FRAMEWORK FOR ASSESSING INTERGENERATIONAL EFFECTS OF DECARBONISATION AND CLIMATE ADAPTATION

Prepared for Sustainability First

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EXECUTIVE SUMMARY

Climate change is affecting our lives today. However, it is likely to have a much more significant effect over the coming decades and centuries. The decisions made today – by governments, companies and households – will have an impact on the wellbeing and livelihoods of future generations. This report focuses specifically on those decisions made by governments and regulators.

Governments regularly make decisions with long term consequences. The funding and delivery of education, health care, major infrastructure, criminal justice and many other areas can all have repercussions beyond the current generation of adults. This is well recognised in standard approaches to appraisal – in particular HM Treasury's Green Book and related guidance.

These standard approaches to policy appraisal consider costs and benefits within a framework under which it is assumed that future generations are wealthier and have access to improved technologies and greater knowledge than current generations. Higher standards of living and a more informed population mean that the magnitude of costs and benefits are smaller than their equivalents today (they are discounted). For example, cancer treatments, techniques to build new bridges and countless other activities are likely to improve over time. Furthermore, the benefit of UK government actions to improve these (and other) activities is largely captured by UK residents. To the extent that the rest of the world benefits from these improvements, the UK earns a return through increasing exports.

Efforts to tackle climate change are an exception to many aspects of this framework:

- Future generations may not be wealthier in terms of income than current generations, particularly to the extent that we fail to properly control climate change;
- Some changes to the natural environment (and their consequences) may not be reversible by future generations, even if they are wealthier in income, knowledge or both; and,
- The benefits of actions to reduce greenhouse gas emissions paid for by UK tax payers cannot be fully captured by UK residents, while UK residents benefit from actions taken by foreign governments.

These unique aspects of climate change and actions to combat it mean that the standard toolkit for examining the costs and benefits of action today needs to be modified. The intergenerational implications of climate change require new thinking about how to undertake the appraisal (cost-benefit analysis) of spending, regulations or other government actions designed to address climate change – whether by reducing greenhouse gas emissions or putting in place measures to adapt to current and anticipated changes.

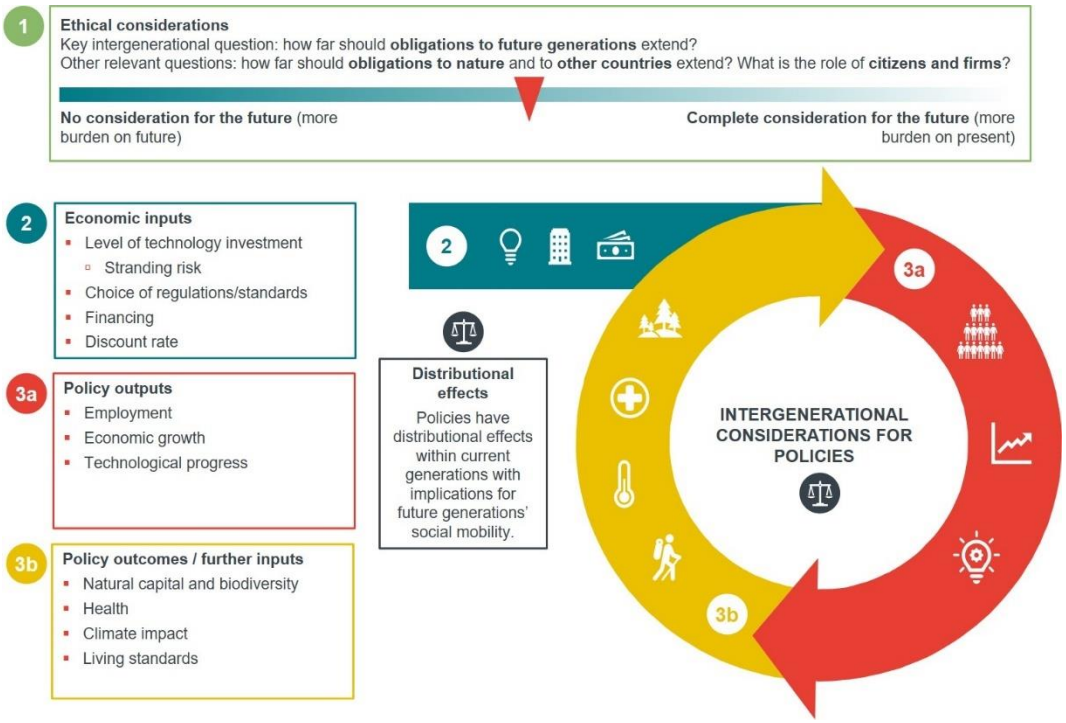
Research has also suggested that the future should be discounted at a lower rate for policies appraising intergenerational issues, such as climate change. HM Treasury's Supplementary Green Book Guidance "Accounting for the Effects of Climate Change" (November 2020) provides an important and valuable starting

point for such thinking. However, the guidance requires considerable additional thinking.

This report presents a very brief examination of these and related issues, with a focus on the approach to appraisal. It was undertaken over a short period, *pro bono* for Sustainability First. It is intended to start a discussion and raises pertinent questions to help develop a framework that tackles the question of intergenerational equity. Developing a comprehensive framework will require more time, discussion and development than was possible in this piece of work.

A framework that successfully tackles the questions above would include the elements summarised in the figure below.

Figure 1 Framework for assessing intergenerational equity



Source: Frontier Economics

In particular, the framework involves ensuring that the:

- **1) ethical considerations** associated with particular policies (such as the degree of consideration for future generations or global context) are apparent for decision makers;
- **2) right economic inputs** are used to populate any analysis: discount rates properly reflect future socio-demographic scenarios and assumptions around financing take climate impacts into account;
- **3a) characterisation of outputs** (or results of policies) recognises the shifting sectoral composition of the UK economy under climate scenarios and explicit estimates of their impact on economic growth; and,
- **3b) impacts on outcomes** (or longer term effects of policies as a result of outputs) beyond measured income for future generations are incorporated into the analysis.

The framework also highlights a few topics that are likely to be pervasive throughout the discussion and warrant further thought. These include the:

- **Circular nature of policy impacts**: current policies and actions drive outputs that develop the state of the future world, which in turn, act as inputs that contribute to decision-making for the further future;
- **Non-linear nature of climate change**: beyond a "tipping point" the effects of climate change will no longer be reversible;
- **Co-benefits or disbenefits of policy action**: Many policy actions can have conjoined benefits or disbenefits across sectors. It is important to keep these linkages in mind as policy actions are deliberated; and
- **Behavioural nudges and consumer action:** Policy action needs to be accompanied by an impetus on consumer action and behavioural nudges. It also needs to build on external catalysts for change such as crises and other widespread events.

Finally, underpinning these scenarios there should be explicit recognition of the impact of UK action on the likelihood of wider global action. The impacts on future generations of climate change and the adaptation measures required will fundamentally depend on the actions of all countries. Analysis of UK actions cannot be confined to the impact on UK residents but must consider how they will influence decisions of other countries and institutions (e.g. international financial institutions, UN and others).

INTRODUCTION

The 2015 Paris Climate Agreement saw the UK and international community commit themselves to limiting global warming to 'well below 2' degrees Celsius and make best efforts to avoid a rise of 1.5°C (UN, 2015). The IPPC Report in 2019 highlighted the impacts of even a 1.5 degree increase and led the UK to put in place legally binding commitments to meet net zero emissions (by 2050 in England and Wales and 2045 in Scotland).

The Climate Change Committee has recommended that the UK's contribution to this objective, in line with its net zero commitments, requires it to reduce its greenhouse gas emissions by 78%[1] by 2035 relative to 1990 (CCC, 2020a). These decarbonisation efforts will also need to be undertaken in parallel with adaptation actions that build resilience to the current and future adverse impacts of climate change.

In the wake of the economic consequences of the COVID-19 pandemic, the UK's commitment to delivering net zero has also come to constitute more than a legally binding decarbonisation target. It has emerged as a core strategic pillar of the Government's economic recovery package and levelling up agenda which aims to 'Build Back Greener' (BEIS, 2020a). Moreover, articulating how environmental policies can have long-term benefits, including social benefit, can help speed up the rate at which these policies are realised. The upcoming UN Climate Change Conference of the Parties (COP26), hosted by the UK and Italy, will provide further opportunities to strengthen ambitious actions and commitments that catalyse transitions to net zero emissions.

The development of international and national policy has to consider, implicitly and explicitly, the wellbeing of future generations. The half-life of greenhouse gases range anywhere from 12 years in the case of methane to centuries in the case of carbon dioxide (Forster et al., 2007). There are also warnings of "tipping points" beyond which irreversible changes to the climate and a domino effect of climate emergencies may be triggered (Lenton et al., 2020). Current decisions made by policymakers will have long term consequences, impacting the wellbeing and livelihoods of future generations.

While the impact of climate inaction is felt more acutely in the future, the costs of action may be borne by the present generation. This risks weaker incentives to solve issues today even where earlier actions reduce costs. This disincentive, known as the tragedy of the horizon[2], would be detrimental to a fair transition to net zero as it places a disproportionate burden on future generations.

In order to avoid such disincentives, it is necessary to appropriately value the future by considering the intergenerational effects of activities (or lack of activity) today. Long-term intergenerational issues are also linked to different contexts that form part of the wider discussion of climate action. They include the fairness/justice, resilience, and stewardship/resource management related aspects of the

[1] The Climate Change Committee's Sixth Carbon Budget requires a 78% reduction in UK territorial emissions between 1990 and 2035.

[2] Articulated by Carney, M. (2020) 'Lecture 4: From Climate Crisis to Real Prosperity [transcript]', *The Reith Lectures 2020.* https://downloads.bbc.co.uk/radio4/reith2020/Reith_2020_Lecture_4_transcript.pdf

relationship between (i) current and future generations; and (ii) the young and the old at any one time (Slaughter and May et al., 2020).

Whilst standard approaches to appraising the costs and benefits of policies today do consider their intergenerational effects, the unique aspects of climate change and associated actions to combat it mean that approaches must be modified to best account for related policies' intergenerational effects.

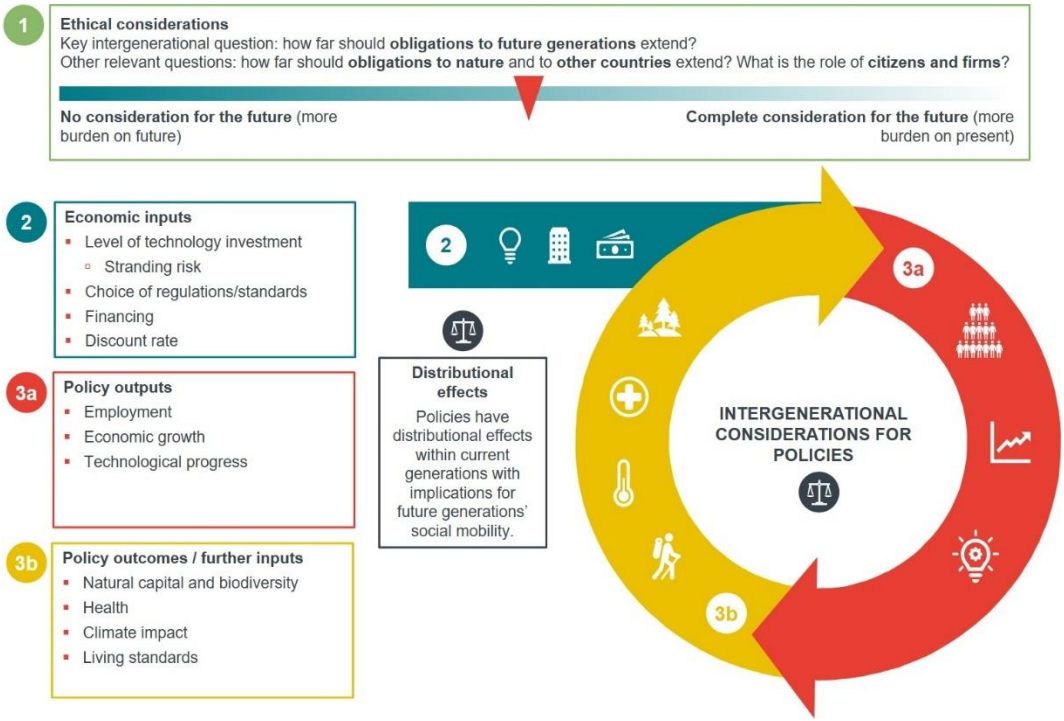
Whether and how to tackle climate change involves issues that span current and future generations, a wider range of different groups within those generations and all sectors of the economy. A framework for considering how to approach decisions about climate change needs to be equally comprehensive. This discussion document is intended to help the development of such a framework rather than provide that framework. Developing the framework will require more time, discussion and elaboration than was possible in this short piece of work.

For the purposes of beginning the discussion, we divide the framework into three parts. Each part investigates the issues that arise when considering:

- Ethical considerations
- Economic inputs
- How best to define outputs and outcomes

We discuss each in turn in the sections that follow.

Figure 2 Framework for assessing intergenerational equity



Source: Frontier Economics

Figure 2 provides a schematic of the framework and presents the main fundamentals covered. Figure 3 presents a more detailed view of the framework, posing relevant questions that could be asked when assessing the intergenerational effects of policies. While elements of this framework might usefully be reflected in the analytical tools that are used to help inform policy

decisions, the aim is not for a "super model" that covers all these dimensions. Instead, the aim is that in any wider consideration of the costs and impacts of a move to net zero (such as HMT's net zero review), these elements and the associated questions should be considered at least qualitatively.

Figure 3 Prompting questions for the framework

<table>
<tr><th>1. Ethical considerations</th><th>2. Economic inputs</th><th>3a. Policy outputs</th><th>3b. Policy outcomes</th></tr>
<tr><td rowspan="2">How far should policymakers take the welfare of future generations into account?

What is the extent of policymakers' global responsibilities?

What is the extent of policymakers' responsibility towards nature?

What is the extent to which policymakers should facilitate civil society and corporations in meeting the above obligations?</td><td rowspan="2">Technology investment: which technological investments are favoured through policy targets and consumer incentives? Is there a stranding risk associated with certain assets as a result of the policy? What are the costs, timing and scale of the investment?

Choice of regulations / standards: What policies and targets are in place to incentivise the uptake of the specified technology?

Financing: How are costs (e.g. asset investment, network investment, R&D costs, etc.) spread over time? How is the project funded over time (e.g. debt or revenues through current taxation)?

Discount rate: what would be the appropriate social discount rate to ensure intergenerational fairness?</td><td>Employment: What is the employment shift required to deliver the policy target? How many jobs will be lost / gained and in which sectors? What proportion of the population require reskilling and education?

Economic growth: What are the implications of the proposed policy on regional and national economic growth? What are the short- and long-term trade-offs between economic growth and stringent environmental policy?

Technological progress: What is the scope of technological advancement and how is it expected to drive down future costs and increase productivity?</td><td>Natural capital and biodiversity: How does the proposed policy preserve, decrease or increase natural capital and biodiversity for future generations?

Health: What is the impact on health (e.g. loss of life, lifetime earnings and health costs) of future generations as a result of the proposed policy?

Climate impact: How effective is the policy in reducing GHG emissions and mitigating / adapting to climate change? How does the proposed policy affect the likelihood of extreme climate events?

Living standards: How does the proposed policy affect the living standards of future generations?</td></tr>
<tr><td colspan="2">Distributional effects: what distributional effect will the policy have within the current generation and how will this affect social mobility for future generations?</td></tr>
</table>

Source: Frontier Economics

ETHICAL CONSIDERATIONS

Implicit in any consideration of the intergenerational effects of decarbonisation and climate adaptation policies lie a range of more fundamental ethical questions that include the extent to which policymakers ought to:

1. Take the welfare of future generations into account;
2. Have a global responsibility;
3. Have a responsibility towards nature itself; and
4. Facilitate civil society and corporations in meeting the above obligations

Policy decisions on the basis of their long-term effects therefore inherently include ethical choices that policymakers and elected representatives themselves ought to take a view on. By understanding and articulating the debate in ethical terms, they may also be able to spur momentum on decarbonisation and climate adaptation, which can happen more quickly as this momentum builds.

The special features of policies that are associated with climate change (the effects of which are global, intertemporal, and inequitable) bring about further unique ethical considerations. Given the complex and wide-ranging nature of policies' associated ethical questions, this report provides a high level overview of key questions and how one might consider them rather than comprehensive responses.

Ultimately these inform political decisions and require clear political leadership by elected representatives. These ethical questions also benefit from the engagement of citizens to whom elected representatives are accountable. Their voices on environmental issues (via various forms of public participation) make public institutions more accountable and responsive to citizens' needs, thereby strengthening decision-making arrangements and producing outcomes that are favourable to a broader cross-section of society[3].

Although we are not experts in the field of ethics, we recognise that there are certain ethical considerations that need to be addressed when discussing the intergenerational effects of climate mitigation and adaptation policies. We briefly summarise our thinking on some of the ethical considerations that need to be taken into account. A more detailed narrative of these ethical considerations can be found in Annex A.

Obligations to future, in addition to current, generations

When considering the intergenerational effects of policies, policymakers require a clear sense of whether they are morally obliged to take the welfare of future generations into account and, if so, by how much and how far into the future these obligations ought to extend. This consideration is particularly salient for questions concerning climate change, which is prone to the 'tragedy of the horizon', the disincentive to address global warming as climate inaction is perceived to be felt more acutely in the future and costs of action are perceived to be borne by the present generation.

[3] For example, the Climate Assembly UK (a representative sample of 100 citizens that spent 6 weeks exploring the issues) gave a clear mandate for bold action centred around fairness.

Policymakers could, for example, have no consideration for the future (implying a high discount rate and greater burden on future generations). Alternatively, they could have a much greater consideration for the future (implying a low discount rate and a greater burden on present generations). It is notable that, for example, in Wales the Well-being of Future Generations Act requires public bodies to think about the long-term impacts of their decisions, making clear that this is a relevant consideration.

Global responsibilities

Given that climate change poses a global challenge, effective measures to address this challenge will require international agreement and cooperation. As such, the UK must consider how its actions link to the decisions of other countries and institutions, as any measures taken have the capacity to prompt wider global action. These challenges raise a number of questions around the UK's global responsibilities, including the extent to which it (i) collaborates with other countries and avoids problems of 'free riding'; (ii) provides support to poorer and more vulnerable countries; and (iii) has a historical obligation to act even quicker in addressing climate change.

In addition, policymakers ought to take a place based perspective when setting decarbonisation and climate adaptation policies to account for the varying effects of global warming that occur within countries (such as adverse effects of rising sea levels on coastal communities).

Obligations to nature

We may have obligations to preserve nature regardless of its positive effects for humans. This is because of its intrinsic worth[4]. For one, ecological systems are complex networks, and their sophistication in terms of their complex adaptability may render them of similar moral standing to human beings. In addition to its complexity, many people turn to nature on account of its sacredness or a wider almost indefinable benefit they derive from the existence of particular natural habitats. In some cases, this can and has resulted in nature's protection from environmentally harmful activities.

Obligations of citizens and firms alongside government

Businesses and civil society play a vital role in addressing climate change alongside governments. Businesses are central to the innovations required to meet the climate challenges that we face, and the strategic targets that they set may impact the natural environment. Alongside the actions of these businesses, society has a direct impact on the environment through their consumption patterns and everyday decisions.

Given the role that businesses and society play in mitigating climate change, it is imperative that effective decarbonisation and climate adaptation policies consider the contributions of all parties to successfully lower the long-term adverse effects of climate change. Governments can make use of various policy tools such as

[4] As articulated further in Dasgupta, 2021.

regulatory initiatives, fiscal measures and behavioural "nudges" to enable businesses and citizens to better tackle environmental challenges. Implementing these policy tools will become increasingly important following the COVID-19 pandemic in order to have a fair transition towards net zero.

ECONOMIC INPUTS

HM Treasury's Supplementary Green Book Review "findings and response" (November 2020) provides an important starting point for valuing and comparing different environmental and non-environmental impacts over time.

Regulators have also made a start in recognising the importance of considering policies' intergenerational effects. Ofwat's Resilience in the Round report (2017), for example, sets out how water companies might build resilience for the future. However, regulators are yet to explicitly set out guidance on how to assess these intergenerational effects.

More generally, there is also relatively limited academic work on the intergenerational effects of decarbonisation and climate adaptation, as recognised in Sustainability First's meta-analysis of current research into distributional and social impacts for these policies (Edmondson, 2020).

Given the need for further discussion and insight on how to assess policies' intergenerational effects, the current report provides a framework to guide a discussion on this topic. The economic analysis that follows needs to take place within the context of active consideration of the ethical issues described in the previous section.

In considering the intergenerational effect of a given policy action, we have identified four key levers or inputs that encapsulate a policy and how it is analysed. There are four economic "inputs" within our framework: technology investment, choice of policy instrument, financing and discount rates.

Technology investment

Government policy can be directed towards endorsing or withdrawing from particular technology investments to meet the goals of net zero emissions. For instance, as set out in the Prime Minister's Ten Point Plan, the government has recently announced a ban on the sale of internal combustion engine (ICE) vehicles from 2030 (HM Government, 2020). Along with the introduction of Clean Air Zones in many cities, this will support the take-up of electric vehicles as a means towards decarbonisation of the transport sector.

A key intergenerational decision is how far technology approaches are to be UK-led or internationally-developed. The choice is essentially between trying to get a first mover advantage or waiting until costs fall as a result of early investment by others. This decision will be motivated by industrial strategy and the choice of approach will likely vary by technology depending where the UK has a comparative advantage.

Another important factor when considering technology specifications that is especially relevant with respect to intergenerational equity is **stranding risk**. It is possible that certain technologies may prove sub-optimal in the future such that investments in these technologies may not further the goal of net zero emissions. Depending how they are funded, such investments could detract from the goal of achieving intergenerational equity.

There is also the opposite consideration - lead times for investments to have an impact. Many infrastructure investments take years or decades to have an impact.

Failure to invest now may leave it too late to achieve certain outcomes in the future. The risks of stranding and of delayed action often have to be traded off and present a critical decision where inter-generational equity comes into play.

For instance, the heat sector faces two broad pathways as per the sixth carbon budget (CCC, 2020a) and the future energy scenarios (National Grid ESO, 2020): deploying hydrogen or electrification. If both gas and electricity distribution networks invested in assets based on different assumptions about the proportion of hydrogen to electric heating, this would lead to asset stranding. Existing gas networks could be subject to stranding depending on the pathway taken.

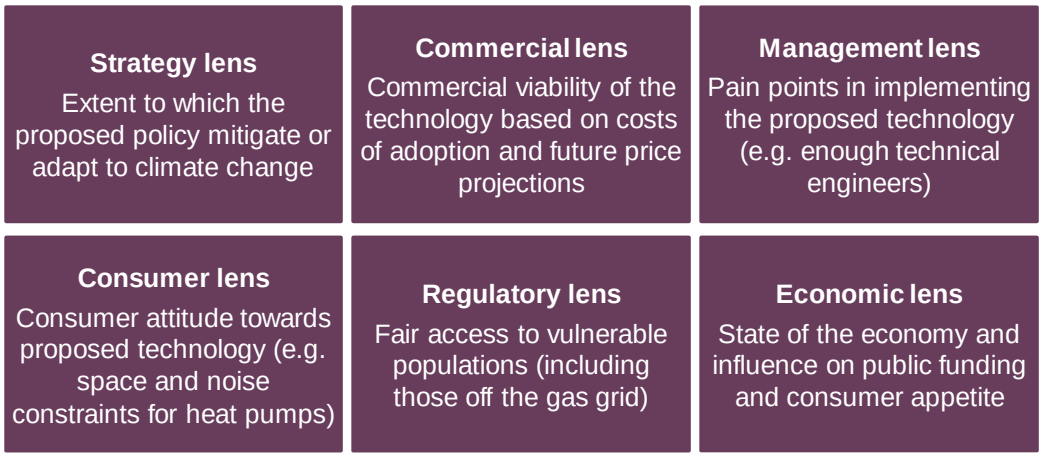
Failure to decide on the path to be taken risks that stranding, but also risks the achievement of the ultimate goal. For example, retrofitting homes with heat pumps cannot be done quickly – if we do not start soon it will not be possible to achieve the levels required to meet net zero targets.

Another example is one where specific technologies may not be optimal in the future and investment in assets and ancillary services related to such technologies may be stranded or made redundant. For example blue hydrogen, which relies on methane, may not be considered a means of achieving net zero emissions in the future if, for instance, there are limitations on the deployment of CCS.

Investment in assets that may be crowded out or may not contribute towards a net zero state of the world in the future will be wasteful. More joined up, whole system forecasting and policy action, as well as a consideration of factors that may make certain technologies more susceptible to stranding at the time of investing, would help in avoiding stranded investments and achieving intergenerational fairness.

In Figure 4 below we have listed a few factors that, aside from the technical feasibility of specific clean technologies, should form part of the business case when weighing up considerations of stranding versus the need for early action for new technology investment. Both sides of the coin need to be considered in evaluating options on whether to proceed. As well as the factors below, the concept of enabling technologies (without which other developments may be held back) merits particular consideration.

Figure 4 Factors to consider for a given technology investment



Note: We have presented a number of relevant factors, but this should not be treated as an exhaustive list.

Choice of regulations and standards

This is a definition of the type of policy to be put in place. Policies can be characterised as "push" or "pull" policies. A "push" involves pushing away practices that are detrimental to the goal of achieving net zero emissions. An example is the recent ban on the sale of ICE vehicles by 2030 as per the Prime Minister's Ten Point Plan (HM Government, 2020). Another would be the use of directives or standards such as the Industrial Emissions Directive (Defra, 2020) that regulates the emissions from industrial instalments, and the Future Buildings Standard (Ministry of Housing, Communities & Local Government, 2021) that bans new homes being built with fossil fuel heating from 2025.

A "pull" in contrast involves promoting technologies that contribute to the goal of achieving net zero emissions. This could involve putting in place subsidies or other incentives to meet targets such as the government target of installing 600,000 heat pumps annually by 2028 or installing 40GW of offshore wind capacity in the UK by 2030 as per the Prime Minister's Ten Point Plan (HM Government, 2020).

Other prominent examples of "pull" policies include the Green Homes Grant (BEIS, 2021a)[5] and the Domestic Renewable Heat Incentive that assist homeowners with energy-efficient and low-carbon heating home improvements. The recently announced Industrial Energy Transformation Fund (BEIS, 2021b) offers grants to businesses in energy-intensive sectors (such as pharmaceuticals, steel, paper and food and drink) to reduce carbon emissions. The Future Fund – Breakthrough, announced in the 2021 Budget, promotes innovation in clean technology by encouraging private investors to co-invest with government (HM Treasury, 2021).

The timeframes set by these policies are important in determining the speed of achieving net zero and, consequently, the intergenerational impact of the policies. The co-benefits that climate related regulations and standards can help deliver can also be important in maximising their acceptability and impact.

Financing

How a project is financed is of great significance with regards to the implications it may have on intergenerational equity. In particular, the sheer scale of the impact of climate change means that climate mitigation and adaptation policies often involve large capital expenditures. It therefore becomes crucial for policymakers to consider how these costs will be spread over time, and who faces the burden of financing the policy. There are various means through which the public sector can raise finance for projects, such as through taxation and debt issuance, each of which have important intergenerational consequences that should be taken into consideration.

Decisions on the level of taxation as well as the mix of taxes can have an impact on how the present generation consumes natural resources, which subsequently has an impact on the resources available to future generations. Taxes can aid in the transition to a low-carbon economy if implemented correctly. However, if not, taxes have the potential to reduce the welfare of the present generation through

[5] Note, the future continuity of the Green Homes Grant may be under deliberation by the government: https://www.moneysavingexpert.com/news/2021/02/green-homes-grant-voucher-funding-cut/

dampening economic activity, reducing household incomes, and potentially increasing the level of unemployment (Kato et al., 2015). Solely financing environmental policy through current taxation would place a substantial amount of the financing burden on current generations. The balance between tax and borrowing needs to consider these issues.

There are many choices to make within each category of measure. For example, revenue raised from taxation can come through income tax or through more targeted taxes (e.g. adding costs to energy bills, to licensing of ICE vehicles, to plastic consumption, etc). Each instrument for financing comes with its own set of advantages and disadvantages and these must be considered bearing in mind factors such as the regressive nature of the instrument (i.e., whether it adversely affects lower income households).

The alternative of financing through increases in consumer energy bills arguably puts a heavier burden on current consumers but is particularly criticised for being more regressive among current consumers (i.e. adversely affecting those on lower incomes) than taxation.

Deciding whether current or future generations should face the financial burden of a policy is not a binary decision. A mix of taxation and debt issuance as a means of financing environmental policy is also an option and evidence has shown that using a combination of the two can speed up the transition to a low-carbon economy and promote intergenerational fairness (Heine, 2019). However, it is important to note that any policy decision can result in costs being felt by both current generations in the near-term *and* future generations in the long-term.

Alongside the question of how to finance a policy is also the consideration of the present and future state of public debt. The coronavirus (COVID-19) pandemic has had a significant impact on the economy and, in turn, on public sector borrowing and debt. UK central government tax and National Insurance receipts in the 11 months-to-February 2021 have fallen by 5.7% compared to the same period last year, while government support for individuals and businesses have increased government spending by 27.9% (ONS, 2021). Coupled with a fall in gross domestic product (GDP), this has resulted in the UK public sector net debt reaching 97.5% of GDP - a level not seen since the early 1960s. The level of public debt will likely remain high in the short- and medium-term and this is something that policymakers must consider when considering how to finance climate change mitigation and adaptation policies.

Discount rates

In order to value the costs and benefits of future climate actions today, it is imperative to be able to compare or place a value on different policy actions on a consistent present value basis. This is achieved through the use of social discount rates (SDRs). Choosing an appropriate SDR that reflects the significance placed on future generations' wellbeing is essential when undertaking any cost-benefit analysis.

By applying a high SDR to future scenarios, we are assuming that future costs and benefits are valued less highly than present costs and benefits. This inherently ignores the very real risks that may be present to society from unmanaged

environmental degradation. Conversely, using a low SDR supports the view that, by acting now, we protect future generations from any negative impacts of a climate emergency.

Broadly, there are two reasons for discounting the future:

- In the future, people are wealthier. A standard assumption is that societies will grow wealthier over time as a result of economic growth. As such, a unit of wealth today is worth more than a unit of wealth at some future point in time.
- Pure time preference. This describes people's general preference for consuming today rather than in the future, independent of any changes in wealth. Applied to an intergenerational context, any pure-time discounting value that is greater than zero effectively places a lower weight on the lives of future generations relative to the lives of present generations. Other than uncertainty surrounding an unavoidable extinction of human life, it is difficult to find ethical arguments to support pure-time discounting in an intergenerational context.

There is significant debate around what an appropriate social discount rate should be, with arguments presented for both a low SDR and a high SDR. Arguments for a low SDR are that it favours investment into the lives of future generations and it does not violate our ethical intuition. Arguments for a high SDR are that future generations are likely to be better off both economically and technologically than past and present generations. Furthermore, a high discount rate may result in the present generation investing into high-yield projects, which may ultimately benefit future generations. Regardless of the magnitude of the SDR, there is a general consensus that that it should decline over time i.e. we increasingly place more weight to future generations.

Since 2003, the UK Treasury's Green Book has recommended using a headline SDR of 3.5% as standard practice (HM Treasury, 2020c). Where certain projects could have an intergenerational impact, the guidance provided in the Green Book suggests that, through the removal of pure-time discounting, a lower SDR can apply. This is reflective of the sentiment that equal weight should be put on the livelihoods of future generations.

An example of this is the case of policies for which there are health or life impacts. Here, the Green Book suggests a lower SDR of 1.5%. This reflects the fact that, as the population becomes wealthier, society does not place a lower value on health. An individual's health is a scarce resource that is not readily substitutable with other purchasable benefits. A similar case can be made for the environment and policies that have negative environmental impacts (HM Treasury, 2020b).

In fact, in a study that surveyed over 200 expert economists on the intergenerational SDR and its component parts, it was shown that the average recommended SDR is 2.27%, with only 10% of experts finding an SDR greater than 3% acceptable (Drupp et al., 2018). This research supports the view that, to address intergenerational concerns, the SDR should be lower than the headline rate of 3.5% that is presently recommended in the UK Treasury's Green Book. HM Treasury is expected to lead an expert external review, which is set to conclude later this year, into whether a new environmental social discount rate should be introduced (HM Treasury, 2020b).

DEFINING OUTPUTS AND OUTCOMES

Outputs

Employment

Decarbonisation and climate adaptation policies will cause changes in the composition of employment as jobs are created in some sectors and lost in others. Jobs in industries that contribute towards achieving a sustainable economy are likely to increase in the future. For example, by advancing offshore wind and encouraging c.£20 billion of investment, the government plans to support up to 60,000 jobs in 2030, double that in 2020 (HM Government, 2020).

On the other hand, jobs are likely to be lost or transformed in 'brown' sectors that have high environmental footprints and whose activities are replaced by green sectors. For example, the North Sea Transition Deal seeks to support workers in the face of potential job losses in the fossil fuels sector by directing their expertise into clean technologies. The intergenerational focus of policy decisions is linked to the training, education and skills provision to allow a transition that minimises long term unemployment.

Preliminary analysis suggests that well implemented green policies do not have to hurt overall employment (OECD, 2017), indicating that policymakers ought to ensure that decarbonisation and adaptation measures are inclusive and fair to workers as well as communities, consumers, and citizens (Robins et al., 2019).

A change in the composition of jobs is likely to result in a structural shift such that certain skills are preferred to others in the future. As a result, to mitigate the negative effects of any job losses associated with a policy, as well as to ensure a smooth transition of workers from declining sectors to emerging ones, training programs will be crucial. These would enable workers to fill in gaps between their existing competencies and the skills required for newly created jobs. Examples of such training programs include the Lifetime Skills Guarantee which will provide training for electric vehicle technicians in the midlands and agroforestry practitioners in Scotland to meet the objectives of the Government's Ten Point Plan for a Green Industrial Revolution (HM Government, 2020).

Additionally, the effects of job losses are compounded across generations with detrimental long-term effects on incomes, health, and educational outcomes. For instance, job loss in parents contributes to a roughly 10% reduction in children's earnings and an increased probability of receiving social assistance[6] (Oreopolous, 2005). These reductions in income can, in turn, bring about worse health and educational outcomes for future generations[7].

[6] Findings are obtained using a Canadian panel of administrative data that follows over 100,000 father-child pairs from 1978 to 1999.

[7] For example, a 10% increase in household income corresponds to an increase in children's birth weight by 0.75% of a standard deviation and an increase in their maths and English test scores by 1.2% of a standard deviation (Carvalho, 2012). Findings are obtained using longitudinal health and nutrition survey data from children born in one of 33 randomly selected barangays in the Metropolitan Cebu area in the Philippines.

Economic growth

The effects of policies aimed at decarbonisation and climate adaptation on economic growth are ambiguous. It is important for policymakers to consider implications for regional and national economic growth, in both the short and long term, as well as the consequential intergenerational effects.

In the long-term, well-designed environmental policy has the ability to support economic growth through incentivising innovation and providing opportunities for new industries to grow. A successful low carbon transition is therefore likely to result in very significant employment opportunities.

Research on the relationship between stringent environmental policy and R&D has shown that stricter environmental regulations can be positively related to R&D expenditure (Yang et al., 2012). For instance, a study by Calel and Dechezlepretre has found that EU ETS increased low-carbon patenting by almost 10% without crowding out other innovation (2016). Another study by Jaffe and Palmer finds that an increase of pollution abatement costs by 1% is associated with a 0.15% increase in R&D expenditures (1997). Carbon policy can stimulate innovation and thereby improve productivity provided that the innovation outweighs the cost of compliance with the policy. Known as the Porter Hypothesis, this has been tested empirically in numerous studies (Frontier Economics, 2019). As such, carbon policies may altogether have a positive effect on productivity, although the measured effects to-date are small.

In the short-term, environmental policies can create costs for industry through several channels such as by changing the price and availability of raw inputs, placing restrictions and regulatory burdens on production processes, and affecting the price and performance of outputs (European Commission, 2008). Empirical evidence has shown that stringent environmental policies have a negative effect on productivity growth in the short-term, which is later offset in the medium-term (Albrizio et al., 2014). However, for firms that are not optimising their current use of inputs, even in the short run, carbon policy can improve productive efficiency.

It is also worth bearing in mind that the type of policy enacted matters. More flexible policy instruments (e.g. market-based policies such as carbon taxes or cap and trade schemes) are more effective in achieving both environmental goals and better economic outcomes than more prescriptive policies such as standards (Frontier Economics, 2019).

This must all be considered within the intergenerational context. Literature is replete with evidence on the persistence of economic growth outcomes across generations. Crucially, the role of environmental policy is to ensure that the Earth's natural resources are consumed efficiently and at a sustainable rate. This ensures that there are enough natural resources available for future generations to contribute to their own wellbeing and to support economic growth in the future (Everett et al., 2010).

Overall, environmental policies can aid in promoting the wellbeing of future generations through sustaining long-term growth, encouraging innovation, and fostering the development of new industries. However, it is essential that policies aimed at mitigation and climate adaptation are well-designed so that any potential

short-term trade-offs that can arise between economic growth and environmental policy are minimised.

Technological progress

A potential output of decarbonisation and climate adaptation policies is advancement in technological progress over time. Improved technology can drive down the costs of clean technology and hence accelerate their adoption. For example, electric vehicles have become more viable due to innovation. EVs exhibit annual performance improvements of roughly 18% for power electronics, 24% for charging and discharging, and 12% for batteries (Fang and Magee, 2020).

Policies accentuating technological progress can target a range of outcomes over generations. For instance, policies can target the development of clean technologies (thereby reducing the impact of climate change through reduced emissions) or target resource-saving technological progress that reduces degradation to ecosystems, all benefitting future generations (Tsuboi, 2019).

Technological advancements may also have intergenerational impacts through influencing health outcomes. For example, advancements that lead to the development of autonomous vehicles have the propensity to increase some health risks (such as air pollution, noise, and sedentarism) yet, if properly regulated, may reduce morbidity and mortality from motor vehicle crashes and may help reshape cities to promote healthy urban environments (Rojas-Rueda, 2020).

Technological progress, induced by decarbonisation or climate adaptation policies, may also bring about changes in productivity (driven by a higher value of output per hour worked). This will have subsequent implications for employment and economic growth and a knock-on intergenerational effect (as elaborated in previous sections).

At a global level there are choices for countries to make as to whether they wish to invest and hope to benefit from technological progress or whether to wait for the developments to be brought forward by others, only investing once costs have fallen. This will likely be driven by industrial strategy and considerations of where the country has a comparative advantage but will also have inter-generational impacts.

Whilst policies that cause technological progress may be capable of bringing about positive intergenerational effects, they have to work in tandem with behavioural change and wider policies that will enable their adoption. Examples of policies that enable the take-up of environmentally friendly technologies include behavioural measures that increase consumers' environmental awareness or 'eco labelling' (Sheoran and Kumar, 2020) or information campaigns that share best practices for reducing one's carbon footprint. Similarly, the benefits of technological advancements in electric vehicles can be best realised with wider policies, such as expanded charging infrastructure (CCC, 2020b).

Finally, technological progress should not come at the expense of non-technology decarbonisation and climate adaptation policies (such as rewilding and reforestation projects) which are themselves able to protect against climate change and enhance natural capital when properly implemented, resulting in positive intergenerational effects (as elaborated upon in the natural capital section).

Outcomes

Natural capital and biodiversity

Policymakers should consider the effect of decarbonisation and climate adaptation policies on natural capital. Natural capital refers to that part of nature which directly or indirectly underpins value to people, including ecosystems, species, freshwater, soils, minerals, air, oceans as well as natural processes and functions. As HMT's Green Book (2020a) clarifies, it includes certain stocks of the elements of nature that have value to society.

Natural capital provides environmental or 'ecosystem' services over time, including those with market value (e.g. minerals, timber, fresh water), non-market value (e.g. outdoor recreation, landscape amenity), and non-use values (e.g. the value people place on the existence of particular habits or species). Consequently, policies that diminish natural capital, would reduce the availability of ecosystem services to future generations.

In particular, biodiversity, is critical to the health and stability of natural capital. The Dasgupta review (2021) recognises the range of ways that biodiversity is of value. These include its value for human existence (prevention of deaths inevitable through its depletion, such as flooding caused by the loss of natural defences); as a direct contributor to human health (e.g. by reducing pollution in water or the mental health benefits of nature); of amenity value (source of enjoyment); as a provider of goods and services (such as water or medicines); of existence value (the idea that species ought to exist even if we do not interact with them); and of intrinsic value (of value independently of whether it means something to us). The Review also recommends making 'inclusive wealth' a measure of progress.

Natural capital and biodiversity can impact future generations through a range of mechanisms as their associated sources of value have beneficial intergenerational effects. For example, better health and wellbeing (which can emerge as a consequence of greater levels of natural capital through better air quality amongst other factors) has positive intergenerational effects (Onuzu et al., 2013). Therefore, a holistic view of the impact of policies on natural capital will be fundamental in appraising long-term effects.

In addition, given circularity, natural capital is also an important input in future decarbonisation and climate adaptation projects in addition to the wider economy as a whole (Everett, 2010). Preserving marine ecosystems, for example provides biochemical resources that could be used for technological advances in biotechnology fields which may enable future biomass projects. Widespread freshwater ecosystems emerging as a result of efforts to increase natural capital in floodplains will enable more effective climate adaptation policies by mitigating the effects of flooding (Lawson et al., 2013). Effectively rewilding particular areas could be associated with improved human capital via higher levels of training and improved guidance (Di Sacco, 2021), which would, in turn, enable improved rewilding projects in the future.

Furthermore, damage to natural capital is potentially irreversible, with impacts extending across multiple generations. Whilst natural capital can be used to

generate growth, it must be used sustainably to ensure long run growth. This is most evident with regard to non-renewable resource (such as minerals and oil) but is also necessary for the consumption of renewable resources (such as fisheries and forests) as well as ecosystem services (such as biodiversity and carbon sequestration) where the rate of recharge and replenishment often exceeds critical thresholds (Everett et al., 2010).

Finally, it is worth noting that decarbonisation and climate adaptation policies may have varying effects on the state of natural capital and can be in tension. For example, seeking to sequester carbon dioxide through monoculture or single species plantations in already biodiverse areas that sequester carbon (such as wetlands) will not bring about the same positive effects for biodiversity as mixed-tree planting in areas that had previously been forested (Sacco, 2021). Other decarbonisation strategies may be associated with land use requirements or mining activities that are at the expense of natural capital (such as expanding electricity grid systems, improving public transport infrastructure, or increasing use of lithium-ion battery storage). These detrimental effects on natural capital, and their associated intergenerational effects, would need to be considered and weighed against the positive effects of policies.

Health

Health outcomes transcend generations and intergenerational policy must consider the links between climate and future health outcomes. Global warming may affect the health of future generations through its pervasive impacts on the food, air, water, shelter and broader environment that society depends on. For example, it will result in direct deaths and injury from a greater frequency of extreme weather events and will also cause people to be increasingly exposed to high temperatures and heatwaves that have negative health impacts ranging from morbidity and mortality (due to heat stress and heatstroke) to exacerbations of cardiovascular and respiratory disease (Watts et al., 2020). The temperature rises brought about by current greenhouse gas emissions will therefore affect the health of those in the future.

Both decarbonisation and climate adaptation measures are generally prone to improving health outcomes by reducing both the direct effects of climate change on health via extreme climate events (such as heat waves, floods, droughts and fires) as well as its indirect effects on health via ecological disruption (such as crop failures, shifting patterns of diseases or social responses that include the displacement of populations after a climate emergency) (Woodward et al., 2014).

According to the IPCC report (2014), if climate change continues as projected, it can adversely affect health through greater risk of injury, disease and death due to more intense heat waves[8] and fire; increased risk of under-nutrition from reduced food production in poor regions and currently food insecure areas; lost work capacity and reduced labour productivity in vulnerable populations; and increased risk of food and water borne and vector-borne diseases (Woodward et al., 2014). There may be positive effects from reductions in cold-related mortality and

[8] Heat related mortality is projected to increase in the UK by 45% by 2020s and by 167% by 2050s when accounting for projected population growth and demographic change (Paavola, 2017).

morbidity due to fewer cold extremes, but overall, the magnitude and severity of negative impacts are projected to increasingly outweigh positive impacts.

Policies that result in a deterioration of the health of the population are also associated with higher healthcare costs, which would have implications for intergenerational equity, as taxpayers of working ages tend to provide the majority of support for public sector spending. In addition, loss of livelihood and productivity as a result of health issues will have compounding intergenerational effects (as mentioned in other sections of the report). According to a 2016 report by the OECD, in the absence of aggressive control, ambient air pollution is projected to cause between 6 million and 9 million deaths per year by 2060, with annual healthcare costs rising to USD 176 billion (from USD 21 billion in 2015), and will result in 3.7 billion work days lost owing to air-pollution related illnesses (increasing from 1.2 billion in 2015). The combination of lost labour productivity, health expenditure, and reduced crop yields will cost approximately 1% of global GDP by 2060 (OECD, 2016).

In addition to health's intrinsic value as an outcome, in that it enhances wellbeing (Lustig, 2006), it also has an instrumental value of enabling better decarbonisation and climate adaptation policies as an input. Improved health outcomes may, for example, increase productivity as a result of better nutrition, improved learning during education, and lower absenteeism. Health's instrumental benefits would be an enabler for the innovation necessary for improved decarbonisation and climate adaptation policies.

Climate impact

It is worth considering the impacts of action today on future climate – even within a framework about climate – because it is not possible to capture all of the effects of future climate change. While this framework captures many of the main outputs and outcomes it cannot be comprehensive. Explicitly including the impacts on climate itself helps to incorporate the wider range of effects not explicitly captured.

Amongst others, future climate change may result in more flooding, increased erosion from storms and sea level rise, glacial retreat, and extensive species loss. All of these may have wider effects than those considered in our framework.

Carbon Brief has found that 69% of a total of 355 extreme weather events around the world, identified based on mapping published attribution studies, were made more likely or more severe by climate change owing to human activities (Carbon brief, 2021). In fact, a Stanford University study from 2020 finds that the common scientific approach of predicting the likelihood of future extreme events leads to significant underestimates and even small increases in global temperatures can significantly increase the probability of extreme weather events, particularly heat waves and heavy rainfall (Diffenbaugh, 2020).

As an example, in the UK in particular, climate change has already increased flooding, with every sixth property (5.2 million properties) exposed to some flood risk , causing damage worth about £1.3 billion per annum on average (Environment Agency, 2009).

The impact of policies on the climate itself is therefore another consideration for policymakers.

Living standards

The impact of environmental policy on living standards is propagated over generations and can feed into society's quality of life through multiple channels. It is therefore important for policymakers to consider the impact of decarbonisation and climate adaptation policies on these measures of living standards.

For instance, living standards are affected by economic growth and productivity, making it crucial to study the impact of decarbonisation and climate adaptation policies on economic growth. A study conducted by the International Labour Organization (ILO) on the impact of heat-stress on labour productivity concluded that a global temperature rise of 1.5°C by the end of the twenty-first century could result in a 2.2% loss of total working hours worldwide due to high temperatures by 2030, a productivity loss equivalent to 80 million full-time jobs. Consequently, this would result in a loss of global GDP by US$2400 billion and have a significant negative impact on the livelihoods of future generations (ILO, 2019).

It is also important to consider the intergenerational impact of policy inaction. A study on the intergenerational impacts of natural disasters found that children in utero and young children exhibit the most long-lasting adverse effects from natural disasters (Caruso, 2017). These effects include less human capital accumulation, worse health outcomes, and fewer assets after reaching adulthood. The study also provides evidence of the intergenerational transmission of shocks. Children of mothers who had been exposed to natural disasters have a lower level of educational attainment and increased chance of falling into child labour. As climate change worsens, the likelihood of environmental shocks will increase. As such, policy inaction associated with decarbonisation and climate adaptation can have long-lasting negative effects for many generations to come, making it imperative for policymakers to consider how living standards of future generations can be impacted by it.

This section only scratches the surface on living standards and does not exhaustively cover all the ways through which living standards may be affected by decarbonisation and climate adaptation policies and the intergenerational impact of such policies.

Distributional effects

Outputs and outcomes of decarbonisation and climate adaptation policies do not have an equal impact across all demographics and regions. Policies that have distributional consequences for current generations are likely to have an intergenerational impact. Policymakers need to incorporate current and future distributional impacts of climate policy decisions, including decisions not to act.

The mechanism through which distributional inequality for current generations detrimentally affects social mobility for future generations is most notably evident through what was termed by Alan Krueger as the ‘Great Gatsby Curve’ (Krueger, 2012). This curve, shown in Figure 5, demonstrates the inverse relationship between income inequality (proxied by the Gini coefficient[9]) and intergenerational

[9] This coefficient shows the distribution of incomes across a population and ranges from zero to one. A high Gini coefficient means that a nation has a high level of income inequality. It is often represented graphically

mobility (proxied by the elasticity between parents' earnings and children's adult earnings[10]). It implies that a concentration of wealth in one generation is associated with a greater fraction of either advantage or disadvantage being passed on between parents and their children. The curve captures the range of underlying gradients that cause current levels of inequality to affect children (and by extension future generations) including the capacity for inequality to bring about varying levels of access to good schools and jobs amongst other effects.

Figure 5 The Great Gatsby Curve: more inequality is associated with less intergenerational mobility

Source: Frontier analysis of Corak (2016), World Bank (2021) data, OECD.Stat data (2021), and Department of Statistics Singapore Key Household Income Trends data (2021)[11].

Given that some areas are more likely to be affected by global warming, it can lead to regional disparities that may compound over time. The choice of decarbonisation and climate adaptation policies may help to alleviate these differences or could exacerbate them. The distributional impact of global warming is, for example, evident in the UK where exposure to heat is greater in the South and East of the country and where people living in urban areas are more exposed than those living in rural areas due to the urban heat island (UHI) effect (Heaviside et al., 2016). Similarly, NO2 concentrations are particularly high in cities near major transport corridors where some socio-economically deprived groups and other ethnic minority groups are over-represented (Brainard, 2002). Additionally, those living in affordable housing and socio-economically disadvantaged households are over-represented in areas at risk from coastal flooding (Houston, 2011).

through the 'Lorenz curve' which shows income or wealth distributions by plotting the population percentile by income on the horizontal axis and cumulative income on the vertical axis. The Gini coefficient is calculated by subtracting the area below the Lorenz curve from the area below the line of perfect equality (0.5 by definition) and dividing this by the area below the line of perfect equality.

10 A higher elasticity between parents' earnings and children's adult earnings reflect a lower degree of economic mobility across generations.

11 Earnings elasticity data is obtained from Corak (2016). Gini coefficient measures are obtained using the average of data available between 2013 and 2018 from World Bank data with the exception of Gini coefficients for New Zealand, which uses OECD data for 2014, and Singapore, which uses Department of Statistics Key Household Income Trends data for 2018. Countries were chosen on the basis of their having intergenerational earnings elasticity data available in Corak (2016).

Certain demographic groups may also be more susceptible to the effects of climate change on account of their vulnerability through exposure, sensitivity or adaptive capacity towards climate change. For example, older people and those with medical conditions can be disproportionately sensitive to climate impacts which puts them at a higher risk for heat related deaths (Arbuthnott, K. and Hajat, 2011).

Decarbonisation and climate adaptation policies by themselves can have distributional impacts within the current generation that compound into the future, some of which could widen inequality. As one example, taxing energy vectors, can increase a range of costs for households which can be distributionally regressive (Guidehouse, 2020). Similarly, subsidies for low-carbon technologies may be distributionally progressive due to reductions in electricity prices spurred by more efficient technology. Moreover, the changes brought about by climate change may render existing measures that support vulnerable groups inadequate.

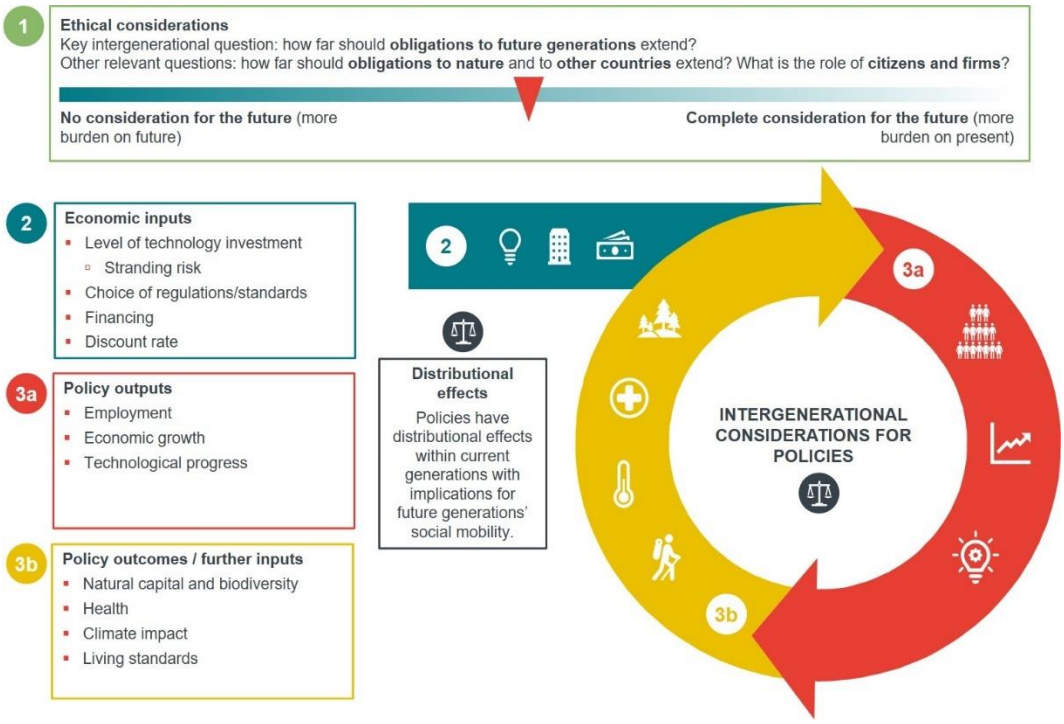
Given the range of distributional impacts that are associated with global warming, decarbonisation and climate adaptation policymakers should consider options to counter these impacts. These may include targeted funding for vulnerable groups, job retraining programs or tax relief policies, amongst other measures.

BRINGING TOGETHER THE FRAMEWORK

The figure below brings together the three elements of the framework: ethical considerations, economic inputs, and defining outputs and outcomes. In addition there are four issues that are pervasive and warrant further thought by policymakers when considering outputs. These include:

- The circular nature of policy impacts
- The non-linear nature of climate change
- Co-benefits or disbenefits of policy actions
- Behavioural nudges and consumer actions

Figure 6 Framework for assessing intergenerational equity



Source: Frontier Economics

The circular nature of policy impacts

The framework is circular to reflect the effects of current policies on the future world which, in turn, act as inputs that contribute to future decision-making. For instance, the state of natural resources in 20 years' time is governed by policy actions today. This future state of natural resources in 20 years' time, however, will act as a constraint on policies that can be enacted at that time. The circular nature of the framework aids in visualising the exact nature of intergenerational fairness and fosters a reflection on the long-term resilience of policies.

The non-linear nature of climate change

An important facet of climate change is its non-linear nature. Beyond a "tipping point" some of the effects of climate change will no longer be reversible. For instance, melting of glaciers, loss of biodiversity and other events may trigger

changes to ecosystems that are irreparable. It is important to consider this non-linearity when assessing the trade-offs between current and future actions and intergenerational consequences of policy action or inaction.

Co-benefits or disbenefits of policy actions

Many policy actions can have conjoined benefits or disbenefits across sectors. It is important to keep these linkages in mind as policy actions are deliberated. For example, policy action providing a stimulus to the electric vehicle industry will likely lead to technological progress and regional economic growth as manufacturing hubs are created, but also cause a shift in employment, requiring additional investment in education and training of labour. In addition, use of electric vehicles will not only reduce GHG emissions but also decrease other forms of air pollution (NOx, SOx) improving air quality and alleviating associated health issues.

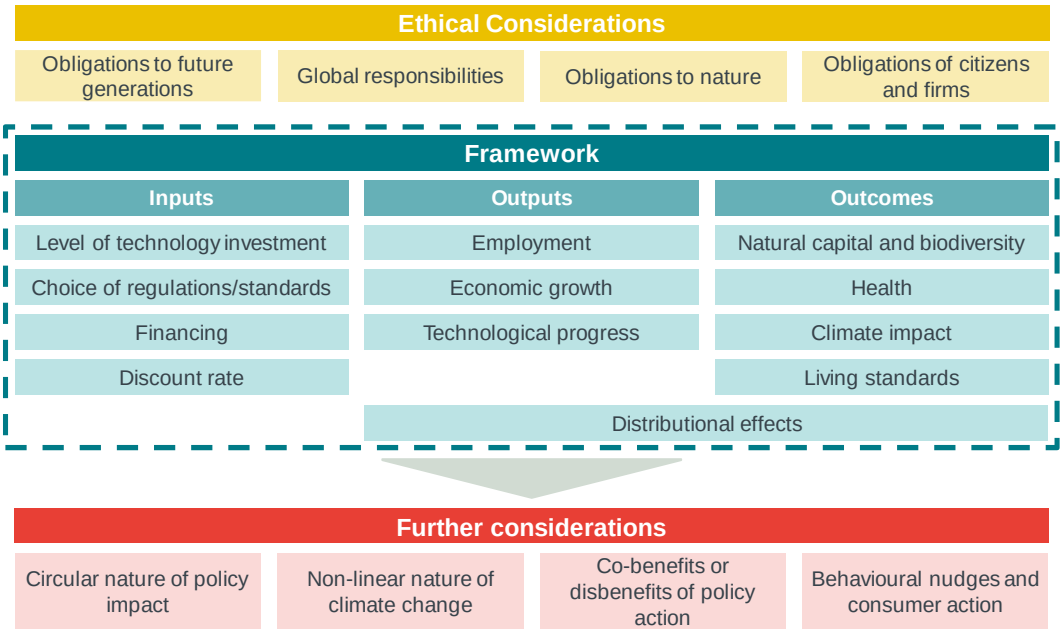
Behavioural nudges and consumer action

Ensuring policy action is based on an understanding of behaviour is important. If climate policy action can be aligned with wider, impactful, events then those events can support – and act as a catalyst – for successful climate action. It is likely that facing the consequences of a risk, such as the COVID-19 pandemic, may raise consciousness (BCG, 2020) and engender behavioural change of climate-related issues. Other events, from volcanic eruptions to rising awareness of health issues linked to obesity, can be spurs to act on climate issues while addressing the particular event itself. Policy action also needs to build on external catalysts for change.

CONCLUSION AND NEXT STEPS

An important tenet of delivering a just transition to net zero is the focus on intergenerational equity. This discussion document surveys and organises evidence and recent discussions to help develop a framework that could incorporate intergenerational considerations into climate discussions. A summary is provided in the figure below.

Figure 7 Summary of topics discussed



Source: Frontier Economics

Developing a comprehensive framework will require more time, discussion and development than was possible in this piece of work. To begin a discussion, we have investigated the following issues as important for policymakers when considering intergenerational equity:

- **Ethical considerations** associated with particular policies (such as the degree of consideration for future generations or global context);
- **Right parameters** are used to populate any analysis: discount rates properly reflect future socio-demographic scenarios and assumptions around financing take climate impacts into account;
- **Characterisation of outputs** recognises the shifting sectoral composition of the economy under climate scenarios and explicit estimates of their impact on economic growth; and
- **Impact on outcomes**, beyond those on measured income, for future generations are incorporated into the analysis.

The framework also highlights a few topics that are likely to be pervasive throughout the discussion and warrant further thought:

- **Circular nature of policy impact**: current policies and actions drive outputs that result in a future world which, in turn, acts as an input that contributes to decision-making for the further future.

- **Non-linear nature of climate change**: beyond a “tipping point” some of the effects of climate change will no longer be reversible.
- **Co-benefits or disbenefits of policy action**: Many policy actions can have conjoined benefits or disbenefits across sectors. It is important to keep these linkages in mind as policy actions are deliberated.
- **Behavioural nudges and consumer action:** Policy action is likely to be more effective when behaviour is taken into account and when it is linked to other events or wider trends.

ANNEX A FURTHER DISCUSSION OF ETHICAL CONSIDERATIONS

This annex expands on the ethical considerations that need to be taken into account when discussing the intergenerational effects of climate mitigation and adaption policies. Again, it should be noted that we are not experts in the field of ethics and any views are on the basis of our own *economic* expertise and research of the literature surrounding ethics.

Obligations to future, in addition to current, generations

When considering projects' intergenerational effects, policymakers need a clear sense of whether they are morally obliged to take the welfare of future generations into account and, if so, by how much and how far into the future these obligations ought to extend. This consideration is particularly salient for questions concerning climate change, which is prone to the 'tragedy of the horizon', the disincentive to address global warming as climate inaction is perceived to be felt more acutely in the future and costs of action are perceived to be borne by the present generation.

Policymakers could, for example, have no consideration for the future (implying a high discount rate and greater burden on future generations). Alternatively, they could have an infinitely greater consideration for the future (implying no discount rate and a greater burden on present generations).

It is notable that for example in Wales the Well-being of Future Generations Act requires public bodies to think about the long-term impacts of their decisions, making clear that this is a relevant consideration.

Aside from the framing of the ethics around future generations presented below, other principles such as "the polluter pays" (which states that the costs of pollution should be borne by those who cause it) indirectly have implications for intergenerational equity. Under this principle, as the current generation continues to emit significant levels of carbon dioxide and create problems for future generations, they have a responsibility to finance the mitigation of the damage they are causing.

There are a range of approaches to considering the ethical dimensions of our responsibility to future generations. Prominent styles of ethical reasoning include[12]:

- **Utilitarianism**: broadly seeks to maximise the greatest good for the greatest number[13]. It may consider good to be the expected sum of well-being over time and across generations. This theory entails that policymakers choose activities and leave behind assets which can "sustain the subsequent sequence of socio-ecological futures that…(they deem) right on utilitarian grounds, aware that succeeding generations will choose in accordance with what is planned for them" (Dasgupta, 2021).

[12] Many of these are set out in Dasgupta (2021).

[13] Early forms of utilitarianism, associated with Jeremy Bentham, sought to maximise a 'hedonic' conception of individual utility (focusing on maximising pleasure and minimising pain). Later forms of utilitarianism, associated with John Stuart Mill, maximise a more general concept of aggregate welfare. It is this latter form of utilitarianism that is more typically used by policymakers (Carney, 2021).

- **Utilitarianism behind the Veil of Ignorance**: approaches utilitarianism (and its application to intergenerational wellbeing) through the lens of principles of justice. Rawls (1972) articulates principles of justice as those to which free and rational policymakers would agree ought to govern their society if they had to choose them from behind a 'veil of ignorance'; that is, ignorance of their own abilities, psychological propensities, and status or position in society. Given that policymakers would not know which generation in society they would belong to, they would be likely to choose policies that maximise expected utility across generations.
- **Discounting Future Generations**: The extent to which future utility is discounted (for the above ethical theories and more generally) is a source of debate, as recognised in the 'Discount rates' section. Economists and philosophers favour both the use of positive rates to discount future well-being[14] as well as applying the same weight to the well-being of present and future generations[15].
- **Intuitionism**: recognises that our moral intuition can enable us to determine the actions (and by extension policies) that are self-evidently right without relying exclusively on a single sacrosanct ethical theory. On this basis, after playing off the implications of one set of moral principles (for example including classical utilitarianism) against others, policymakers may appeal to their intuition in order to advocate a particular policy.
- **Intrinsic theory of value**[16]: goods or services may have an intrinsic value that does not vary depending on how people perceive or price them. Instead, the objective value of goods and services spans wider determinants of their worth, such as the way in which they are produced. On this basis, an intrinsic theory of value may preserve wellbeing of future generations, given that this is a constituent of objects' worth, regardless of pricing.

Global responsibilities

Given that climate change poses a global challenge, effective measures to address this challenge will require international agreement and cooperation. The impacts felt by future generations will depend on the actions of all countries, with measures taken by the UK capable of prompting wider global action. In addition, analysis of UK actions cannot be confined to the impact on UK residents but must consider how it links into the decisions of other countries and institutions.

These challenges raise a number of questions around the UK's global responsibilities, including the extent to which it:

- **Collaborates with other countries and avoids problems of 'free riding':** given that decarbonisation and climate adaptation policies constitute a global public good, collective action to address global warming may be prone to the

[14] Including Arrow, K.J. and M. Kurz (1970), *Public Investment, the Rate of Return and Optimal Fiscal Policy*, Baltimore: Johns Hopkins University Press.

[15] Including Parfit, D. (1984), *Reasons and Persons*, Oxford: Oxford University Press.

[16] An early example of the intrinsic theory of value was articulated in Adam Smith's *Theory of Moral Sentiments* (1759) where his 'Labour Theory of Value' argued that the economic value of goods was determined by the amount of socially necessary labour to produce it.

'tragedy of the commons': the disincentive to address climate change arising from its local costs and global benefits. Given the scale of climate change's effects, countries must accompany measures that price negative externalities (through a carbon tax) with voluntary participation in sustained, coordinated, international efforts to counter these effects. Multilateral regimes can aid this process by defining the gains to co-operation, sharing them equitably, and sustaining co-operation in ways that overcome incentives for free-riding.

- **Provides support to poorer and more vulnerable countries:** the poorest countries are likely to be hit the hardest by the adverse effects of climate change (and have the least capacity to adapt to these effects) whereas richer countries are better able to bear the burdens of adjusting to them. As a result, global warming will exacerbate inequality between countries which may oblige richer countries to maintain greater duties in tackling climate change and to support more vulnerable countries[17].
- **Has a historical obligation to act even quicker in addressing climate change:** Richer countries are also responsible for the bulk of accumulated stocks of greenhouse gas emissions (Stern, 2007). The UK, for example, has been responsible for a disproportionate share of historic emissions as the country that industrialised first. These historic emissions may oblige the UK to decarbonise at an even faster rate than other countries and thereby reduce the relative duties of those countries with lower historic emissions to tackle climate change. The relative importance of countries' current wealth versus their historic emissions in bearing greater burdens to tackle global warming remains, however, a source of disagreement (Bou-Habib, 2019).

The effects of climate change and the level of responsiveness to it also vary within countries in addition to between them. The UK's coastal and rural communities, for example, will be particularly adversely affected by rising sea levels and a greater prominence of drought respectively. As a result, when setting decarbonisation and climate adaptation policies, policymakers also ought to take a place based perspective that accounts for these varying effects within countries.

Obligations to nature

Obligations to nature are beginning to be recognised on a legal basis, with Ecuador's Constitution being the first in the world to recognise legally enforceable Rights of Nature in 2008 (prohibiting the extraction of non-renewable resources in protected areas). Whilst policies that preserve nature may be likely to have positive intergenerational effects (as elaborated upon in the 'Natural capital and biodiversity' section), we may have obligations to nature regardless of its positive effects for humans and on account of its *intrinsic* worth. This is evident from the fact that nature may have[18]:

- **Moral standing:** it may be appropriate to impart a notion of 'personhood' to ecological systems that is analogous to the quality of personhood possessed

[17] Principle 7 of the Rio declaration on environment and development (Rio Declaration, 1992), for example, recognises that that "developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command."

[18] As articulated further in Dasgupta, 2021.

by humans that renders them worthy of our moral respect. One means by which applying personhood to nature may be possible is on the grounds that ecosystems as a whole (rather than individual animals) are sufficiently sophisticated in terms of their complex adaptability to warrant moral standing. Ecosystems, for example, have a defined self with clear interests (such as systemic stability and resilience amidst a trend towards greater entropy) that may render them of similar moral standing to human beings.

- **Sacredness:** many people locate the sacred in nature on account of its capacity to invoke the transcendent, without necessarily being tied to religion. In some cases, this can result in nature's protection from activities such as logging and hunting (evident, for example, in numerous sacred groves in Benin).

As well as having obligations to nature, we are also embedded in nature and depend upon it for our existence (including, for example, through the air we breathe and water we drink). As a result, it is also in our own self-interest to preserve nature.

Obligations of citizens and firms alongside government

Businesses and civil society play an important role in addressing climate change in addition to governments. Whilst governments set decarbonisation and climate adaptation policies, as well as finance them, businesses set strategies that also impact the environment and play a role in the innovations required to meet climate challenges. Civil society has the capacity to provide a public consensus for a sustainable economy including through votes and consumer decisions that can confer legitimacy to different governments and brands, and can directly impact the environment through their consumption patterns. Effective decarbonisation and climate adaptation policies will therefore recognise the interaction between government, businesses, and civil society in lowering the long-term adverse effects of climate change.

Government policies may enable businesses and citizens to better address environmental challenges. These include fiscal measures (such as prices on pollution and support for R&D) as well as regulatory initiatives (including investor Environmental, Social and Governance [ESG] reporting requirements and clean fuel mandates).

Behavioural policies, can also be an effective and inexpensive way of encouraging socially beneficial changes in public behaviour through "nudges" (or non-intrusive interventions that guide people toward a desirable action). For this reason, the CCC recommends that the "government should…ensure that policy frameworks are designed in a way that encourages…behavioural change" (CCC, 2020a). Potential behavioural measures might involve information campaigns that share best practices for reducing one's carbon footprint or improvements in the effectiveness of smart meter rollout (which can prompt people to become more aware of their energy consumption). The implementation of behavioural measures in the aftermath of the COVID-19 pandemic will also be particularly important for meeting environmental targets. Schemes that are already proposed include the 'Grow Back Greener' fund which involves greening streets, alongside other measures (London Assembly, 2021). This could encourage more people to walk

or cycle to offices. The opportunity to use other key ‘events’ (personal life-stage milestones, national events and global crises) as catalysts to accelerate behavioural and societal change to further climate related policies needs ongoing consideration.

ANNEX B BIBLIOGRAPHY

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