by importing more and continue to do so for as long as cheaper alternatives are available. This will lead to offshoring of a wider range of our consumption needs, without necessarily reducing global emissions, but certainly reducing the investment, jobs and income generation delivered by domestic production.

The implications of such outcomes for a wider set of 'just transition' and regional 'levelling up' agendas should be a key motivator for focussing any policy support in the near term not only on maintaining current competitiveness but on delivering the efficiency gains in changing production processes that could ultimately deliver new sources of comparative advantage for UK industry.

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6. Conclusion

Net zero principle #5: Net zero is a societal and public policy challenge more than it is a technological one

The central message emerging from this position paper is that our research at CEP shows how enabling and delivering the transition to a net zero economy really is a societal and public policy challenge more than it is a technological one. While further technology developments will of course be necessary to meet our ambitious emissions reductions/elimination targets, the fact that no country in the world has yet been able to fully enact all the solutions already proven technically feasible and deployable, demonstrates the need to understand and respond to a wider set of public policy challenges and issues in designing decarbonisation pathways.

Moreover, given that (under a UNFCCC framework that primary focusses on territorial emissions) perhaps the simplest route to achieving 'net zero' in any one locality, region, or nation is to simply regard carbon-intensive activity as 'sunset industries' that should be halted or allowed to phase out with support directed only to 'green' activity, there is a real risk of simply shifting emissions – and associated investment, jobs and GDP – overseas. However, such outcomes are contrary not only to the need for global emissions reduction, but also to 'climate justice', 'just transitions', and regional 'levelling up' agendas.

Rather, we have focussed attention on how policymakers, business and citizens need to work together to focus attention on reducing emissions at current locations, while recognising and addressing sources of cost and price pressures, ideally in ways that increase the productivity of the economy overall, and the resource, energy, and carbon efficiency within and across different sectors.

This is the key to unlocking pathways to net zero that are characterised by genuine 'green growth', crucially generating sufficient returns to government, firms, and individuals that could be drawn on to counter the inevitable distribution consequences of delivering such a transformative shift in how our transitioning economy functions. However, it requires a substantial step up in research activity focussed on understanding the economic and societal outcomes of alternative decarbonisation actions and pathways, in addition to, and complementing, R&D focus on the technical feasibility and deployment of technical solutions.

> "Policymakers, business and citizens need to work together to focus attention on reducing emissions at current locations, while recognising and addressing sources of cost and price pressures, ideally in ways that increase the productivity of the economy overall, and the resource, energy, and carbon efficiency within and across different sectors".

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References

1 Our applied analytical approach involves development and use of a computable general equilibrium (CGE) model that can be configured in a range of ways to simulate how the economy may adjust in response to the introduction of different scenarios. We routinely varying model configurations to assess the sensitivity of outcomes to varying assumptions regarding how different markets within and constraints on the economic system operate, and/or what type of policy approaches may be adopted.

2 See the open access paper on the CEP Net Zero Principles Framework published in the peer reviewed journal Local Economy at https://journals.sagepub.com/doi/full/10.1177/0269094220984742. An earlier statement of the framework (with applied examples) is available via a CEP Policy Brief at https://strathprints.strath.ac.uk/71580/.

3 A paper focussing on an example where a UK CO2 Transport and Storage (T&S) industry is initially introduced to service the Scottish Grangemouth cluster only is forthcoming in the peer reviewed journal Local Economy. This will be available at https://doi.org/10.1177/02690942211055687. A shorter policy brief is available at https://strathprints.strath.ac.uk/72094/. We have also conducted analysis where the UK T&S industry is introduced to service four clusters across Grangemouth, North and South Humber, Merseyside and Teeside, with a paper currently under peer review. Please contact karen.turner@strath.ac.uk for a copy of the full paper, and/or see https://strathprints.strath.ac.uk/72953/

4 In our scenarios we assume the support provided to the new T&S industry involves guaranteeing demand for the new (initially oversized) industry's output, in order to ensure capacity created is maintained in a manner that de-risks the initial investment required and delivers the economies of scale required to ultimately reduce costs to users.

5 For example, see the open access paper published in the peer reviewed journal Energy Policy at https://www.sciencedirect.com/science/article/pii/S0301421521002457, and the linked policy brief at https://strathprints.strath.ac.uk/59492/. Later policy-facing analyses building on these foundations and focussing on funding approaches including ECO can be found in the open accessed peer reviewed paper also published in Energy Policy at https://www.sciencedirect.com/science/article/pii/S0301421521002457 and/or the linked policy brief at https://strathprints.strath.ac.uk/71454/.

6 See work cited in the previous endnote, and also the open access paper published in the peer reviewed journal Regional Studies at https://www.sciencedirect.com/science/article/pii/S0301421517305888.

7 See the open access paper published in the peer reviewed journal Energy Policy at https://www.sciencedirect.com/science/article/pii/S0301421519307049 and/or the linked policy brief at https://strathprints.strath.ac.uk/67741/.

8 See the open access paper published in the peer reviewed journal Energy at https://www.sciencedirect.com/science/article/pii/S0360544221015838 for analysis focussing on the potential impacts of increased productivity in renewable energy supply (focussed on a Spanish case study but with generic lessons emerging).

9 The study, conducted in cooperation with, and input from, with colleagues in the Clean Growth team at the UK Department for Business, Energy and Industrial Strategy (BEIS) is reported in the research brief at https://strathprints.strath.ac.uk/77545/.

10 See the open access paper published in the peer reviewed journal Ecological Economics at https://www.sciencedirect.com/science/article/pii/S0921800921000367 for analysis based on a case study for the Scottish Chemicals industry. For a copy of a paper currently undergoing peer review with UK analysis and/or contact karen.turner@strath.ac.uk for. Also see the policy brief at https://strathprints.strath.ac.uk/72094/.