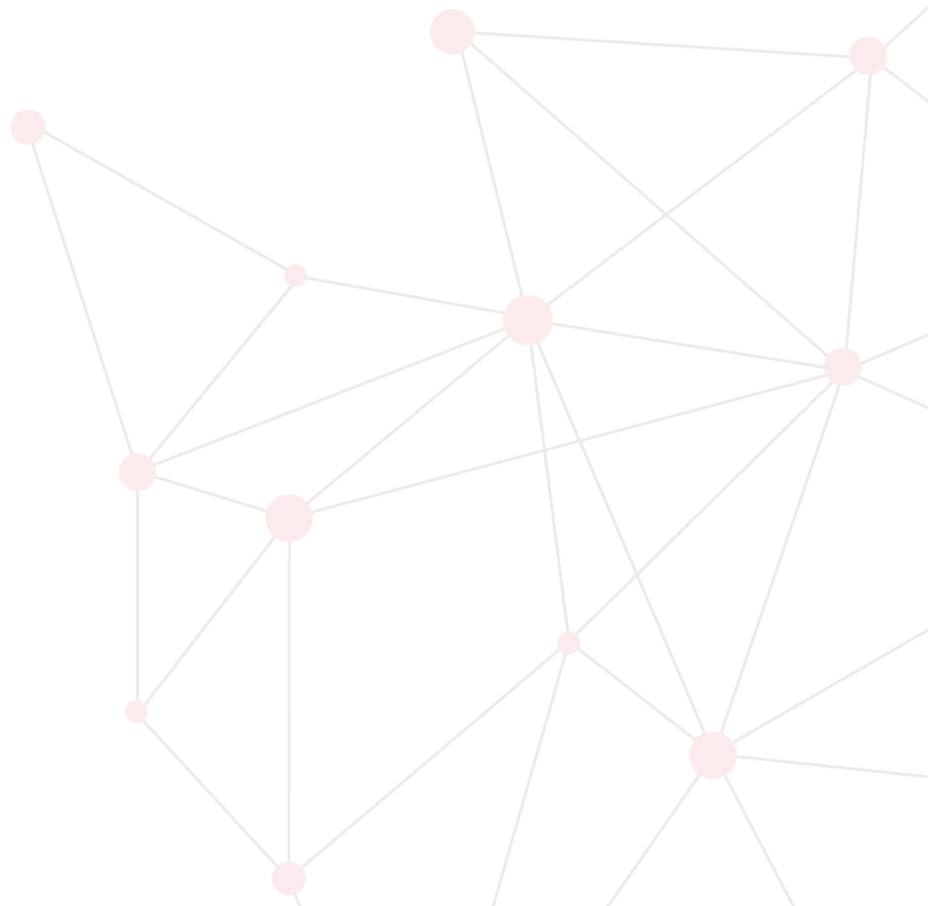

Economics and ethics for sustainable development in a changing world: risk, growth and public action

Tanner Lectures on Human Values

Nicholas Stern



The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is hosted by the Global School of Sustainability at LSE and is funded by the Grantham Foundation for the Protection of the Environment.
www.lse.ac.uk/granthaminstitute

About the author

Nicholas Stern is IG Patel Professor of Economics and Government, Chair of the Global School of Sustainability and Chair of the Grantham Research Institute on Climate Change and the Environment, all at the London School of Economics and Political Science.

These lectures were prepared with Maria João Pimenta and Delfina Godfrid to whom the author is very grateful. A first draft was shared with discussants in February 2026. This version reflects revisions following the delivery of the lectures in March 2026.

Acknowledgements

The author is very grateful for the comments and guidance of John Broome, Tim Besley, Cameron Hepburn, Niki Lacey, Christian List, Luiz Awazu Pereira da Silva, Amartya Sen, David Soskice, Charles Stafford, Adair Turner and Dimitri Zenghelis. The paper was presented in two parts at Stanford University on 12 and 13 March 2026 as the Tanner Lectures, organised by the McCoy Family Center for Ethics in Society. The author is very grateful for the discussion following those lectures and particularly the ideas and comments of discussants Heather Boushey, Simon Caney and Gretchen Daily, and the Chair, Leif Wenar.

The views expressed in this paper represent those of the author. The author declares no conflict of interest in the preparation of this report.

This paper was first published in October 2026 by the Grantham Research Institute on Climate Change and the Environment.

© The author, 2026

Licensed under [CC BY-NC 4.0](https://creativecommons.org/licenses/by-nc/4.0/). Commercial permission requests should be directed to gri@lse.ac.uk.

Suggested citation: Stern N (2026) *Economics and Ethics for Sustainable Development in a Changing World: Risk, Growth and Public Action*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

Contents

Introduction: the questions and the argument	4
Section 1. The science, received economics, technology	8
1.1. The science of a changing climate: scale of risk; urgency of action	8
1.2. The narrow economics of climate change: Pigou; standard growth models; minor perturbations; discounting	12
1.3. Technology and investment	18
Section 2. Growth, economics, and public action	24
2.1. The growth story of the 21st century	24
2.2. The new economics of climate change	27
2.3. Public action: galvanising action and the role of the state	33
Section 3. Rights, justice, and the state	37
3.1. Ethical perspectives on public and individual action	39
3.2. Rights to development and sustainability	44
3.3. Justice and equity	46
3.4. Public discussion and the role of the state	50
Concluding comments	52
References	56

Introduction: the questions and the argument

Obert Clark Tanner expressed the hope that the Tanner Lectures would contribute to intellectual and moral life, but also the hope that they might have practical consequences for the quality of personal and social life. The crises that we now face around climate change, biodiversity, and the environment more generally, surely require both that we deepen our understanding of the intellectual and moral issues they raise and that we grapple, and urgently, with the practicalities of action.

Understanding the ethical issues associated with these crises requires, first an understanding of the nature of the problems we face in terms of their basic scientific, technological, economic, political, and social structure and logic. Indeed, one important theme of these lectures will be that we cannot engage with the ethical issues satisfactorily unless we are indeed clear about both the nature of the problems and the structure of the potential responses. I began by setting out the basic questions and the overall framework of the argument, before getting to work on the details.

In the first section, we will examine these basics of the logic of the problem together with the questions to be examined. I will show where they lead in terms of strategies and policies. Section 1 lays the foundations both for the new growth story (Section 2) and the ethics (Section 3). I will not dwell at length on the science and technology. But they are crucial to what follows. So much has been achieved in their understanding and advance. The science is clear, strong, and well established. It points to grave danger from inaction. On the other hand, technology is moving at great pace and opening ever more possibilities for action. Every time we look at the science, our situation looks worse, and every time we look at the technology, it looks better. The crucial starting point is the recognition of the enormity of the risks that we face and their implications for the urgency of action. Delay is profoundly dangerous. It could lead to unmanageable dynamics and instabilities with our physical environment becoming ever rapidly more hostile and our ability to control change ever weaker. The scale and dynamics of these risks is critical to the ethics and to the necessary action. The science tells us we must act, and urgently. The technology tells us how we can act, and effectively.

These crises have their origins in the immense pressures on the biosphere and the environment associated with the extraordinary growth of global output and income since the Second World War, enabled, in large measure, by energy generated by the burning of fossil fuels. The growth of income per capita of around a factor of four, together with population growth of around a factor of three, generated a 13-fold increase in global economic output since 1950 (Roser, 2019). These developments have brought many benefits, including an increase in global life expectancy of around 25 years and a substantial reduction in poverty across the world (UN, 2024).¹ The challenge now is to break the destructive relationship between economic activity on the one hand and climate, biodiversity, and the environment on the other, so that the progress in our shared prosperity, on all its dimensions, may continue, and poverty in the world can continue to be reduced.

At the outset, let me stress that climate, biodiversity, natural capital, and the environment more generally must be examined together. They overlap, interact, share common causes, and are intertwined. Thus, when I say “climate,” I am usually in this paper, also referring to them all.

Negligence and inaction could put the lives of hundreds of millions, perhaps billions, at risk. It could cause the movement of hundreds of millions or billions of people, creating high risk of major and lasting conflict. These are the stakes we are playing for. The necessary urgency and scale of action which follows from the science indicates that weak or delayed action over these next two or three decades could bring immense damages to our societies and their well-being, possibly

¹ The crises of Covid 19 and of war in recent years has seen a rise in poverty in many parts of the world.

resulting in unstable spirals which could reverse growth and development, generate a long period of decline, kill and maim many, and cause great volatility.

The ethical analyses we offer should be capable of informing the question of how to tackle risks of immense magnitude. And we must calibrate our actions to these magnitudes. For many, these risks could be existential. In the analysis of decisions and risk I will take a largely consequentialist view of the ethics in the first two sections of this paper, although I will also introduce and emphasise the ideas of sustainability and sustainable development, which stress rights of and obligations to future generations. I broaden ethical perspectives in the third section, where I will focus in particular on rights, freedom, and justice.

Looking back, in my view, there have been important strands in the economics of climate change which have been unhelpful and misleading. Much of the early literature made the mistake of trying to shoehorn a problem involving great risk and potential major disruption to growth and development into models with only modest disturbances around an underlying path of steady growth. I will also return briefly to issues of discounting which have been prominent, including around the Stern Review. I will argue that much of the criticism of the approach used in the Stern Review was confused, in large measure because it started with the wrong concepts, avoided explicit treatment of ethics, embodied an inadequate treatment of risks, showed only limited awareness of public economics in imperfect economies, and misunderstood the (minimal) relevance of information from capital markets for the ethics at issue here. The ethics is crucial to the economic analysis in this context, in highlighting issues, defining concepts and understanding information. And the economic structure of the climate challenge shapes the ethical questions. The economics and ethics are deeply intertwined and interact directly.

However, I do think that the economics of climate change has improved in the last decade or so, and I will try to describe where the economics now points in terms of the opportunities for growth and development, which will be part of, and which will flow from, action on climate. It is instructive to understand how some of the early economics was misguided as a basis for where economics should now be moving. That is one of the tasks of the first section of this paper.

The second section of this paper will be on what I have described in my recent book as “The growth story of the 21st century.”² This dynamic story of investment and change is the modern economics of climate change. Delivery on that growth story is, in my view, an economic and political imperative as well as an ethical imperative. It is the route to avoiding climate catastrophe while reducing poverty and fostering development. I will show how the actions, in terms of investment, innovation, and structural and systemic change, that we have to take to tackle these crises will also set us on new paths of growth. The new paths that we describe will not arise if public policy is passive. The new types of investment and innovation on the scale and pace required, together with the necessary structural and systemic change, will require active public policy if they are to become reality. Most of the investment will be in the private sector, but it will be public policy and institutions that will guide that investment towards the new directions that we now need. Change on this scale will not be easy, and there will be many obstacles along the way. But, ultimately, weak action or inaction is even more difficult. Surely insisting on driving towards catastrophe should be seen as unrealistic, notwithstanding the difficulties of delivering the substantial change necessary to embark on the new path.

The framing of the issues that arise from the fundamentals of the science, technology, and ethics, will have major implications for how to structure and pursue the economics. From Sections 1 and 2, these concern: the analysis of extreme risk; the dynamics of structural change; the tackling of a number of key market failures; the theory and practice of discounting. In all four areas, in my view, the received economics has been inadequate, although the subject is now moving in better directions.

² See Stern (2025), *The Growth Story of the 21st Century: The Economics and Opportunity of Climate Action*. As an LSE Press publication, this is available as open access and the digital version is free of charge.

Some narrow, and commonly encountered,³ formulations of the ethical issues express those issues in terms of questions of how to assess or value trade-offs between environment and income, or of how to “allocate carbon space.” Such formulations arise in large measure from a misspecification of the logic and structure of the problem. The approach set out in these lectures from the basics of the underlying structure and logic of the problem: we will ask how far we can find ways forward which improve both the environment and incomes for both poor and rich people and across nations. And how we can improve the welfare both of this generation, particularly poorer countries and people, and those that follow. The answer to these questions is essentially in terms of embracing the new growth story, as we will describe here, and to carry through the necessary investments and structural change to deliver it. Explaining why that is the answer requires setting out the basic structure and the economics of the problem, and that is why I must spend time on those issues.

In the third section, I will emphasise ethical approaches which invoke rights, freedoms, duties and justice, alongside the consequentialist approach that is standard in economics. The ethical questions embodied in the climate crisis which we must examine raise deep issues of rights of individuals and groups, which cannot be understood solely using consequentialism in the ways which are standard in economics. The logic of the problem gives rise to major questions of justice within and between generations: it is richer people who have generated and, per capita continue to generate, greater greenhouse gas (GHG) emissions, which are at the root of the climate problems. Poorer people who have contributed less per capita, often far less, are hit earlier and harder by the consequences of climate change. I will emphasise that whilst there is a right to development, inherent in many discussions of human rights, it does not imply a right to emit.

Whilst the rights approach has had some presence in economics, it has been mostly on the sidelines. I will also argue, albeit briefly, that the moral codes embodied in major philosophies and in the great religions also point to strong action on climate. These codes speak in terms of duties to others and to the natural environment and should, in my view, play a powerful role in our discussion and understanding of the ethics of public action on climate.

The conclusions from the combination of the analytical basics and the ethics have major implications for the political philosophy associated with climate, in particular, for the role of the state. Further, given the centrality of the ethics in shaping public policy, there is a duty in public life to discuss these ethics in an explicit, open way. Not only do the ethics have implications for the role of the state, part of the duty of the state is to offer public forums for the discussion of the ethics themselves. Further, such discussion can improve the perceived acceptability and efficacy of action.

The necessary transformation of the world economy will be difficult. Notwithstanding the great potential gains from effective action and strong investment, there will be major obstacles and dislocations. Both the analysis of the problem and the underlying ethics will be subject to debate, challenge and opposition. There will be vigorous pushback. The political economy will not be easy. Public debate will be necessary not only, as noted, for the effectiveness of the change itself, but also because it is part of a democratic approach to major decisions. Some may argue that whatever the logic behind the case, the scale and pace of change described cannot be delivered. That the prospects for the action advocated are not realistic. I shall argue the contrary. Inaction and hesitation will have such severe consequences that it is delay that should be seen as unrealistic. And unethical.

Of special importance for these Tanner Lectures will be their *conclusions for ethics and moral philosophy*. These are as follows, in summary form.

First, the way ethical questions are framed must be based on a clear understanding of the logical structure of the problems under examination, here particularly the science, technology, and

³ For an example from the popular but serious media, see the BBC programme on Radio 4, *Moral Maze* – see episode titled “Is ‘net zero’ a moral pursuit?” (September 2025).

economics. This is a basic methodological point. In the case under examination, climate change, our economic framing shows the following. i) There is no horse race between economic growth and climate action. ii) Investing in new clean technology, rapidly and at scale, can drive a new growth story, much more attractive than the dirty, destructive models of the past. iii) The logic of our problem is inherently dynamic in the sense of structural, systemic and technological change. iv) The analytical framework must reflect both the magnitude of the risk, which for many is existential, and the necessary pace and scale of the response. On the basis of this logic of the problem, the ethical questions and the case for action concern how to realise this growth story for all. And particularly for poorer countries. Further, the pursuit of this approach requires asking who has what responsibilities and who plays what role. From this perspective, the ethical questions should not be focused primarily on asking about relative valuations for hypothesised trade-offs or about static-allocation approaches to distributional issues; this is a challenge where the dynamics are of the essence.

Second, the consequentialist approach, whilst common in economics and absolutely essential here, *is by itself* not an adequate framework to give guidance on some of the key ethical issues which arise in thinking about action on climate change. i) Climate change requires a consideration of rights, justice and fairness, alongside the consequential analysis of extreme risk. In combining consequentialist and rights-based approaches, I argue that the central concept under consideration is the right to development. ii) The right to development is, in my view, the core concept in relation to rights in this context. It has been central to much of public discussion from the 18th century (Mary Wollstonecraft, Thomas Paine, the US Declaration of Independence), through to Amartya Sen and *Development as Freedom* (1999), and the Sustainable Development Goals of 2015. We note that the right “not to be harmed,” more familiar to some, is within the right to development. iii) The right to development is a crucial idea in understanding justice and fairness. In this dynamic and growth-oriented case, fairness is not about the fair distribution of the carbon space (and thus the right to emit), relative to some invoked distributive criteria, but rather the fair distribution of development opportunities, and thus the right to development.

Third, the major philosophical traditions and the leading religions all point to strong and urgent action on climate. Thus, in this sense, differences in approaches to ethics should not be a barrier to action.

Further, these lectures will also have significant conclusions for political philosophy and political economy. These include the following. First, collaboration and mutual support must be at the heart of action if it is to realise the great opportunities and reduce the immense risks. Second, the new path requires an active state in setting strategy and giving stable and credible incentives for the private investment which will be at the core of the new growth story. The state must also foster public discussion and understanding, if action is to be robust and effective. Third, understanding and acting on dislocation and push-back, and issues of justice in the transition, should be an ethical and practical priority, both to avoid derailing action and as a matter of ethics. The transition will require real leadership and strong communications. Universities, media, and social movements all have their role to play.

The arguments in the lectures come together to show that delivering, and urgently, on the new growth story is an economic imperative, an ethical imperative, and a political imperative. Section 2 shows the economic imperative, whilst also touching on the political. Section 3 offers an analysis of the ethical imperative and draws out the political imperative.

Section 1. The science, received economics, technology

In this section we set out the basic structure and elements of the climate crisis and the economic and technological response.⁴ In so doing we lay the foundations for our economic and ethical analyses, the results of which form the key conclusions of this paper.

1.1. The science of a changing climate: scale of risk; urgency of action

The science of climate change and the role of greenhouse gases (GHGs) starts two centuries ago, with Joseph Fourier's 1824 paper showing that the atmosphere was trapping the exit of heat.⁵ Eunice Newton Foote (1856) and John Tyndall (1859), in the mid-20 century, independently identified, experimentally, gases responsible for the trapping. Calculations on the potential magnitude of the effect were made by Svante Arrhenius in 1896, indicating, he suggested, that a doubling of atmospheric CO₂ would raise the Earth's temperature⁶ by around 5°C (the temperature increase from a doubling is now known as the climate sensitivity; current estimates are around 3-4°C). By the 1920s and 1930s, the explanation of how the greenhouse effect worked was emerging using quantum theory: CO₂ molecules and other greenhouse gases oscillate at a frequency that interferes with (traps) infrared energy which comes from the earth's surface, preventing some of it from escaping from the atmosphere. Essentially the GHGs are those gases present in the atmosphere where molecules oscillate at such a frequency.

This is sound and strong science where the basic theories are transparent and straightforward, and where the key elements of understanding the forces at work emerged more than a century ago. The evidence over the years has continually reinforced the theories. Note that it is the total concentrations of GHGs in the atmosphere that determine the extent of trapping, and that it makes little difference where the GHGs have come from, whether it be London or Johannesburg, Los Angeles or Beijing.⁷ If concentrations rise, temperature will rise.

Temperatures are not stabilised unless concentrations are stabilised. It follows that stabilisation of temperature will occur when sources and sinks for GHGs in the atmosphere are balanced. That notion of balance is the idea behind "net-zero emissions."⁸ The earlier in time that net zero is achieved, the lower the temperature at which the earth stabilises.⁹ I trust these fundamentals are well understood, particularly at a university with the scientific distinction of Stanford.

With this scientific background, let us ask where the world is heading. Possible paths of emissions are described in Figure 1.1. Under current policies and actions, global average surface temperatures increases are likely to be around 2.5 to 3°C, by the end of this century, above reference levels (second half of the 19th century). Such increases would be highly dangerous, as we shall see, but we should note that prior to the UNFCCC Paris Agreement of 2015, the world seemed to be on a path heading for 4°C or more at the end of this century. It is estimated that emissions in 2030-40 are likely to be 20-30% lower than anticipated prior to the Paris Agreement (IEA, 2015, 2023, 2025). Thus, progress is possible. And we should note that if articulated plans

⁴ To remind, when I speak of the climate crisis, it should be understood to refer also to the biodiversity crisis, and environmental crises more generally.

⁵ Fourier looked at theoretical heat balances of outflows and inflows and concluded that the earth's surface was substantially warmer than the simple theory would indicate. Thus he supposed, correctly, that something was trapping the exit of heat.

⁶ This is measured as the "average global surface temperature" averaged in a given period over geographies and for times within the period. If temperatures increases are being measured intertemporally, then the baseline is usually the second half of the 19th century, essentially the beginning of a coal-based industrial revolution, with the use of oil and gas building over the 20th century.

⁷ Technically, there can be slight hemispheric differences in GHG concentrations associated with where emissions occur. However, GHGs mix throughout the atmosphere relatively quickly. Even short-lived gases like methane spread globally within about one to two years (Schuck et al., 2024). The broad point stands that carbon, and GHGs, emitted in one place affect us all.

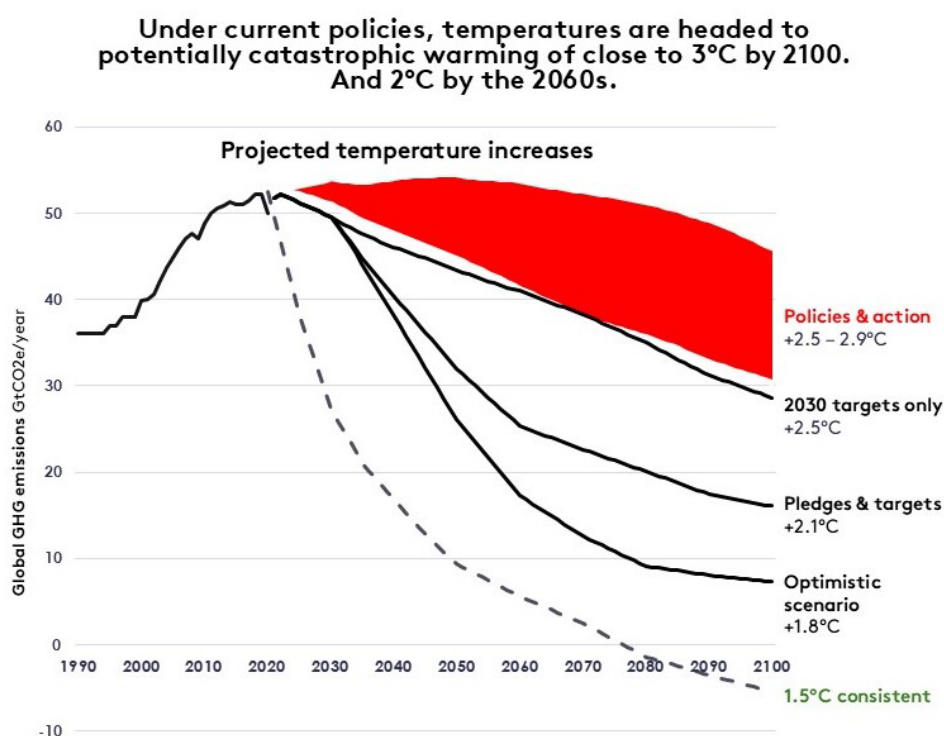
⁸ Once net-zero emissions are achieved, atmospheric concentrations fall over centuries due to natural carbon cycle processes (Rogelj et al., 2018).

⁹ The foundations of the science are, crudely speaking, as described here, but there are subtleties around these basic effects, concerning e.g., the composition and lifetimes of different GHGs. For a helpful discussion of the climate science, see e.g. Dessler (2021).

and commitments for emissions reductions (as submitted to the UNFCCC) are actually achieved, then the end-century temperature would likely be less than 2.5°C, perhaps close to 2°C. We must note, however, the current policies and actions are not yet consistent with these plans and commitments.

The idea of the carbon budget describes the total amount of future emissions that could be consistent with staying below a given temperature limit (e.g., 1.5°C or 2°C) with a specified probability. It is a useful way to express the necessary scale and urgency of action and is often related to a historical budget starting at a much earlier date, to illustrate how much of such “space” we have already consumed, and how much (or little) remains. We examine the idea of “rights to the carbon space” in Section 3.

Figure 1.1. Projected temperature increases under different emissions reduction paths



Source: Climate Action Tracker (2023)

We are headed for real danger. As I have already emphasised, every time we look at the science it seems to be more worrying. When we published the Stern Review, 20 years ago, the Third Assessment Report (AR3) of the IPCC was available.¹⁰ The risks already looked very severe. We now have AR6, and AR7 is under preparation. We also have an IPCC report of 2018 comparing the impacts and effects of 1.5°C and 2°C and showing that the effects of 2°C are likely much more dangerous than 1.5°C – see Figure 1.2. Every IPCC report, from AR1 to AR6, has shown that the effects of climate change are likely to be still more severe and occur still earlier than previously anticipated. Temperature is rising faster than anticipated in earlier reports and the potential consequences of any given temperature are worse than anticipated. For example, when the work on the Stern Review was taking place (2005/6), average global surface temperature was 0.8°C and we thought that around 0.2°C would be added per decade in the next two decades. That would have taken us to around 1.2°C now (2026). But we are close to 1.5°C now.

¹⁰ The Assessment Reports (ARs) are conducted by the Intergovernmental Panel on Climate Change (IPCC), the UN body that monitors and assesses climate-change science (it also examines policy questions) and issues ARs every six or seven years.

Figure 1.2. The consequences of failure could be devastating; the difference between 1.5°C and 2°C is potentially very strong

	1.5°C	2°C	2°C vs 1.5°C
Extreme Heat¹ (Proportion of global pop. exposed to severe heat at least once every 5 years)	14%	37%	x2.6
Number of sea-ice-free Arctic summers²	At least 1 after ~100 years of stabilised warming	At least 1 after ~10 years of stabilised warming	x10
Bioclimatic range loss of >50%³			
Vertebrate species	4%	8%	x2
Plant species	8%	16%	x2
Insect species	6%	18%	x2

Differences between 1.5°C and 2°C are major. Differences from 2°C to 2.5°C, and then to 3°C likely still bigger.

Exceeding 1.5°C could trigger multiple tipping points including for Greenland and West Antarctic Ice Sheets, coral reefs and the boreal permafrost (Armstrong McKay et al., 2022).

Sources: ¹Dosio et al. (2018); ²IPCC (2018); ³Warren et al. (2018).

Given that overshooting the temperature target of 1.5°C now seems certain and that of 2°C seems likely, together with the potential severe consequences of such temperature increase, negative emissions technologies will be essential. These involve carbon dioxide removal or CDR. Forests, for example, involve natural CDR. There are also mechanical and physical methods for CDR. Beyond CDR, “geoengineering technologies” are increasingly proposed, including Solar Radiation Management (SRM), or trying to control the entry of solar radiation into the atmosphere. The ethics and politics of geoengineering have been discussed in the philosophical and other literature. Most commentators have argued that any deployment should be accompanied by robust governance frameworks, and that geoengineering should not replace emissions reductions (e.g., Caney, 2016; Gardiner, 2010; Jamieson, 1996; for an overview see Preston, 2013). And for a brief discussion of the policies and problems see section 3.4 below.

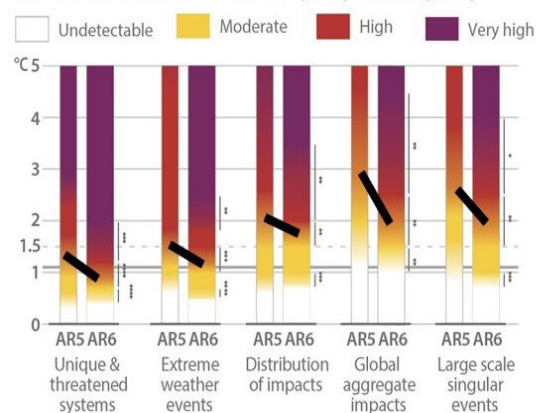
The increasing risks identified by the science are illustrated in Figure 1.3. Likelihoods of tipping points which were previously associated in analyses with temperature increases of 4°C or so now appear to occur around 2°C or so. If those tipping points were to be triggered, the subsequent feedback effects and dynamic instabilities could have devastating consequences – see Figure 1.4. Many parts of the world would see conditions so hostile that lives and livelihoods would be threatened on a huge scale, implying that hundreds of millions, possibly billions, would have to move. Many of those who could not move would be in precarious or impossible circumstances. The consequences of such movements could be large-scale conflict, the reasons for which could not be “switched off.” Such impacts could reverse development and growth, perhaps dramatically. Possibilities for development could be severely curtailed for many across the world.

Figure 1.3. The more we learn, the worse it looks

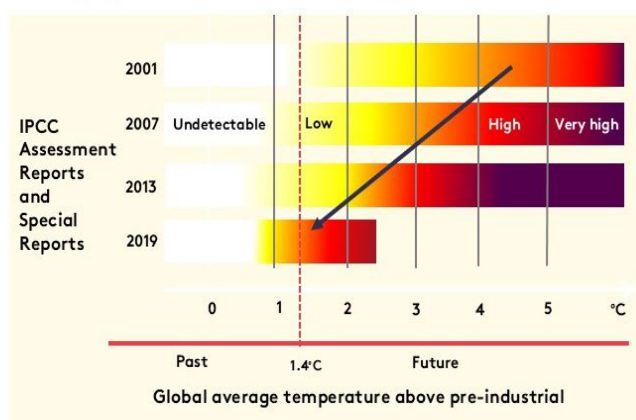
As emissions go on rising and the science advances, the evidence gets ever clearer and more worrying. The need for strong and urgent action is ever more intense.

Risk/Impact

Global reasons for concern in AR5 (2014) vs. AR6 (2022)



Changing risk assessment of tipping points



Sources: Left-hand side: IPCC (2023), via Rogelj (2025); Right-hand side: Lenton (2025).

Figure 1.4. Risks escalating: tipping points and their interconnections

Future risks escalate rapidly with every fraction of degree of warming, particularly as 'tipping points' could be passed.

Tipping points would create powerful dynamic feedbacks, rapid temperature increases, instability, and environmental catastrophes.



Source: map from Lenton et al. (2019)

The climate crisis is closely intertwined with the biodiversity crisis. The biodiversity crisis refers to the rapid loss across many varieties of life at all levels of the biosphere, from genes to species, and up to the ecosystems and biomes that they form. Biodiversity is crucial to our existence. It underpins ecosystem services that sustain the lives and livelihoods of humans by supporting

natural sustainability and resilience, including through water, air, food production, and so on. When ecosystems are degraded, they become vulnerable to tipping points too. Whilst different, the processes of climate change and biodiversity loss have many shared causes and mutually reinforce or accelerate each other, leading to potentially destructive cycles. The recognition of common drivers, such as the burning of fossil fuels and the destruction of forests, gives us indications of areas for intervention which can tackle the two crises together.

The science demonstrates the stakes for which we are playing and why action is so urgent. Understanding the magnitude and nature of the risks is critical to an understanding of the structure of the problem and the framing of the economic, ethical, and political issues. Action will take place in a world that is growing and changing rapidly, particularly for developing countries. The science indicates clearly that the next two decades are critical; action, particularly around investment and innovation in the second quarter of this century will either imply very damaging and self-destructive carbon lock-in or enable sustainable long-term growth. For example, in India, more than half the infrastructure that will be present in mid-century will be built between now and then (Kouamé, 2024). It is in emerging markets and developing countries (EMDCs) that the bulk of the world's growth will occur. If this infrastructure investment and economic growth occur in anything like the same way over this quarter century as in the past in rich countries, then 3°C would likely be out of reach, let alone the "well below 2°C" target of the Paris Agreement. At the same time, emissions from the developed world and China constitute close to 70% of current totals (Our World in Data, 2025).¹¹ What happens in these countries will be critical too. Even though developed country emissions are falling, and China's are peaking around now, unless these emissions fall much faster than currently anticipated, the Paris targets will be out of reach. The required response must be on great scale, intense urgency, and involve all countries.

This paper is rooted in a basic methodological point: questions in moral philosophy must be framed by a clear understanding of the scientific and economic structures underlying the issues under examination. The structure of our problem here is dynamic and one of great and changing risks. And major economic opportunities are embodied in the large and urgent action that the science demands. The response will be shaped in large measure by investment, innovation, and structural change. This is where the economics comes in. Technology, and how it can be advanced, will play a crucial role in shaping what is possible. How we can and should respond to these imperatives to act will be determined by the combination of the science, the economics, the technology and the ethics that we bring to those immense issues. We turn first to the economics, and the imperatives and opportunities. A perspective which runs through this paper and the lectures is that I am optimistic about what we can do, but deeply worried about what we will do.

1.2. The narrow economics of climate change: Pigou; standard growth models; minor perturbations; discounting

We have just set out the key lessons from the science: inaction, or weak or delayed action, could have immense consequences for lives and livelihoods in the future. For many, these could be existential. Unfortunately, initial attempts at the economic analysis of climate change presented economic impacts in terms of minor perturbations around an underlying growth path. Not surprisingly, if we build models where, by assumption, we will be much richer when the assumed modest effects of climate change come through, the case for acting strongly on climate will appear weak. Indeed, in a paper (Nordhaus, 1991) based on one of the most influential of the early models (see Nordhaus, 1992) it was argued that the long-run "optimum" temperature would be 3.5°C. That conclusion, long regarded as profoundly misleading by scientists and ecologists, would surely now be generally seen as absurd, given the catastrophic state of the

¹¹ Though rich countries generated the majority of cumulative historical emissions, middle-income countries, which are home to three-quarters of the world's population, are now the main generators of current flows of emissions.

world it would very likely embody.¹² The ethics is shaped by the logic of the economic structure, including the great risks. Choices of action and policy in the economics are shaped by the ethics, which surely require us to act to avoid putting future generations at such great risk (see the ethical arguments examined in Section 3 below).

Much of the early public policy discussion was, in large measure, founded on the understanding that greenhouse gas emissions constitute an externality and that a “Pigouvian tax” should play a central role in correcting for that externality. The argument for such a tax, or carbon pricing, which puts a price on the externality, is indeed very powerful (see section 2.2 for an explanation).

The mistake was not in proposing such a tax or pricing; it is indeed a crucial part of the policy armoury in tackling climate change. The mistake was in arguing, in summary form, that “economics tells us this is unambiguously the most efficient policy, and that if we put such a tax in place, we will have dealt effectively and efficiently with the problem.” That statement is simply wrong, and not in a minor way; it is seriously misleading. Whilst we should indeed have a strong carbon price, there are several other key market failures of great relevance here, including: those around research and development (R&D); those concerning imperfections in capital markets; those associated with networks and systems; those associated with information; and, crucially, those associated with other forms of pollution linked to burning fossil fuels. None of these five further failures, beyond the GHG externality, are small. The mistake was not in embracing Pigou and highlighting the great market failure associated with the emissions of greenhouse gas; it was in arguing that fixing this was, in large measure, all we had to do on the ‘public policy’ front. In addition, as we shall argue, the urgency of taking climate action could lead to a reduction in political or other obstacles to tackling these market failures (for further discussion see sections 2.2, 2.3, and 3.4 below).

Further, and importantly, the aggregate growth models used in the intertemporal description of the intersection of the science and the economics, the Integrated Assessment Models (IAMs), in the tradition of Nordhaus (1991, 1992), are, by their aggregate assumptions, unable to throw light on the critical systemic and structural changes which will be necessary in the climate response, because these issues are essentially excluded from the models. These systemic, structural, and technological responses include the way we build and run our cities, how we reform our energy and transport systems, the functioning of our land and forest systems, our oceans and so on. Thus, the models are essentially silent on the central issues of the response to climate action. In addition, the assumptions on technological change embodied in these models did not recognise or anticipate the extraordinary pace of technological improvements we have witnessed in the last two decades. We should recognise, however (and see Section 2), that, beyond the modellers, the pace of technological change which has occurred was not foreseen by most commentators. Furthermore, these economic models, when estimating damages from climate change, still do not integrate the cascading and compounding effects, and tipping points, that are inherent in climate risks, and that would undermine economic growth (see Abrams et al., 2026). An assumption of an essentially constant underlying growth rate, impervious to climate risks, makes little sense in this context.

On the public policy side, it is crucial for effective policymaking that we recognise that confining attention to Pigouvian taxes will not generate the structural and systemic change at the pace and scale that we now see is necessary to avoid catastrophe and to unlock sustainable growth. Whilst a price of carbon should be a central feature of public policy, and I cannot emphasise this strongly enough, it does not, by itself, redesign our cities or lead to a recasting of land and forest systems. Systemic change requires a systemic approach to public action.

¹² Nordhaus, much later, subsequently revised that “optimum calculation” down to 3°C by 2100 (Nordhaus, 2018). As we have already indicated 3°C would be very dangerous. The inadequacies of these models in terms of risk assessments, and the assumptions of (largely) exogenous growth, remain major. Further, as we shall argue, they by assumption are silent on the key action issues, particularly concerning structural and systemic change.

Finally, on the problems and mistakes of early analysis, we should highlight misleading treatments of discounting. There was, in discussions of discounting, a pervasive lack of clarity on the concept, too little emphasis on the scale of risks, an assumption of underlying growth, naivety on the role of information available in capital markets, and too little awareness of the relevant economics of policy in imperfect economies. I want to be clear and strong here since the discussion of discounting around the Stern Review was lively and much of it was muddled. I would like to devote a little space to setting out explicitly how to think about discounting in this context. I think the approach to discounting in the Stern Review and my subsequent writings (e.g. Stern, 2009, 2015, 2025) has been broadly correct. Indeed, I was criticised for using a “low” discount rate. But if we take the potential risks seriously, people of the future could be much worse off than now, and that raises the possibility of placing, for some outcomes, a higher value on a unit of cost or benefit to those in the future relative to now. That would involve, for some possible paths of outcomes, negative discount rates.

To explain what I have just said and to guide ways forward, let me begin by describing how we should approach discounting. This approach is summarised in Figure 1.5. We must start with a clear definition of the concept of discounting. Thus, the analytical place to start is the social discount factor (SDF¹³), which is the relative social valuation of an extra unit (e.g. of consumption) in the future relative to an extra unit now. This relative value is the concept at issue in assessing and combining consequences occurring at different points in time in a standard consequentialist or cost-benefit approach, in that it weighs impacts now relative to those in the future. In a more detailed approach, the unit would be indexed by the individual receiving it and, with uncertainty, the state of the world in which it occurs; discount factors would generally vary across these dimensions, and over time. The SDF is like a relative price of future benefits (relative to now). Relative prices are the economist’s “stock in trade.”

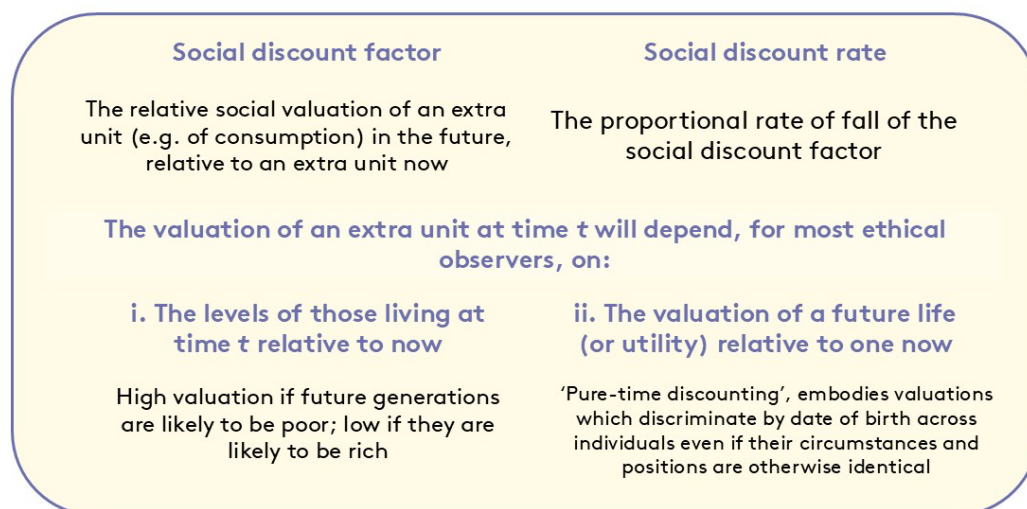
Relative valuations will, in general, depend on social values in relation to increments of consumption or income to people with different standards of living. Many would regard an extra unit for a person who is better off as having a lower social value than for someone who is worse off. That is, of course, a value judgement, but one which many would make. We can see that starting with the right concept points us immediately to key issues shaping social valuations, here relative incomes.

The concept concerns the relative valuation of consequences which occur in the future relative to the value of a unit of account now. The purpose is to help guide decision-making on actions taken at a given point of time, e.g., the present, the consequences of which will play out over the future. How appropriate discounting is assessed will depend on the perspective of the decision-maker. If the decision-makers are individuals, we would expect it to vary across them because there will be varying perspectives on the future. For our purpose here, the decision-maker is society as a whole, looking to decide on investment and climate strategies. We are asking what an ethical perspective on discounting should embody. In principle here from the perspective of the world as a whole.

¹³ In analyses expressing the issues mathematically we can specify the SDF, at time t , in continuous time, as $\lambda(t)$.

Figure 1.5. Discounting: understanding inter-temporal valuations

Decisions now affect lives and livelihoods, and the risks faced, in the future. Intertemporal valuations are central.



If future generations are better off, then the discount factors, with the value judgements indicated in Figure 1.5, would be less than one, or the social weight on consumption increments in the future would be less than now. Thus, in this case, we would be “discounting” future increments relative to the present. But, particularly if we are negligent on climate action, future generations could be worse off than now, and the social weight on consumption increments for a future generation, in this perspective, would be greater than one. This tells us that social discount factors will depend on our own actions. They are not some exogenous pieces of information that can be entirely imported from outside our analyses, particularly as in those cases considered here, where we are considering policy which can affect our future in a major way.

The social discount rate (SDR) is a concept derived from the social discount factor (SDF). The SDR is the proportional rate of the fall of SDF.¹⁴ If the discount factor for an extra unit next year is 0.97, then the SDR is 3%. Too much of commentary on discounting leaps straight to the question, “what is the SDR in your analysis?”. This is potentially misleading in a number of important ways. First, it can divert attention, in contrast to starting with the SDF, from the key question of how well-off future generations will be. We must, and prominently in our analyses, entertain the real possibility that climate change will make future generations worse off. Second, it encourages treating the SDR as if it is exogenous. We often hear the definite article, “the”, in this context with the idea that it is some parameter that can be set from outside the analysis of the evolution of the economy under different policy scenarios. Third, people may make statements of the kind “we should set the SDR at, say 3%” often by appealing to rates in capital markets. Fourth, a focus on the SDR often comes with the assumption that it is constant over time. If we think in terms of the SDF and ask about relative incomes over time, we can see that there is little to justify such an assumption of constancy of the SDR. Sometimes constancy over time is in the context of a model of constant underlying growth, so that incomes rise in a basic exogenous and steady way (see formula in footnote 15); but we know that unmanaged or weakly managed climate change can disrupt growth.

The appeal to rates in capital markets to justify a “choice of discount rate” is fundamentally mistaken. Individuals’ actions in capital markets are not an articulation of social values. Actors in these markets are expressing private preferences in the context of their understanding of the

¹⁴ The SDR becomes, in a mathematical formulation, $-\dot{\lambda}/\lambda$. In a growth model where c is consumption, $u(\cdot)$ a utility function, and the objective function is an integration of discounted utility $(u(c)e^{-\delta t})$ over time, the SDF is $\lambda = u'(c)e^{-\delta t}$, where u' is the first derivative of u . Its proportionate rate of fall, the SDR, is $\eta(\dot{c}/c) + \delta$, where η is the elasticity of the social marginal utility of consumption with respect to consumption (i.e. $-u'' \cdot c / u'$, where u'' is the second derivative of u) and δ the “pure-time discount rate”, attaching a lower weight, if δ is positive, to utility occurring in the future. In this formulation the SDR is η times the consumption growth rate plus the rate of pure-time discounting. This expression has attracted much attention, and is often associated with the Ramsey rule.

workings of markets and of their assessment of future prospects. The rates in the markets have little or nothing to tell us about social preferences. Further, capital markets are full of imperfections around risk, information, collateral, and so on, and thus themselves do not reflect private marginal inter-temporal valuations, let alone social values for societal decisions.¹⁵ Thus, even if one makes the mistake of believing that such markets could, if they are perfect, reveal social preferences, we should recognise that the imperfections are major and thus even private preferences are not revealed by interest rates.

One further important issue concerns “pure-time discounting.”¹⁶ This involves assigning a weight to a future individual, or their utility, which is lower than that for an otherwise identical individual in the present (where “identical” here covers every aspect of relevance, including consumption levels), except that the future individual is in the future. This is essentially discrimination by date of birth. It is very difficult to offer a serious ethical argument that could justify this. Opposition to such discounting has a long philosophical tradition, including Frank Ramsey (1928), A.C. Pigou, (1920) John Maynard Keynes (1936), Roy Harrod (1948), James Mirrlees (1967).¹⁷ And, the notion of “symmetry”, in the sense of social decisions being dependent only on the collection of preferences and utilities and not on who holds them or how they are labelled, is a standard assumption in social choice theory (see e.g., Arrow, 1951, or Sen 1970a).

We should recognise that there is a different argument for such discounting which is not discrimination. This is associated with an exogenous threat (e.g., a large asteroid) which could wipe out the population so that, in this event, the individual in the future, and their utility, would not exist. An expected utility approach, then, in formulating the sum of utilities across time and across possible outcomes, weights future utilities by the probability that the individual will exist. That probability could be less than one.¹⁸ An exogenous threat is not the same issue as the analysis of risks which arise from our own actions. Managing these (endogenous) risks should be a direct part of our analysis.

The approach to discounting that I have described is basically that of the Stern Review and my subsequent writings (see e.g., Stern, 2008, 2014a, 2014b; Stern et al., 2022). It is one that I learned from reflection and analysis, from the literature, and from my teachers such as James Mirrlees and Kenneth Arrow. I still think that it is sound and that those who criticised the approach to discounting in the Stern Review were largely mistaken or misguided for the reasons I have described.¹⁹ And I note that anyone who has understood the above discussion of discounting should regard the question “what is the discount rate in your analysis?,” with emphasis on the definite article, as evidence that the person asking has a weak understanding of the issues.

In retrospect, as I have argued (see section 1.1), the Stern Review, far from overstating risks or being “alarmist”, as some argued, understated them. Correspondingly, we have to entertain the possibility of attaching higher weights to increments in future consumption or income than now, thus negative SDRs in some circumstances.

¹⁵ The basic microeconomic theory of a consumer maximising utility in perfect markets indicates that, at an optimum for the consumer, the price of a good in the market reflects the marginal utility of that good to the consumer.

¹⁶ In the mathematical formulation in footnote 15, then $\delta = 0$ represents the absence of pure-time discounting, and the level of δ captures its intensity, if above zero.

¹⁷ In appealing to past distinguished commentators on this issue, I cannot ignore the work of Kenneth Arrow. Arrow (1999a, 1999b), drawing on Koopmans, argues that discounting is logically necessary in the following sense: without impatience the optimal saving rate could become arbitrarily close to 100%. This is the “strong argument” in favour of discounting. Arrow’s weak argument: “the strong ethical requirement that all generations be treated alike, itself reasonable, contradicts a strong intuition that it is not morally acceptable to demand excessively high savings rates [thus sacrifice] of any one generation, or even of every generation.” As I set out in the Stern Review and my Richard Ely lecture of 2008, this result is highly dependent on the model assumptions of no technical progress and infinite time horizon. We know there is much technical progress underway and more to come. And as I have outlined, we are looking at the next few decades and not infinitely into the future. Indeed, the opportunities and challenges are likely to change radically and are endogenous to our actions.

¹⁸ For a fairly recent discussion of such issues and some references, see Chichilnisky, Hammond, and Stern (2020).

¹⁹ For an exposition of the theory of shadow prices (discounting is embedded in this) in imperfect economies, see Drèze and Stern (1987). See also section 2.2 below.

As the messages from the science become ever more worrying, the balance of our attention in policy analyses should move towards policy to manage those risks. Discounting will, of course, come into the analyses, but those analyses and conclusions will largely be shaped, in my view, by the question of how we can understand and manage the risks.

This is illustrated by Box 1 in my Richard Ely Lecture of January 2008, published in the *American Economic Review*, arguing, I hope obviously, that there is a central role for both risks and the ethics of discounting. Box 1 is reproduced here as Figure 1.6. I felt the need then to make the point as part of interactions with my good friend, the late Marty Weitzman, who, rightly, emphasised the central role of the magnitude of the risk. Marty saw the critical role of the magnitude of risk clearly when others, such as Bill Nordhaus, were underplaying the risk. Box 1 shows that in comparing two paths, there will always be a specification of risk which dominates choice for a given approach to discounting. And for a given specification of risk, there will always be an approach to discounting which dominates choices, e.g., if we discount so heavily that we attach zero weight to all effects occurring after the time when the impacts associated with the risk appear. My reason for offering this observation here is that I now think that whilst the discussions of discounting were not only confused and confusing in many quarters, they also attached too much importance to discounting in the context of the argument and relevant decisions. I would now place ever-increasing emphasis on the immense risks we face, the urgency of responding to those risks, and the attractive new paths of growth on offer.

Figure 1.6. Box 1 from Stern (2008) on risk and discounting.

ROLE FOR BOTH RISK AND ETHICS	
•	Write the expected utility integral as $\int_0^\infty g(t)f(t) dt$, where $g(t) = E[\hat{u}(c)]$, and $\hat{u}$ is the welfare difference without and with climate change; $f(t)$ is the pure-time discount factor. $g(t)$ will depend on model structure, policies/path, and shape of $u(c)$. It is possible that $g(t)$ is infinite for some finite T (see Weitzman 2007a).
•	For any given $g(t)$, we can construct $f(t)$ so that $\int_0^\infty g(t)f(t) dt < \varepsilon$ for any $\varepsilon > 0$, i.e., there are arbitrarily small losses from climate change. An example is $f(t) = (1/g(t))e^{-\delta t}$ with $\delta > 1/\varepsilon$.
•	For any given $f(t)$, we can construct $g(t)$ so that there are infinite losses from climate change, i.e., $\int_0^\infty g(t)f(t) dt = \infty$. An example is $g(t) = 1/f(t)$.
•	Clearly, both ethical values and risk play key roles.

Source: Stern (2008)

In retrospect, the following quote from Nordhaus' review of the Stern Review is shockingly mistaken. It is extraordinary that a leading and distinguished member of the profession could misunderstand discounting in such serious ways. He is far from alone (see e.g., Mendelsohn, 2008; Becker et al., 2010).²⁰

The Review's unambiguous conclusions about the need for extreme immediate action will not survive the substitution of assumptions that are consistent with today's marketplace real interest rates and savings rates. (Nordhaus, 2007, p. 686).

The quote commits a whole series of mistakes. It suggests that rates in capital markets have ethical significance. They do not. It suggests that discount rates should be much higher. That misses the dangers of lower incomes in the future. It suggests that discount rates can be imported from outside. It ignores capital market imperfections even if one pursues the mistaken idea that capital market rates are relevant to the ethics. It suggests that strong and timely action to avoid catastrophic outcomes is "extreme." Figure 1.7 summarises key aspects of the muddled

²⁰ I am grateful to Christian List for reminding me of this statement by Nordhaus.

history of discounting in climate economics. Looking back, those who wanted higher discount rates, had modest views of risk, and assumed indefinite growth, were profoundly wrong. The basic conclusions of the Stern Review, on the importance of major and urgent action, stand strong, and in retrospect, should have been still stronger.

Figure 1.7. Discounting and risk: a muddled history in economics

In retrospect, the following quote from Bill Nordhaus' review of the Stern Review is shockingly mistaken:

"The Review's unambiguous conclusions about the need for extreme immediate action will not survive the substitution of assumptions that are consistent with today's marketplace real interest rates and savings rates."

(Nordhaus, 2007, p. 686)

Three major mistakes in one quote:

- 1 It is **not "extreme"** to turn away from a cliff-edge and invest in an attractive new path. Given the risks, it can be seen as reckless not to turn.
- 2 It **misunderstands** discounting. Three misunderstandings here: (a) social discount rates are endogenous, they cannot simply be "imported" from outside; (b) markets do not carry social values; (c) and even if they did, capital markets are highly imperfect and do not reflect either private or public marginal valuations.
- 3 It **overstates** the importance of discounting relative to risk in this context.

Five mistakes, if we decompose the second into its three elements.

In retrospect, the Stern Review, far from overstating risks or being "alarmist", understated the risks.

Both ethical values and risk play key roles, but we now see risk as ever more important, and impacts ever more severe and closer in time.

The case for urgent action is now mostly driven by the magnitude of future risks; of a magnitude likely to dominate any reasonable or well-founded discounting (see Stern, AER, 2008). And discounting itself must recognise significant probabilities of decline of living standards.

1.3. Technology and investment

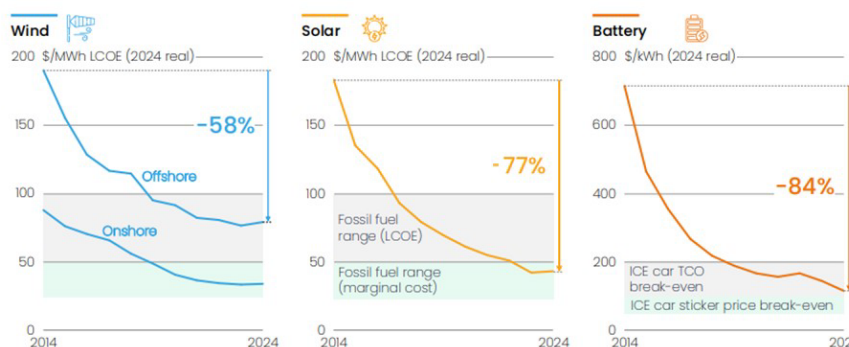
Whilst every time we look at the science, it gets worse, every time we look at technology, it gets better. Technological change, particularly since the Paris Agreement, has been remarkable. Space constraints permit only a brief treatment (see Stern, 2025, for further discussion), but recognising the pace of advance and the potential for the future is critical to the new story of growth which arises from climate action. And that potential for growth, which lies in the climate response, will have a profound influence on how we frame the ethical questions and issues. It moves us from looking at climate ethics primarily as a burden-sharing question, or even a question of dividing up the carbon space, to a focus on how to work together to create, foster and support the opportunities for growth and development and the closely connected right to development. Further, just as the location of coal and iron ore, at the heart of new technology in the 19th century industrial revolution, influenced the economic geography of that time, there will be powerful influences on economic geography from the new technologies, with activities moving towards locations with clean, cheap power. This adoption of new and clean technologies will also have effects on employment, particularly for those in dirty industries. Making sure that the dislocation of livelihoods is managed, and that "the transition to the clean" takes place in an equitable and just way, is of great importance. We discuss dislocation and justice in Sections 2 and 3.

Figure 1.8. The pace of technological change

Wind and solar, including storage, now offer the lowest cost means of generating electricity in most of the world. Key cost reduction drivers:

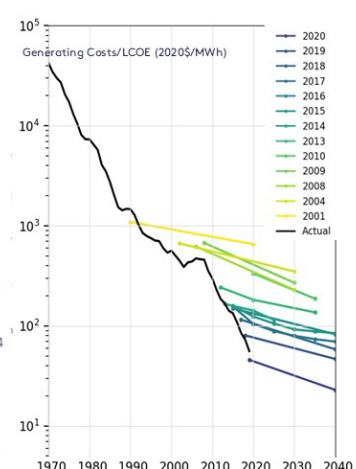
- (a) Learning-by-doing (b) Economies of scale (c) R&D and innovation

Renewable power technologies: decreases in the levelised cost of electricity



- In 2022 to 2023 alone, cost of solar PV declined by 12%, and between 3–7% for wind (IRENA, 2024).
- In 2023, around 90% of global net power capacity additions were solar and wind; only 6% from fossil fuels (BloombergNEF, 2024).

Actual vs IEA projected LCOE of solar PV



Note: Global averages for new installations.

Source: Left-hand side: Ember (2025); right-hand side: Ives et al. (2021)

As Figure 1.8 shows, the cost of renewable energy and of batteries has plunged in the last decade. And in many cases far more rapidly than anticipated. A decade ago, a solar panel would have cost around US\$2 per watt; it would now be around 30 cents per watt in the US and below 10 cents in China (IEA, 2020; Swanson and Rappeport, 2024). In the last few years, around 90% of global net power capacity additions came from solar and wind (BloombergNEF, 2024). China added 300GW of renewable capacity in 2023 (S&P Global, 2024); this magnitude is illustrated by comparison with the total accumulated capacity in the UK of all forms of around 100GW (Ember, 2024). The pace of falls in cost and rises in the installation of renewables has been remarkable. Renewables are now the lowest cost means of generating electricity in most of the world (see Figure 1.8). As the work of the Energy Transition Commission (2025) has shown, increasingly, in terms of cost reductions, solar has run ahead of wind. Countries in the sun-belt already have major advantages, and the superiority of solar PV is likely to increase. And storage for solar is usually overnight in the sun-belt, but for wind it will often need to be longer.

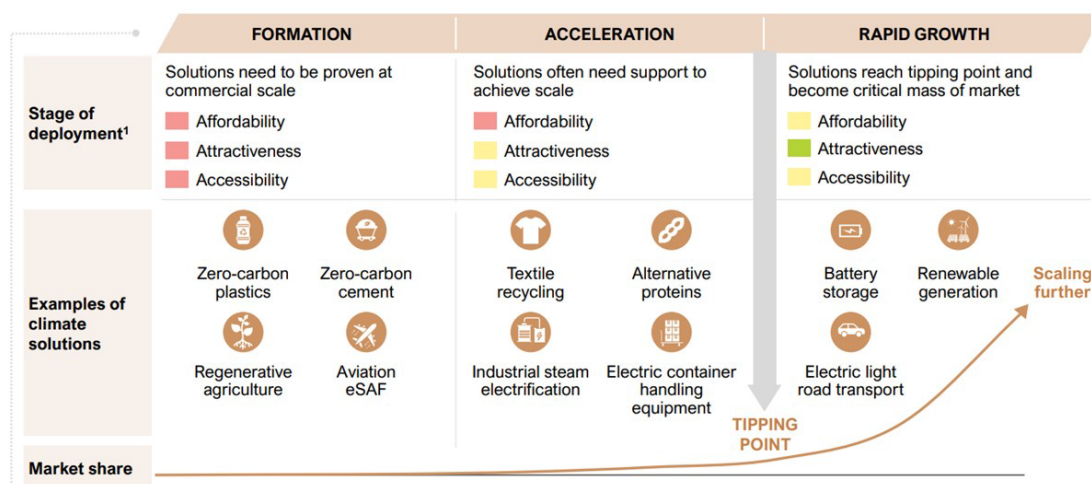
The clean is now cheaper than the dirty in sectors and activities accounting for around one-third of emissions (Systemiq, 2020).²¹ That proportion will likely grow rapidly in the next decade. This is illustrated in Figure 1.9. As costs fall, and the attractiveness and accessibility of new technologies advance, the process of adoption can reach tipping points where investment in the new activities and approaches moves rapidly to dominate. We are already there in renewable power generation, battery storage, and EVs. Other sectors or activities are more distant from tipping points and rapid acceleration of adoption, such as sustainable aviation fuel or zero-carbon cement. A central challenge in policy is to work to bring the tipping points in these more difficult sectors as early as possible.²² Whilst the role of the state is critical to fostering this progress, the story is in large measure one of entrepreneurship, with the private sector as the key protagonist.

²¹ For a lively discussion of the way the reduction in price of clean energy has been forging a path faster than most anticipated, see Tom Steyer's book, *Cleaner, Faster, Better* (2024).

²² It should be noted that not all types of clean technologies are prone to economies of scale. Not all are modular, replicable, and scalable. Electric vehicles (EVs), batteries, and solar panels (so-called electrotech) are very amenable to these sources of scale economies. On the other hand, broader clean tech, such as carbon capture and storage (CCS), nuclear energy, and hydrogen are likely to be relatively more bespoke, often adding additional cost (e.g., for CCS) to an existing process rather than substituting it.

Figure 1.9. The scope for clean innovation is immense: illustrative overview of different stages of technology deployment

Positive technological tipping points refer to critical cost and technology thresholds after which the technology outcompetes incumbents. Adoption and diffusion accelerate due to affordability, attractiveness, and accessibility



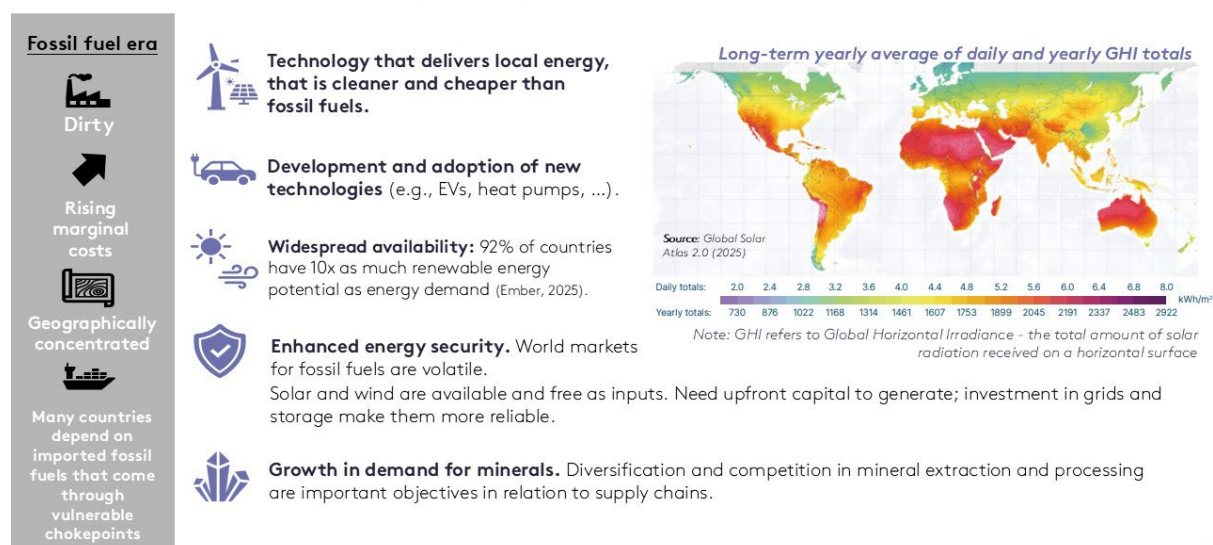
¹Note that the colouring (red, yellow, green) of the 'affordability,' 'attractiveness,' and 'accessibility' criteria is an indication of the competitiveness against the conventional solution. Not all technologies will follow the same trajectory. Stern chaired the board of Systemiq until April 2026 but is not the author of the paper quoted here.

Source: Bottom row: Systemiq (2026, forthcoming)

As adoption and diffusion of the new technologies advance, we will see a changing world economic geography – see Figure 1.10. Activities will move towards locations with endowments of clean, cheap energy, particularly where those are combined with the availability of minerals in demand for the new technologies. Indeed, crucially, AI investors will seek cheap and clean sources of the energy necessary to power, compute, train, and store data. The EMDCs have 70% of the world's solar and wind resources and 50% of the critical minerals (RMI, 2024). Countries so endowed will gain comparative advantage in a changing world. This changing geography will embody dislocation where older areas of production diminish in relative importance. This is likely to be cause of friction between nations and managing these issues will be an important part of the transition (see Section 2 and 3 below).

Figure 1.10. A new energy landscape and a new economic geography

Changing comparative advantages and new technological demands for various resources are altering the location of economic activities, generating new industries, and shifting trade and investment flows.



Source: right-hand side: Global Solar Atlas 2.0 (2025)

For the transition to go at the necessary pace, investment must increase strongly – see Figure 1.11 for the increases necessary in the EMDCs, other than China, for climate action. Given likely relative rates of growth it will be particularly in these countries that the future of the climate will, in large measure, be determined.

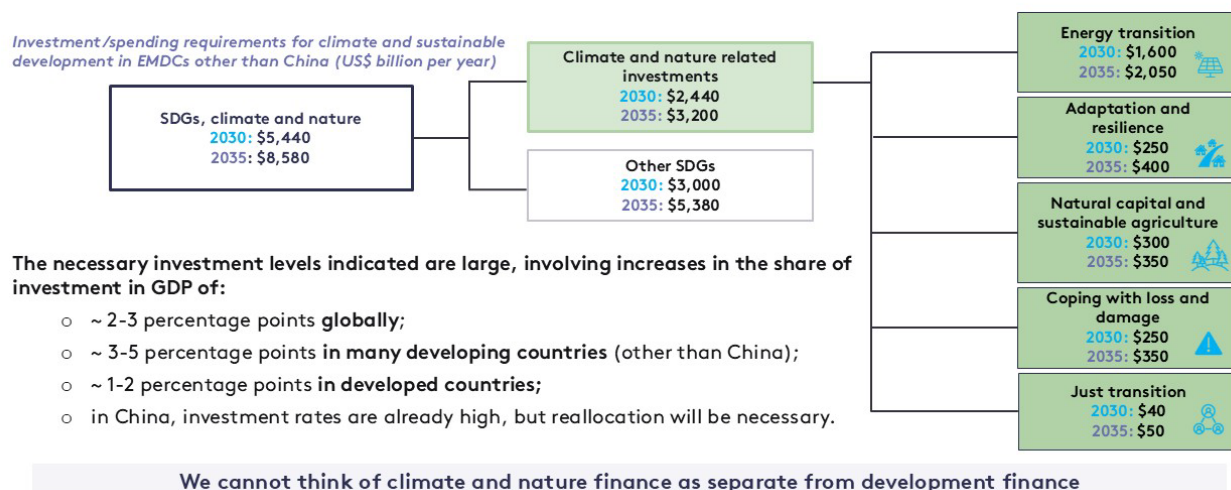
The bulk of this investment will be for the energy transition, but adaptation and natural capital will also be important areas for climate investment. Technical change is, for the most part, embodied in investment. Countries will not run down the old until they have built the new, i.e., made substantial investments in the new. And developing countries cannot leapfrog the old dirty approaches and embrace the new without investment. The big challenge of policy and finance is to promote that investment (see Section 2). For the world as a whole, the overall necessary increase in the investment rate would likely be 2 or 3 percentage points, and for many EMDC economies, we are talking about investment increases, relative to now, of 4 or 5% of GDP.

Whilst these are major increases, they are also a realistic and feasible goal for a number of reasons. First, investment rates have in recent times been historically low. Second, the world has potential savings rates which can accommodate such investment. And third, failing to do so puts the world in great peril.²³ Analysis, discussion, and communication of this feasibility is crucial to inform public understanding and help make change politically acceptable. In improving the communication of, and making the case for, this investment imperative and opportunity, we will see in section 2.3 that the story is one where obligations come together with self-interest. To emphasise, fostering the understanding that there are both imperative and opportunity could be powerful in shaping the understanding of the political imperative to act, and garnering public support.

²³ The decade 2010 to 2019 was a special opportunity to expand investment, given the weakness of demand after the global financial crisis. Sadly, that opportunity was, in many countries, missed. Whilst there remains some such potential in parts of Asia, the world macro position has changed, since Covid19 and wars in Ukraine and Iran, and for many countries, an expansion of the share of investment will involve a reduction in the share of consumption. But the investments, if well-chosen and managed, will achieve strong returns and foster growth. Sound investments raise wellbeing.

Figure 1.11. Making it happen: investment needs for climate and sustainable development in EMDCs other than China

Climate action requires substantial investment across all countries and sectors, especially in EMDCs. These investments are not just about meeting climate targets –they are fundamental to economic growth and progress on the SDGs, within which the Paris Agreement objectives are embedded.



Sources: 2030 numbers from Bhattacharya et al. (2024); 2035 numbers from Bhattacharya et al. (2025)

In Figure 1.11, we identify a total necessary flow of climate and nature investment of US\$2.44 trillion in 2030 in EMDCs other than China. This would cover energy transition, adaptation/resilience (and “loss and damage”), natural capital, and a just transition. These are total flows, domestic and foreign.

We argue (in Bhattacharya et al., 2024), roughly speaking, that around 60% of US\$2.44 trillion could be financed internally; the 40% of external finance yields the number of US\$1 trillion. Of this external flow, at least half could be private finance, if appropriate MDB and other development finance flows combine with it. A core constraint on EMDC financing, in particular, is perceived sovereign risk. Risk-reduction instruments, such as guarantees, and forms of blended finance, will be essential to mobilise capital in EMDCs. The necessary MDB (and other development finance) flows would need to be about US\$250 billion per annum by 2030. Our paper shows (see also NK Singh and Larry Summers, 2023a, 2023b) that such flows from the MDBs could be achieved with a better use of existing capital and only a small increase in paid-in capital. Additional sources of concessional money would be necessary (e.g., from SDRs at the IMF, voluntary carbon markets, and other sources), but the call on the budgets of rich countries would be modest.²⁴

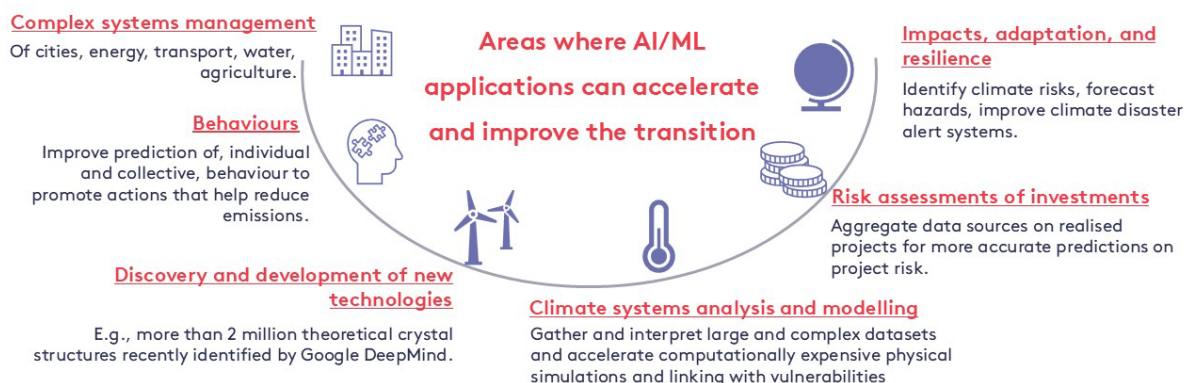
There is one piece of good fortune that has accompanied the climate crisis, and that is that the AI revolution is gathering pace. There is great potential for AI to combine with the investment and technology driving the green transition to make the new growth story still faster and stronger.

The areas where AI will likely have the greatest impact are set out in Figure 1.12. Perhaps the most important on the emissions reduction side will be the design of systems change, the management of that change, and the running of new systems. The transition will require much more efficient, productive and less polluted cities. Cities are complex systems. The management of these systems is information-intensive, and many adjustments are required in real time. AI can be very productive here. Energy and transport, interwoven with cities, are also complex systems, information-intensive and needing careful design for a changing future, and intelligent real-time adjustments. Similarly for land and water.

²⁴ Around US\$10 billion per annum for around eight years from all shareholders. For the UK, for example, that might be around half a billion dollars a year for eight years, an annual rate of around 0.02 per cent of GDP or around £1 in every £5,000 of UK GDP (assuming UK GDP is around £3 trillion).

Figure 1.12. The great potential of AI and ICT to accelerate the transition

AI can bring pace, innovation, and efficiency to the transition; and enhance green technology, accelerating positive technological tipping points and the deployment of breakthrough technologies in key sectors (fusion, quantum chemistry, alternative protein design, materials...).



Source: adapted Stern et al. (2025)

Beyond the management of systems change, AI can be powerful in the discovery of new technologies and materials, as we have already seen for AlphaFold in the characterisation of the structure of proteins (O'Donnell, 2024). It can be of great significance too in behaviour change, in particular, providing consumers and producers the kind of timely information, in the right form, that will allow and encourage them to make more timely, more efficient and cleaner decisions. Examples are choices of planting and harvesting times in agriculture, and on where and when to take crops to market.

On building adaptation and resilience to the impacts of climate change, AI can, and is already, providing real-time information, for example, in Bangladesh and India to warn of approaching extreme weather events (Matias, 2024). It can link such information to vulnerabilities. And climate models are themselves modelling complex systems, the understanding of which is crucial to providing information and analyses to guide adaptation and the building of resilience in the medium- and long-term, as well as the more immediate. For example, if patterns of rainfall and heat or cold are likely to be changing over the year, or the years, good information can be of great value to farmers in choosing irrigation systems, cropping patterns, and so on. And good information will help them to adjust to weather in real time.

We should note here that whilst these key applications are data-intensive, they carry nowhere near the data and energy intensity of large language models (LLMs) and other forms of AI, which “scrape” all evidence, in all geographies and languages, over all history. The kind of AI applications for climate and development that we have described can save much more energy than it uses (see, e.g., Stern et al., 2025).

The powerful combination of the green transition, with its investments and technologies, together with AI will give “the growth story of the 21st century;” green and intelligent growth. The economics and potential of that growth story is the subject to which we now turn.

Section 2. Growth, economics, and public action

The first part of this paper, based on the science, demonstrated the imperative of urgent action. It also showed that technology has moved so strongly that we now have great opportunities to chart a new story of growth, much more attractive and resilient than the dirty, destructive models of the past. Realising that new story will involve both investment and structural change, on substantial scale. We set out in section 2.1, the key drivers of that new growth story; in section 2.2, the basic economics that we need to apply and to build in order to understand and guide the creation of the new path of growth; in section 2.3, the politics and public action that must be understood and navigated in the process, both national and international.

2.1. The growth story of the 21st century

Before going into the detail of the analysis of the new growth story, we should be clear on three points which will frame and give context to that story.

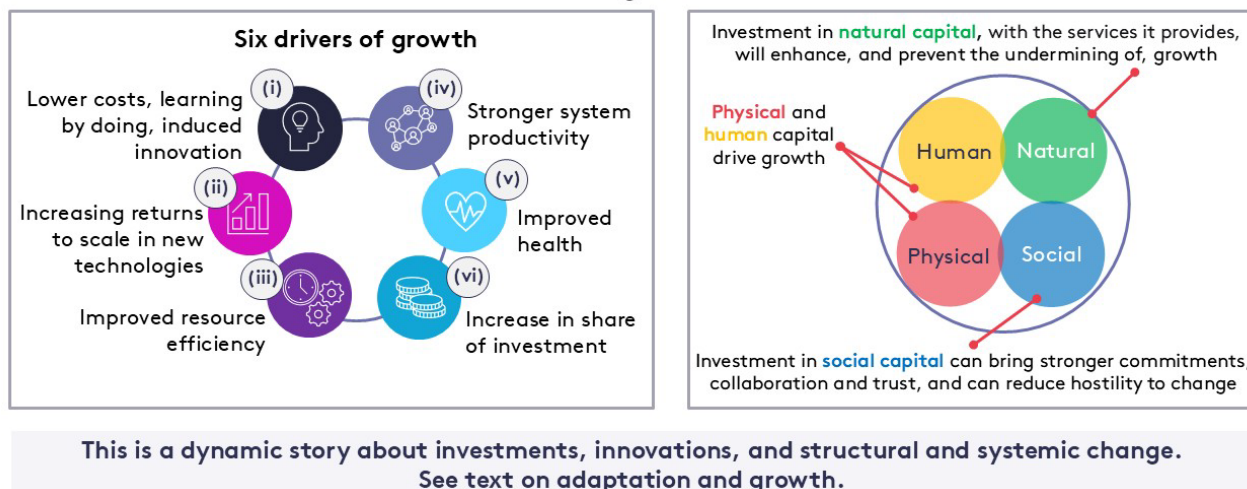
First, the urgency for action applies to all countries; the science tell us that it is the total flow of emissions over time that is at issue. But the urgency is particularly intense in relation to the EMDCs where most growth and investment, especially around infrastructure, will take place in the coming two decades. Second, whilst I will focus mainly on physical investment and infrastructure, i.e., *physical capital*, investment in *human and natural capital* will be critical elements in the story. So too *social capital*. There will be more on these different forms of capital in the next two sub-sections (2.2 and 2.3). Third, in making the argument that climate action, and the associated investment and structural change, will drive growth, we are also disposing of the argument that there is some kind of horse-race or inevitable trade-off between climate or environment action and economic growth. I will return briefly to that point and show how common arguments which attempt to establish the inevitability of such a trade-off are mistaken.

The six drivers of the new growth story are set out in diagrammatic form in Figure 2.1. That figure also emphasises the importance of investment in all four capitals for sustainable development and the new growth story (see next sub-section for a discussion of sustainability). This growth story applies in all of the short, medium, and long term. In the short term, investment for climate expands demand and sharpens supply.²⁵ In the short and medium term, it stimulates innovation and creativity à la Schumpeter, and in the long term, there is no growth without climate action; any attempt at high-carbon growth will undermine itself through its creation of a hostile and destructive natural environment.

²⁵ Under current macroeconomic conditions, many countries are characterised by inflationary pressures rather than deficient demand. In these countries the supply-side benefits of climate investment may be more salient than demand expansion effects; at least in the medium term. In the absence of a liquidity trap (à la Keynes), additional demand stimulus could mean higher central bank policy rates, potentially crowding out private investment. Thus, expansion of investment may require some reduction in consumption. But note that reducing consumption for sound and strong investment makes a country better off, just as it does for an individual.

Figure 2.1. The growth story of the 21st century

Promoting sustainability and sustainable development requires strong investment in all four capitals. There is no inevitable ‘trade-off’ between climate action and growth. On the contrary, this investment drives growth.



Let us examine briefly, in turn, the six key drivers of the new growth story, whilst recognising that they are interwoven and mutually reinforcing.

- For much of emissions (see section 1.3 above), the clean, or low carbon, is already cheaper than the dirty, or high carbon, even without a carbon tax, or any subsidy. Further, these involve activities, technologies, or sectors where there is continuing learning-by-doing and strong innovation. For many other activities where the clean is not yet cheaper than the dirty, there is strong progress in innovation and lowering costs (see Turner, 2026).
- Many of the activities involve increasing returns to scale.²⁶ For example, via large-scale procurement, the cost of LED bulbs in India was reduced by 85% over four years (Anadon et al., 2022). The same phenomenon is occurring in India with the large-scale procurement of electric buses (Anadon et al., 2022). Economies of scale also occur with the coordination of standards for city procurement across the world.
- Many economies embody great inefficiencies in the use of resources, particularly energy. This is a result of many market failures, including in capital markets for the finance of necessary investment and in the weakness of information, but it is also, in many cases, a consequence of poor design and short-run approaches to cost-cutting in the past. Systemically too, inefficiency has often been “baked into” structures which offer insufficient incentives for recycling and re-using, for example, in buildings, equipment, and household goods. Ideas associated with the circular economy are relevant here. And poor infrastructure, particularly around storage and transport, can contribute to substantial food losses. Increased efficiency gives increased productivity, which yields stronger growth.
- Stronger system operation in the key systems of cities, energy, transport, land, and water can lead to major increases in productivity. For example, cities where you have difficulty moving and breathing will be less productive than those where such problems are less acute.
- Systems of land usage which degrade land, destroy forests, undermine water supplies, and pollute rivers and oceans, damage productivity.
- Improving health, particularly through reduced air pollution, can increase productivity. Air pollution kills and maims on a massive scale, with 6-10 million global deaths a year (in around 60 million total annual deaths per year) (IHME, 2021; Vohra et al., 2021). Much of

²⁶ Particularly where they are modular, replicable, and scalable – see section 1.3.

that is associated with burning fossil fuels. Infrastructure that facilitates greater walking and cycling will improve health and productivity, as do lower-carbon, usually healthier, diets. Of course, the moral arguments against such killing and maiming would be regarded by many as much stronger than simply the loss of productivity.

- vii. Climate action involves strongly increased investment, and that itself will drive growth. Investment related to climate, efficiency, and innovation provides an opportunity to address the chronic underinvestment and weak productivity growth that has characterised much of the global economy in recent decades. The imperative of climate action can help overcome political and institutional barriers that have prevented necessary investment in infrastructure, innovation, and productive capacity, while simultaneously tackling multiple market failures. Notwithstanding a tightening of the world macroeconomic situation post-Covid and in the context of wars, at the global level, substantial surplus savings remain. These are seeking productive deployment, and climate investment offers a vehicle for channelling these resources toward high-return opportunities that could otherwise remain untapped.

Elaborations of these arguments and evidence relevant to the statements around these drivers are provided in my book, *The Growth Story of the 21st Century: the economics and opportunity of climate action* (Stern, 2025). We should note also that only the last of these effects on growth, via increased investments, form part of the standard aggregate macro and growth models that are used in the finance ministries and central banks of the world. Building a better economics of growth, and making better use of existing economics, particularly around innovation, structural and systemic change, and market imperfections, will be a key part of guiding a transition to the new growth story (see section 2.2).

In setting out this new growth story we are arguing, explicitly and strongly, that there is no horse-race or inevitable trade-off between climate or environment action on the one hand and growth on the other. Let us note too that some of the standard arguments offered as to why there must be a trade-off are simply wrong. For example, one hears the argument that an added criterion, here environment/climate, must diminish performance measured against an existing target. That is false in an inefficient world, and we have already seen in section 1.2 a whole collection of major market failures relevant to climate, which result in a thoroughly inefficient world. The imperative of climate action can help us reduce the intensity of those failures (and see section 2.2 below) and, in doing so, reduce inefficiencies and move towards frontiers of what is possible. We should, for example, be pursuing energy efficiency, deploying renewables, driving forward on electrification, improving the functioning of systems, reducing air pollution, even if we had never heard of climate change. Market failures, which slow progress on these fronts, could be easier to overcome with the added imperative of climate action.

Another line of argument suggesting the “inevitability of a trade-off” is where we are told that development requires energy and energy requires carbon. The first of these statements is correct, but the second is false. By showing both how climate action can drive growth and the errors in the arguments that there is an inevitable trade-off, we have demonstrated that this “horse-race” argument is deeply flawed.

In making the argument that there is no inevitable trade-off between climate action and growth, we should also note that there is no automatic trade-off between action for mitigation and action for adaptation. Many investments and actions offer both. Here are examples: mangroves capture carbon and protect against storm surges; restoring degraded land captures carbon and offers resilience; effective public transport reduces emissions and helps provide protection in difficult conditions. And all of these foster development, particularly for poorer people. We should also stress that the evidence shows that the returns to investments for adaptation, or building resilience more generally, are very high (Global Commission on Adaptation, 2019; Systemiq, 2025; World Resources Institute, 2025). High-return investments foster growth.

One final remark on this growth story: it is indeed a growth story and not about de-growth. But it is absolutely not an argument in favour of some sort of indefinite growth, whatever that would

mean. It is about opportunities for growth, for raising living standards, and for reducing poverty, in all countries, in the coming two or three decades. Such growth would be fundamentally different from the polluting forms of growth in the past. This new story is about investments, innovation, and structural change that break the current destructive relationship between the environment and growth, and economic activity more generally. It unlocks sustainable development. It is very difficult to conceive of feasible routes to sustainable development and growth other than those with the investments, innovation, and structural and systemic change described here. That is why I used the definite article in the title of my book, *"The Growth Story of the 21st Century."* There is also deep and understandable suspicion in many developing countries that de-growth wants to restrict their growth, just when they are beginning to move strongly and where the problem was in large measure caused by the nature of growth in rich countries.

On de-growth, we must emphasise that we will not achieve net-zero emissions by having zero consumption or zero population, at least, I hope not.²⁷ The task of policy is to break the link between economic activity, production and consumption, on the one hand, and damage to our environment on the other, including via reducing emissions. We have seen that this is indeed possible, and the route is attractive. An attempt to push de-growth on to an unwilling population could be deeply damaging to the pursuit of policies which could get us to net zero in real time. I should, however, emphasise that there are a number of action areas where the arguments and policies advanced here would intersect with those advocating "de-growth;" particularly in the avoidance of waste, fostering efficiency in resource use, promotes recycling and re-using and so on.

2.2. The new economics of climate change

Seeking an understanding of what is necessary to tackle climate change, to create the new growth story, and to increase well-being, sets an agenda for economic analysis. That agenda includes strong and innovative investment and rapid structural change. Economics already offers much that is necessary for such analysis in terms of concepts and ideas, but these must be applied carefully, together with the creation of necessary new advances, particularly around the dynamics of systemic and structural change. The transformation we have argued as necessary is unprecedented in economic history in terms of pace and scale.²⁸ Thus, we should not expect everything needed to be in "the economics tool cupboard" or there to be a full set of clear examples from the past. There will be work to do, but I would argue that economic analysis and economic history can provide us with enough to guide action and to move quickly. And pace is of the essence. Further, we will learn much along the way and must design our activities so that we can take the opportunities to learn from experience and from each other, both nationally and internationally.

I will point to five key areas of policy and action which require careful economic analysis in relation to the transition and to building the new growth story. In all of them pace and scale should be centre stage.

- i. Breadth and clarity in the specification of objectives, including a broad approach to the understanding of well-being and its change over time, and in the specification of areas of investment and activity to mobilise.
- ii. The analysis of the dynamics of systemic and structural change, and within this, the centrality of investment and innovation.

²⁷ One can also point to rationed, or consumption restricted, and inefficient economies of the past, such as post-war Eastern Europe, the Soviet Union, and North Korea, where the system and its low consumption exacerbated environmental degradation and stymied innovation.

²⁸ A change to a war-time economy can be rapid and major, but this transition is global and over a number of decades.

- iii. The recognition of the range of market failures that could hamper action and how they can be overcome, taking account of difficulties associated with the credibility of government policies and plans, and with potential government failure.
- iv. An understanding of how to influence relevant behaviour of individuals, firms and communities and how to build, guide, and strengthen relevant institutions.
- v. New approaches to the analysis of immense risks.

The new growth story will look very different from the dirty, destructive models of the past. The ways in which the transition towards it is assessed and guided should reflect an understanding of both the dimensions of well-being it is designed to enhance and of the key mechanisms crucial to its advance. And the duties and rights of all the players involved should be discussed, recognised, motivated, and monitored. Broadly speaking, we are seeking here a path of development which is sustainable, resilient and inclusive, in contrast to past models which have shown themselves to be unsustainable, fragile, and divisive. Resilience should be understood and assessed in relation to difficulties arising from the natural environment, broadly understood, but also in terms of economic and political structures. Inclusiveness, or the lack thereof, and inequalities are relevant across a whole range of dimensions of well-being.

The first of these areas includes objectives and here sustainability is of central importance. So too is multi-dimensionality, going beyond output and consumption, to include education, health, environment, inequality, and so on. A working definition of sustainability is “offering to future generations opportunities at least as good as those that were available to this generation, assuming they behave in a similar way towards those that follow.”²⁹ Their opportunities will depend on their endowments: physical capital (infrastructure, buildings, equipment, and so on); human capital (health, education, knowledge, skills); natural capital (the whole environmental system and biomes, including land, water, forests, oceans); and social capital (mutual trust, functioning and constructive institutions, cohesive relations, sense of fairness in relation to inequalities, and so on). All of these capitals can be augmented by investment or reduced by negligence or destruction. They are mutually supportive. Together they shape what is possible. Some of the objectives will be flows, such as income or consumption, and others will be stocks or assets such as the state of the environment or state of health of the population.

Sustainability, leaving the future generations in no worse a condition, is a modest ambition. Generally, the shared objective would likely be or should be “sustainable development”, thus advancing development in a sustainable way. One broadly accepted example of shared objectives (in the sense of adoption by the UN in 2015 as targets for 2030) is the Sustainable Development Goals (SDGs). Notably, these are an expanded version of the Millennium Development Goals (MDGs) adopted at the UN in 2000 as targets for 2015.

The emphasis on sustainability in moving from the MDGs to the SDGs arose from increasing observation of and concern with environmental damage. And note that the MDGs were targets to be achieved in countries of the developing world. The SDGs are for all countries: it is actions everywhere that affect sustainability. Most of the targets in the case of the MDGs were not, and, in the case of the SDGs, will not be, achieved, although good progress has been made on a number of fronts. Nevertheless, the statement of the key dimensions for measurement of objectives is of importance in defining and understanding the nature of those objectives. So too for showing how they can indeed be measured. They have proved useful guides for action and reporting of results. It is striking how the importance of sustainability grew to prominence in the period 2000-2015, when there was a growing understanding of the great climate, biodiversity, and environmental damage and destruction that had occurred and that continued. This

²⁹ We should note Robert Solow’s definition (1995, 18): “[t]he duty imposed by sustainability is to bequeath to posterity not any particular thing [...] but rather to endow them with whatever it takes to achieve a standard of living at least as good as our own and to look after their next generation similarly.” In my definition, I take ‘to behave similarly’ to encapsulate ‘looking after’ the next generation. We should note also the definition used by the Brundtland Commission (“Our Common Future”, UN, 1987, p.17), “[meeting] the needs of the present without compromising the ability of future generations to meet their own needs.” Again, that is similar in spirit, but “needs” are not easily defined, and “opportunities” points to agencies and freedoms and is more dynamic and development-oriented.

understanding, together with increasing appreciation of the growth potential of climate action, was an important element in obtaining the UNFCCC Paris Agreement of December 2015, and, as we have seen, there was following from that agreement, together with the adoption of the SDGs earlier in 2015, a real strategic change in global approaches to development objectives and choices. The agreement itself demonstrated that countries could come together to chart international strategic action, notwithstanding its flaws and ambiguities. As we saw in Section 1, the Paris agreement did provide a strategic sense of direction that helped motivate strong creativity and technical progress.

The second area on our list for economists concerns dynamics and systemic change. The new growth story is driven by investment, innovation, and structural, systemic and technological change at pace and scale. These are non-marginal changes with powerful dynamic and systemic forces at play. Some dislocation and disruption will be involved. Our economics should be much more strongly focused on these key dynamic features, including disruption. All too often, it deals with models which are fairly static, are in equilibrium, and have only modest changes in structures. We need analyses and perspectives which are much more dynamic and structural. The big increase in investment necessary, together with the major structural and systemic change, will bring difficulties and push-back. They will be macroeconomic challenges and gainers and losers. But given the overall gains that the strategy offers and the immense risks of inaction or weak action, it is vital that ways are found to overcome the difficulties and challenges. Macro policy will in some cases require the reduction of consumption: it is important that citizens see that this brings strong gains and can make them better off as well as their children and grandchildren. Early experience of those gains is likely to be essential to acceptance. Responsible macro policies must be created whilst not arbitrarily constraining investment through inappropriate fiscal rules. It is important that fiscal rules reflect societal objectives, the reality of circumstances, both liabilities and assets, and macroeconomic constraints. And they must be stable and credible if capital markets are to work well.

Some discrimination between new “green debt” and legacy debt may be necessary. But borrowing at affordable rates will depend on credible fiscal policies; hence the importance of fully-funded government consumption expenditure and robust government revenue streams. This is not the place for a detailed discussion of fiscal rules, but I should stress that the observation that some versions seem arbitrary or inappropriate should not be seen as a counsel of fiscal imprudence. On the contrary, if the fiscal is seen to be badly managed then both the willingness to invest and the availability of finance for investment will be damaged.

There will be individuals and communities that experience serious dislocation and losses and investments in those communities and individuals, in places and people, will be an essential element of a just and effective transition. Participation in policy discussion and decisions will be crucial here (see Section 3 for further discussion).

The analysis and perspectives required must go way beyond just one model. We will need to understand better than we do now how the economic development of cities can be influenced. How we can restructure energy and transport systems. How to reform toxic and dysfunctional agricultural systems, and so on. The challenge will be to create a collection of such analyses and modelling. And to learn from relevant experience. Overall policymaking based on this approach would involve experienced, wise, and creative judgement in putting various relevant analyses, perspectives, and experiences, together. Further, the design of both analyses and actions for change should recognise and allow for learning along the way. So much of all this is unprecedented.

The third area concerns overcoming market failures. Earlier, in section 1.2, I set out six crucial market failures of central relevance to climate action. The first of these is the greenhouse gas externality. It is this market failure which receives most attention. And rightly so; it is at the core of the problem. The damage arising from GHG emissions constitutes an externality in the sense that the activity of one agent affects the welfare of other agents in a way that is not, without policy, reflected in the price of goods and services. Private and social costs differ. Agents do not

face the full social costs of their actions, leading them to over-indulge in polluting activities. Arthur Cecil Pigou showed in the early 20th century that taxation could effectively bridge this gap between private and social costs (see Pigou, 1920). These Pigouvian taxes are an insight of great value and absolutely should be at the centre of discussion on the policy stage.

However, as argued above in section 1.2 on carbon taxes, it is important to note that economists have been mistaken in saying that a carbon tax is all we need to have in place, or that it is unambiguously the single most efficient tool for tackling climate change. That is to ignore the other crucially important market failures and the limitations of the price mechanism, by itself, to create systemic and structural change. On the other hand, political commentators who claim that implementing a carbon tax is too difficult are also mistaken. For example, the carbon price is around €80 per tonne of CO₂ equivalent, under the EU Emissions Trading System (ETS) (early summer, 2026, Trading Economics, 2026) and the ETS has played a major role in reducing EU emissions. Although both lines of argument are mistaken in their narrowness, I would place heavy emphasis both on the need for carbon pricing, and on a recognition of the reality that the difficulties in implementation are substantial.

As indicated in section 1.2, there are five other market failures at play in addition to the emission of GHGs. These are associated with: R and D; capital markets; networks (grids, transport, etc); information in a changing world; co-benefits, particularly concerning pollution and health. The challenges of climate change offer an opportunity to take vigorous action to try to mitigate those market failures. The recognition of the urgency and importance of the issues could reduce the difficulty in tackling the underlying causes of these market failures. While there is not the space in this paper to review the many necessary actions, we should be clear that there is much in economics and experience that can help us. For example, development banks and appropriate guarantees can reduce risk and bring down the cost of finance. There are examples where the desire to accelerate climate action has indeed led to an expansion of national development banking; the UK created the Green Investment Bank in 2012, and it played a key role in financing investment in offshore wind electricity generation.³⁰ Standards can overcome some informational failures. For example, climate-related financial disclosure rules for some institutions in France led to better information for purchasers on the carbon content of products. R and D can be supported. Climate and sustainability are priority areas for the UKRI (the UK national research funding body). It is in the reduction of these market failures and their impacts, that much of the thrust of the argument around combining climate action and growth finds its power. Crudely speaking, the reduction of inefficiency allows us to move towards production and other frontiers and not just along them.³¹

The effectiveness of policymaking is not just a matter of identifying the right policies. It is also about credibility. The new growth story has investment at its heart, and investors need to assess risks and returns over the medium and long term, as well as the short. Governments cannot commit over the indefinite future with total certainty, but they can create mechanisms or institutions, that reduce uncertainty and strengthen confidence. These can be international treaties or agreements, such as in the European Union. They can involve national or international development banks committed to social and economic progress and looking beyond the short term. Their involvement enhances confidence in the policy environment. Legislation can be helpful, such as the climate change legislation in the UK setting targets for emissions reductions 15 years ahead. None of these give total certainty, but together they can reduce uncertainty and offer a sense of strategic direction. Given opportunities and confidence, private investors will respond.

³⁰ The Green Investment Bank was sold to the Australian firm Macquarie Group in 2017. The decision to sell was a mistake in my view. I was involved in the shadow board establishing the Green Investment Bank and opposed its sale. It was doing a good job in fostering investment and it was helping bring down cost of capital by helping to reduce and manage risk. Its ability to do that depended on its public backing and on its mandate.

³¹ We must think of this statement in dynamic terms. The effects of the investment, innovation, and structural change we are discussing here go way beyond “movements towards and along given frontiers,” in a simple static sense.

The fourth area focuses on behaviour and institutions. The structure and functioning of institutions are important elements in creating sound and credible incentives to foster investment in the new path. But policy must also be able to adjust to learning and to changing circumstances. A key part of policy, therefore, is to be *predictably flexible*. Thus, when policies are announced, such as a subsidy for renewables, the path to removing the subsidy as costs fall and diffusion advances should also be announced. Failure to do this in the past, with sudden and unexpected withdrawal, undermines confidence in future policy. In many countries, monetary policy is set according to these principles, and the public understands the principles for interest rate changes in relation to risks of inflation and unemployment, for example. But in the cases at issue here, the horizons are longer.

Behaviour will be influenced by information and public discussion. If consumers wish to buy low-carbon products, they will need information on the carbon content, just as many would wish to know whether a carpet is made by child labour. Shareholders will want to know how firms are understanding and reacting to the climate crisis, as it will influence their perception of risk. The requirement for information can itself influence behaviour in that it focuses attention on key aspects of actions and opens actors and their actions to scrutiny from society.

Political, social, and legal institutions influence decisions and strategic directions. Even without formal rules a shared understanding across politics of what constitutes responsible behaviour can be valuable here.³² A polity that looks to create and build cohesion and stability can provide a more conducive environment for investment than one where policies in relation to growth and the environment are heavily contested and seen as fragile. Public participation in decision-making would be important here; for example, a local community might be more likely to accept a transmission line if they can discuss routes and if they can benefit, for example, from attractive pricing of electricity. Social and religious values and movements will influence how people see their environmental responsibilities. Indeed, a number of religions point to responsibilities to “mother nature” or the duty of stewardship to the work of the creator (see Section 3). Religious leaders may be more trusted than politicians. The messengers, in addition to the messages can be crucial, a point the late Danny Kahneman, the distinguished psychologist, made to me in the early stages of the Stern Review two decades ago.

Legal structures in many countries are now supporting or enforcing climate and environmental responsibilities. Since 2015, more than 2,900 climate litigation cases have been registered globally (Setzer and Higham, 2025). An exemplary case is that of *Lliuya v. RWE*, first filed in 2015. Although it was eventually dismissed in 2025, the Peruvian farmer’s, Saúl Luciano Lliuya, case argued that the German energy company RWE, as one of the largest CO₂ emitters in the world, should be held accountable for the increased risk of flooding caused by the melting glacier, which puts Lliuya’s community in danger. Landmark cases at the national level include *Urgenda v. The State of the Netherlands* (2018) and *Neubauer et al. v. Germany* (2020), which forced governments to strengthen emissions targets under their obligations to the Paris Agreement. We have also seen the example of the UK Climate Legislation and the Climate Change Committee. The International Court of Justice in the Hague gave a strong Advisory Opinion on 23rd July 2025. It argued that there was an obligation on nations to produce plans (formally their Nationally Determined Contributions, NDCs, associated with the UNFCCC) consistent with the goals of the Paris Agreement. Further, in that Advisory Opinion, there was a duty to cooperate to realise the goals of the Paris Agreement.

Economics, for example, in the work of Daron Acemoglu, Simon Johnson, and James Robinson (see e.g., Acemoglu et al., 2001, Acemoglu and Robinson, 2012) or in the work of my LSE colleagues Tim Besley and Torsten Persson (e.g., Besley and Persson, 2023, 2025), has seen

³² In the UK, that shared understanding seems to have been dissipating (see Hennessy and Blick, 2019, on the decline of the viability of the ‘good chap’ system in the UK). See also Lord Peter Hennessy’s valedictory speech in the House of Lords on 18 May 2026 (Hansard, 2026). He warned of the dangers of decline in decency in public life.

institutional structures moving to centre stage. These ideas could and should offer important guidance in the analysis of climate change.

The necessary pace and scale of change, together with the importance of institutional structures in the process of transition, imply that the state will have to play a strong role in guiding and fostering the change. We return to that issue in the next sub-section and in Section 3.

Finally, on the importance of new approaches in economics, we should emphasise that the analysis of extreme risk, on a scale and of a nature which is existential for many, is a crucial analytical and practical issue. The standard model of behaviour towards uncertainty, the maximisation of expected utility, can break down when some outcomes might be “extreme”, for example, where deaths on a major scale are involved. In these models, some standard utility functions might attach a utility of minus infinity to some possible outcomes. That was the difficulty the late Marty Weitzman emphasised (see Weitzman, 2009). If we do not associate minus infinity with such outcomes, then if we are to persist with an expected utility approach, we have to put in a figure for the cost of a death or a life lost. The problem is that the specification of these numbers on the “cost of a life”, when considering global policy which could result in hundreds of millions of deaths, would, in huge measure, determine the calculation of the action deemed to be optimum.³³ Given the uncertainties over the choice of these numbers, the result of such analyses could be of little help to decision-making. And some might see, in this global context of potentially huge consequences, the figures on “cost of life” as arbitrary. And there would be other real difficulties, for example, over whether it should vary across countries or communities.

Joseph Stiglitz and I have explored these issues of risk, and one way forward is to speak of “guardrails”, much as one might erect barriers on approaches to a dangerous cliff (Stern et al., 2022). That is, broadly speaking, the approach adopted in the Paris temperature targets. Whilst we do not erect guardrails on all cliffsides, we do, or we should, where cliffs are very dangerous. In this case, the scale of the danger is indeed a lesson from the science.

Moving beyond catastrophic risks at the global level, those responsible for managing risk at the country level require significant research advances in relation to the magnitude of risks and how to integrate them into models and analyses. Climate risks fundamentally alter the macro-economy. Tipping points and non-linear risks render standard assumptions of steady growth, stable risk premia, and exogenous discounting untenable. Delayed action compounds this: by depressing expected growth and elevating risk and risk premia, it undermines macroeconomic stability and debt dynamics, while rendering growth rates, interest rates, and sovereign spreads increasingly policy contingent. Furthermore, physical and transition shocks affect inflation, collateral values, and financial stability. Taken together, these pressures call for innovation in monetary and financial policy and, in particular, for integrating climate risk into central bank reaction functions and macroprudential frameworks. Academic economists have a critical role to play in encouraging central banks toward the possibility of such innovation.³⁴

In all of the five examples in relation to policy and action considered here, all of which are major, there is much, as I have argued, that economics can contribute to the analysis of the transition and to help frame and guide policies and actions. But in each case, we have to go beyond the simplistic standard models.

³³ “The value of life” can be a useful concept in the management of healthcare or the design of road systems, particularly in maintaining consistency of decision-making across activities. But the issue here is strategic decision making determining global outcomes. In my view, emphasis on ‘discovering’ or ‘specifying’ a “value of life” would be diversionary in this context, in that it would seek a value which is necessarily difficult to specify, and seen as somewhat arbitrary by many, but which would have a very powerful influence on calculated “optimums.”

³⁴ I am grateful for discussions with Luiz Pereira da Silva on these points.

2.3. Public action: galvanising action and the role of the state

We have seen in Sections 1 and 2.1 the necessary rapid pace and large scale of the response to the crises, particularly around investment. Such action embodies both an imperative to manage risk and an opportunity to foster a new form of growth. And in the last sub-section, we examined some of the details of policies and actions necessary to deliver on the transition and the necessary investment and to realise the new path of growth. All this implies that the politics of delivery will not be easy. We now examine some of the challenges of delivery and their implications for the role of the state. In so doing, we consider four sets of issues: public understanding and values; the political economy of vested interests, push-back and dislocations; practical obstacles to getting things done; and international political challenges.

Change of this magnitude will need public support. That in turn requires understanding of the issues, particularly of the dangers and opportunities, and some sharing of values and goals. Public discussion will be critical here, as Jürgen Habermas has emphasised in his ideas of “discourse ethics” and “the public sphere.” But that ethical discussion will itself require some discussion of the nature of the challenges and some building and sharing of understanding of the issues they raise. Some of the differences of opinion will not be about the ethics. For example, some have argued, mistakenly in my view, that we must make a choice between environment and growth. That is an analytical and empirical question rather than one about values and ethics. Some persist in denying the science, notwithstanding its longevity, strength, clarity and empirical support, and pretend that the problem is minor or non-existent.

Part of the role of the state, and of individual and community responsibilities, is to initiate and participate in such discussions. The public forum, square, or sphere is crucial here, and it can emerge or be fostered in various ways. Citizens’ assemblies have promise. These bring citizens together, often with backgrounds which are representative of those found in the general population, to listen to, examine and discuss evidence and analysis on a given subject on which decisions are necessary. They can help individuals form considered views and express concerns (see e.g. Climate Assembly UK, 2020; Convention Citoyenne pour le Climate, 2021). An open political system should foster such discussions. And it should welcome contributions from and interactions with non-governmental and religious forums and movements. This is not just about democracy, fundamental though that is. Without such public discussion, opposition may prevent action in cases where inaction is dangerous; it is also about the practicalities of delivery.

Such discussions and attempts at public action will run into challenges from vested interests. Sometimes that will take the form of disinformation, such as the climate denial fostered by some oil and gas companies in the past, and documented so clearly and convincingly by Naomi Oreskes and her colleagues (e.g., Oreskes and Conway, 2010).

There will be push-back from those who fear the transition will cause them inconvenience or loss. For example, some will oppose new transmission lines for power grids which are close to them. Others may not wish to switch from oil- or gas-fuelled heating to air-source or ground-source heat pumps, and resent the imposition of standards that require the change. There could be opposition from those who think, or are encouraged to think, that their fuel or energy prices will rise. And there will be some in fossil-fuel and related industries who will lose their jobs. Others in fossil-fuel industries, or owners, would see major reductions in their wealth. There are powerful vested interests.

These political economy examples show that there will be many obstacles and pitfalls along the way: the transition will not be easy. It is important to listen, discuss, analyse, and design carefully if it is going to be possible to “get things done.” And such interactions can and should, as a matter of democracy and practicality, be initiated from “bottom up” and not just be “top down.”

Where price rises or regulation are necessary, careful phasing of implementation together with support for the poorest can ease the transition.³⁵ Where new methods are cheaper it is important for that to be seen in prices facing the public earlier rather than later.

Loss of jobs in running down the fossil-fuel industries would happen alongside the rise in jobs in the new activities. There will be more new job opportunities created than old lost (IEA, 2021; IRENA, 2021). But those losing jobs in the old cannot always find jobs in the new, for which they might be qualified, near their homes. Investment in people in reskilling and in the places where jobs are lost will be key to managing the transition in a just way. There are many examples where transitions have been done badly, such as the movement away from coal in the UK in the 1980s, which brought severe strife and resulted in cities and regions which were depressed for decades. But other examples, such as the running down of coal mining in Spain, where, more recently, there has been a smoother and more cohesive process of change (European Commission, 2025). It seems that participation of local communities in design and implementation in Spain was a crucial element in the relative success.

The above discussion, and it is a key underlying theme throughout these lectures, shows that the main obstacles to a successful transition are not mainly technological, although there is much to do there, for example, in so-called “hard-to-abate” sectors. The biggest obstacles lie in economics, politics, and society. A successful transition will need careful and well-designed policies and a participatory approach to overcome them. If the obstacles are not overcome and the resistance to the transition prevails, then the outcome, a rapidly deteriorating climate, biosphere, and the environment would be deeply damaging for the vast majority of people across the world, particularly for the poorest.

International collaboration is essential. Emissions are a global public bad, and their reduction is a global public good. For action to be effective at the scale and pace necessary, all countries must be involved. If the transition is seen as a burden, then each country is likely to ask whether others should bear a greater share of the burden. But if the transition is recognised as a new growth story, then the first question becomes, how can countries act themselves to realise the new growth story? Second, since it is in the self-interest of each country for other countries to act, countries should ask how they can assist other countries.

A framing of climate change as overwhelmingly a problem of the commons, where free-riding is identified as the key and overarching difficulty, is not, by itself, adequate in capturing the issues. Whilst free-riding does have some relevance here, self-interest increasingly points away from free-riding and towards action. There are two arguments for country action based on self-interest: the growth story from action and the avoidance of the extreme risks, which arises from inaction. The growth story is not just a path for developing countries, but crucial for all countries. This is not a zero-sum game. When one country advances clean technologies, it drives down costs for all; when a large economy sets ambitious targets and strong standards, it shifts the standards for all producers on the global market. Each advance has spillover effects, in knowledge, in investment, and in the demonstration that the transition is achievable. These gains overlap with and reinforce each other. Further, there is an international dimension to the idea, discussed in section 2.2 and 2.3, that understanding the urgency of climate action could help overcome key relevant market failures, which reduce productivity and inhibit advancement. Countries may recognise the spillovers from acting together, and their resolve might be strengthened from seeing the actions and examples of others. I will speak to the ethical obligations and responsibilities of different actors in Section 3; they provide the third argument for action, namely, climate action is what we *should* do. Self-interest and ethical obligations come together.

That collaboration is possible is demonstrated by the international agreements on climate, biodiversity, and the environment, particularly the UNFCCC Paris Agreement of 2015. This

³⁵ The rich and powerful may also seek compensation. In thinking about compensation, both wealth, and sources of wealth are relevant issues. Many would argue that poorer people and those whose livelihoods come primarily from their labour should have priority. And that wealth that has arisen from activities that damage others has less claim to protection.

generated a new sense of direction, which was a crucial element in the rapid technological advance of the last decade and in the advance of new investment, particularly in power and electric vehicles. Before Paris, the temperature at the end of this century was forecast as likely around 4°C. On current policies, it is 2.5 to 3°C, and perhaps below 2.5°C or close to 2°C if countries deliver on their NDC commitments. Temperatures in the region of 2.5°C would still be extremely dangerous, but the Paris Agreement and its consequences show that advance really is feasible. The challenge now is acceleration.

These three sets of arguments for strong climate action, two around self-interest, achieving growth and avoiding damage, and the third around ethics, will be revisited in the next section. We must recognise, however, important political difficulties and challenges, which are impeding action, and indeed some, including vested interests who are vigorously opposing action. One source of opposition is the political anger around the lack of growth over the last two decades or so and the reduction of living standards for many, within stagnant economies, particularly in the rich world. That is then linked in public discourse to the (false) allegation that climate action reduces growth. Brexit and the election of President Trump can be understood as, in part, consequences of anger with the status quo, which was seen as not delivering for many ordinary people. That anger was directed at incumbents and elites. For many, the digital revolution has added to a sense of exclusion. In this context, climate risks are being seen by some as an elite issue.

Some of the anger has also been directed at “foreigners”, both at immigrants and at countries seen to be “taking advantage” of your nation. That occurred with Brexit; witness the false idea, energetically perpetuated by those seeking votes for Brexit, that “Europe” was taking hundreds of billions of pounds net a year from the UK that could be spent on the health service. And President Trump’s apparent understanding of trade deficits with another country as being evidence of a rip-off by that country.³⁶ We may indeed be facing dangerous political tipping points in domestic and international action, with climate seen as a “foreign”, as well as elite, issue.

For these reasons, I see the realising of the new growth story as a political imperative. It can help overcome the sense of deprivation. Macroeconomic instability, weak growth, perceived social injustices, and poorly designed policies can fuel populist backlash against climate action, even though weak climate action will exacerbate all these problems. Weak, ineffective, poorly designed and badly communicated climate policies will perpetuate resentment, anger, and create rejection of climate action. A bold, just, and fair transition must therefore be framed as both an economic necessity and a democratic safeguard.

Further we can and must show the advantages of international collaboration. Such collaboration will require convincing arguments, examples, and leadership. It should be possible, as Mark Carney, PM of Canada, argued at Davos in January 2026, “to help solve global problems...it’s building coalitions that work, issues [sic] by issue, with partners who share enough common ground to act together” (Carney, 2026). See also my piece with NK Singh in the Indian Express on the eve of 2026 (Singh and Stern, 2025), where we argued that flexible international arrangements and collaborations could, in this changing world, deliver strategic and effective action.

The beginnings of a recognition of the new growth opportunities from climate action was a key foundation to the Paris Agreement.³⁷ The required acceleration will depend on a still stronger understanding of these opportunities if they are to be grasped at the scale and pace needed, and with the collaborations necessary. Financial support from rich countries will have to be at centre stage and, as I have argued, that should be based on an understanding of both moral obligation

³⁶ That obviously rides roughshod over the basic economic observation that a deficit is the difference between your income and your expenditure; in other words, it arises, in large measure, from your own choices. And further that in a world with many countries, patterns of trade will be associated with surpluses with some countries and deficits with other others. As Bob Solow, the great economist, famously put it “I buy haircuts from my barber, but he buys nothing from me.”

³⁷ With some international colleagues, we worked to help build that understanding through the Global Commission on the Economy and Climate, and its publications around the New Climate Economy.

and on 'enlightened' self-interest.³⁸ And it will need to involve, centrally, international institutions, particularly the MDBs. If it does so, then major flows, especially from the private sector, can be mobilised at very modest costs to the budgets of rich countries, as we saw in Section 1.

A shared understanding of the relevant ethics, rights and obligations will be crucial. That is the set of issues to which we now turn.

³⁸ Indeed, in the broader philosophical literature on climate ethics, there is strong support for the view that wealthy industrialised countries have enhanced responsibilities to act, based on their contribution to the problem, as well as their ability to pay (see Gardiner et al., 2010). See section 3 that follows.

Section 3. Rights, justice, and the state

The science makes clear that there is an imperative to act, urgently and on scale, as argued in Section 1. In examining the economics, I have argued that an analysis of the immense risks associated with inaction or delay in tackling the crises of climate and biodiversity demands a different analytical approach from much of the received literature on the economics of climate change. The magnitude and nature of the risks, together with the increases in investment and the rapid structural change that are necessary to respond to those crises, cannot and should not be forced into the narrow structures of the standard workhorses in economics: static general equilibrium, marginal cost-benefit analysis, and aggregated exogenous growth models. Useful though those techniques are in some contexts, they cannot go to the heart of the issues here; they omit, and thus are silent on, what really matters in terms of understanding the problem and designing action. We also saw, in Section 2, that there is much that economics can contribute to the analysis of policy and action, and that the actions, identified in terms of investment and structural change, which can respond effectively to the climate crisis, could generate an attractive new form of growth. The approach to ethical issues in analysing policy responses was mostly consequentialist, as is standard in economics.

Building on the understanding of the science and of where, on the basis of that science, economics should focus, this last section of these lectures examines ethics more broadly. As we saw in the first two parts, both the scale of risks and the issues around the scale, urgency, and potential dislocation embodied in the response, force us to go beyond the standard marginal approach of much of “positive economic analysis.”³⁹ In the case of inaction, lives could be lost on a massive scale, and effective action involves rapid and large-scale change. We must also go beyond the standard consequentialist approach of economics in our ethics and in our “normative economics.” The magnitude and nature of the crises are such that we have to embrace directly issues and questions of moral philosophy, concerning potentially huge effects of our actions on the lives and livelihoods of others. That broader perspective on moral philosophy is all too rare in economics. And we have to ask important and intersecting questions of political philosophy. Who is responsible for taking decisions and actions on this scale? An answer will, in part, involve asking who is responsible for the crisis. We must ask how change can be designed and decided and who delivers what. We have to ask about the role of the community and state. And how to “get things done.” Moral and political philosophy have to be at centre stage.

This is not to argue that the conventional consequentialist approach of standard policy analyses in economics should be discarded or put to one side. On the contrary, broadly speaking, that approach runs through the bulk of the arguments set out in this paper. The challenge is to combine it with other ethical approaches in a context where the nature and magnitude of change demand it. I do note, however, that many economists show reluctance to discuss values, such as social welfare weightings, within a consequentialist approach, let alone venture outside the standard approach.

Or, even worse, because it involves mistakes in the ethical analysis rather than the choice to avoid it, some appear to think that social values can be imported from markets. An egregious example both thoroughly mistaken and seriously misleading, is Nordhaus’s suggestion, discussed in section 1.2 above, that we can import rates of interest or return from capital markets to give us social discount rates for ethical assessments. Put simply, the suggestion that we can make valid policy assessments without some explicit discussion of values is logically unacceptable.⁴⁰

At the same time there is a long history of scholars who are eminent philosophers and distinguished economists, including Adam Smith, Karl Marx, Frank Ramsey, John Maynard Keynes,

³⁹ For the non-economists, “positive” refers to an analysis without values coming in, or policy proposals being made, whereas “normative” introduces values and can point to policy recommendations.

⁴⁰ Some may argue that proposing a change where some are better off and none are worse off (i.e. a “Pareto improvement”) involves only minimal moral statements. But even that is misleading, as there will be issues of liberalism and distribution (see e.g., Sen, 1970b).

and a shining example amongst current scholars, Amartya Sen. Good economics really can, and has, brought rigorous economics and serious philosophy together.

In my view, the narrowness of much of practice and teaching in economics in relation to the ethics of public actions, has led to a reduction of relevance and some hostility to the subject of economics itself. I have long hoped that moral philosophy, and indeed political philosophy, in relation to economic analysis and decision-making should become a stronger element in an economics education. To insist that only the narrow consequentialist perspective represents “rationality” in policymaking is not only misguided, but also damages the subject of economics and its reputation.

The combining of the consequentialist approach and that of rights and justice in responding to the climate and biodiversity crises, is the primary subject and purpose of this last section of my Tanner Lectures. This section consists of four segments. First, we step back and consider other approaches to these great issues given the broad range of relevant moral perspectives. This will be extremely brief in relation to the richness of ethical approaches which could be brought to bear. We consider the Aristotelian, Kantian, and social contractarian perspectives and how they could apply to the climate challenges. That is the subject matter of section 3.1. I will argue that embracing each of these perspectives would point to a duty to take strong action. Thus, conclusions associated with the ethical approaches that are emphasised in these lectures, consequentialism and rights and justice, would not be overturned by bringing those other perspectives into the discussion. I will also argue that the same conclusion holds if we think of bringing the perspectives of the world’s great religions to the climate challenge. These broader perspectives, on the whole, emphasise duties rather than rights.

In section 3.2, the focus is on the key ideas of the right to development and the criterion of sustainability, in relation to the rights of future generations. I will show how these principles can and should guide action. And I argue that they can be and should be combined with the consequentialist approaches and conclusions of the first part of these lectures. In so doing, I argue that the central concept of rights under consideration is the right to development. The right to development is crucial for understanding justice and fairness, in this context. I argue that, in the case of climate change, fairness is not about the fair distribution of the carbon space (and thus the right to emit) but rather the fair distribution of development opportunities, and thus the right to development. We should note that the right to development contains within it the narrower notion of the right “not to be harmed,” which has broad acceptance. Many of the arguments presented here would carry through based on that narrower right. The right to development, as also the right not to be harmed, is long-standing and well-founded in basic principles of moral philosophy, as we shall see. It does not involve inventing some ad-hoc new right (e.g., “the right to emit”) which has little logical basis.

We then turn, in section 3.3, to notions of justice and equity in the context of climate action. Richer people and nations have contributed more to the creation of the crises, and the consequences hit the poorest people and nations earliest and hardest. We have to ask what follows from that important observation in terms of implications for future growth of different economies and of their emissions, and the moral obligations of different players. I will argue that the shared challenge across nations and peoples should be one of fostering the investments necessary in all countries, and particularly in developing countries, that can launch us all on this new path of growth. It is not about dividing up some notional carbon space (see section 1.1), or the claim that if others have emitted in the past, then I have the right to emit now; both of these positions are, in my view, mistaken. Further, and this is a different point, I think that insisting on putting compensation at centre stage is often confusing in logic⁴¹ and usually divisive in practice. I would not, however, quarrel with the basic idea that those harmed have a right to compensation.

⁴¹ It is difficult to identify who should be individually responsible. Individuals and countries have complex histories. And what did they know of the relevance of emissions centuries ago?

Indeed, their right to development has been restricted. My argument here is that the structure and logic of the problem points to more effective and more constructive ways forward.

In section 3.4, I will emphasise that the key directions of change identified, and the necessary magnitude of that change, require an active and purposive role for the state. In this context, I will also emphasise the importance of public discussion both of values and of the role of the state. Such discussion matters, as already argued in Section 2, for democracy and for the legitimacy and effectiveness of public action.

Finally, I will draw together how the logic of the climate challenge has forced us to think anew about both economics and ethics and their relationship. The two are irresistibly intertwined. They drive each other along in a way that leads us to both real conclusions for action and a deeper understanding of community, of the state and of ethics. And combining them carefully provides a sharper understanding of the real strategic choices, rather than assumed and narrowly focused, trade-offs. Those perspectives on the economics and ethics require new perspectives on the politics too, particularly political economy and the role of the state.

3.1. Ethical perspectives on public and individual action

As argued above, the scale of the crises and necessary action raises basic issues of rights, justice, and duties, which go beyond the simple and standard, often largely marginal, consequentialist approach to ethics generally used in economics. I will emphasise in particular rights and sustainability. Ideas of rights emerged in Western philosophy particularly strongly in the 18th century and the age of Enlightenment. We shall focus on their application to the issues of the climate and environment and the right to development, rather than examining them more generally. That will take us in the following sub-sections to sustainability and to ideas of climate justice. Before we do that, we must recognise that leading philosophers and the great religions have examined and set out ideas of duties and ethical behaviours in relation to the environment, individuals, and communities for many centuries, indeed for millennia. We examine the perspectives they bring and the guidance for behaviour and ethics that they offer. In this sub-section. I will argue, all too briefly, that these approaches also point to strong and urgent action. Indeed, a key point in the lecture, made in this section, is that the application of these philosophical traditions and religious perspectives fosters agreement on the ethical justification of such action, even though individuals and communities might each have different ethical arguments.⁴² Thus, the approach I have emphasised, combining consequentialism and rights, sits comfortably, in terms of conclusions on ethical behaviour and actions, alongside those other approaches. And I should emphasise again that their focus is, in the main, on duties rather than rights.

To bring out the structure of the arguments, at the cost, no doubt, of considerable oversimplification, the ideas from major philosophies as applied to environment/climate are set out in Table 3.1 and of the great religions in Table 3.2. I do not attempt a general discussion of these moral philosophies; the focus is on application to environmental issues. For comparison, and to keep ideas together, the approaches that I have embraced, of consequentialism and of rights, are set out in Table 3.3.

⁴² A colleague and friend, Charles Stafford, a distinguished anthropologist of the LSE, commented that some readers might ask: if the view on this is so unanimous, why is humanity not taking strong climate action? And shared some potential arguments in this respect. Though one argument could be that it is because humans are self-interested agents, there is strong evidence that humans are a cooperative species (see Tomasello, 2009). In turn, people may behave uncooperatively, unwittingly, because they lack the vantage point or information needed to do the right thing. Another argument could be that how people live and behave is a function not only of the 'morality' that is encoded in things such as religion, but also of the 'ethics' they themselves figure out in practice. To do what the religion/philosophy/morality suggests may be a challenge when it comes to the 'ordinary ethics' of an individual, which can sometimes collide with standard moral rules (see Stafford, 2010). A different kind of argument is that political and political-economy considerations intervene in real life, overriding philosophical and religious considerations, as well as the everyday ethics of ordinary people on the ground. From this last perspective, the problem of inaction is a strongly political one rather than one focused principally on ethical difficulties.

Table 3.1: Ethical perspectives applied to climate action. Understanding and describing moral behaviour and duties

Some major philosophical traditions	The guidance they offer
Aristotelian, or virtue, ethics	Unvirtuous to behave recklessly towards lives and livelihoods of others. See Aristotle (c. 350 BCE [2000], 350 BCE [2011]).
Kantian ethics	Categorical imperative, first formulation: you act as you would wish others to act. In this case, you would wish others to act to protect the environment, and you should do the same. Categorical imperative, second formulation: you should never treat humanity as a means to an end. In this case, you should not use future generations as an instrument for your own self-interest. See Kant (1785).
Social contract perspectives	If you were behind a 'veil of ignorance' (see Rawls, 1971) as to which generation you would be in, you would wish all generations to protect lives and livelihoods of those that follow.⁴³ For earlier contractarian thought, see Hobbes (1651 [1994]), Locke (1689 [1988]), and Rousseau (1762 [1973]).
Habermasian, or discourse, ethics	Role of public discourse and universalism. The latter is different from but with some relevant similarities to Kant. Discussed briefly in section 3.4. See Habermas (1981, 1983).

⁴³ The idea of 'justice as fairness,' central to Rawls' *A Theory of Justice*, has self-acknowledged Kantian roots, in Kant's constructivism (see Rawls, 1980). Kantian constructivism holds that principles of justice are constructed through a procedure rather than discovered as independent moral truths. Rawls' "original position," or "behind the veil of ignorance," offers such a procedure of construction through which moral principles are developed. I am grateful to my LSE colleague Niki Lacey for this observation.

Table 3.2: Major religions and climate action

Major religions	The guidance they offer
Christianity	For example, Pope Francis and <i>Laudato Si'</i> (2015) and <i>Laudate Deum</i> (2023). Genesis 2.15. Duty of stewardship of God's creation. Pope Francis also said (2014) "If we destroy creation, then creation will destroy us." ⁴⁴
Islam	<i>Al Mizan: A Covenant for the Earth</i> (2024). The Holy Quran: "To change the nature of God's creation is satanic." Also, Genesis 2.15.
Judaism	<i>The Sacred Earth: Jewish perspectives on Our Planet</i> (Rabbi Kahn, 2023). Appeals similarly to Old Testament as above.
Hinduism, Buddhism, Taoism	All these place respect for, and duties towards nature at centre stage (see e.g., <i>Sacred Nature</i> , Karen Armstrong (2022)). They emphasise, on the whole, both duties to nature and to others.
Codes of indigenous peoples	Duties towards "mother nature", e.g. embodied in the Ecuadorian constitution, that of Bhutan, and in the "Law of the rights of Mother Earth" in Bolivia. ⁴⁵ Many indigenous cultures see nature as having intrinsic value or rights and emphasise the human obligation of maintaining harmony with it or being guardians of it. For example, the Oromo people of Ethiopia (see Kelbessa, 2010) or the Māori of New Zealand (Watene, 2016). See also Caney (2025).

⁴⁴ The stewardship reading of Genesis reflected here, that is humans as caretakers accountable for creation's wellbeing, is the dominant position within Christianity. It is affirmed by Catholic teaching, as in *Laudato Si'* and *Laudate Deum*, by most mainline Protestant bodies, and by the mainstream of American evangelicalism itself, including the "creation care" tradition of the National Association of Evangelicals and the Evangelical Climate Initiative. A minority current within American evangelicalism, for example, the Cornwall Alliance for the Stewardship of Creation, reads the Genesis mandate to "have dominion" (*radah*) as licence to transform the natural world to enrich creation and human wellbeing, rather than as a call to protect it from encroachment (Edvardsson Björnberg et al., 2020). The Alliance also argues that the Earth's systems are divinely designed to be robust and self-correcting, so that aggressive climate mitigation is unnecessary. This reading is not endorsed by major denominational authorities and lacks a parallel in Jewish or Islamic tradition. A broader use of "dominion" language appears in Christian dominionism, a movement prominent in the American political right that invokes Genesis 1 to argue for Christian authority over civil institutions, less specifically the natural environment. Biblical scholars also disagree on how to read the underlying Hebrew on purely exegetical grounds, a largely separate debate from this political one.

⁴⁵ See also Rachel Carson, *Silent Spring* (1962), and Robert Macfarlane (2025), *Is a River Alive?*

Table 3.3: Rights-based approaches and consequentialism

Rights and freedoms
The right to development: freedom to pursue a life that one has reason to value (Sen, 1999, <i>Development as Freedom</i>); US Declaration of Independence (1776): “unalienable rights; that amongst these are life, liberty and the pursuit of happiness;” Mary Wollstonecraft (1792), Thomas Paine (1791); opening statement of Sustainable Development Goals (UN, 2015). See section 3.2 for further discussion. Environmental destruction and emissions of GHGs damage the rights of development of others, particularly future generations but also within this generation.
Consequentialism⁴⁶ (including Utilitarianism)⁴⁷
The standard approach in much of economics: the assessment of whether or not a policy or action should be pursued based on valuing and assessing its consequences (often in terms of “costs and benefits”). Such a consequentialist framework is closely tied to “welfarism:” an approach whereby social decisions are evaluated based on their effects on individual welfare (see, e.g., Sen, 1999) and an aggregation is made across the individual effects. Welfarism is central to much of economic analysis using social welfare functions (standard welfare economics). Utilitarianism is a special case of welfarism where the assessment of consequences is via utilities attached to or experienced by the individuals of the population and where their utilities are specified ⁴⁸ and summed to provide a criterion for economic and social decisions (à la Jeremy Bentham, 1789, <i>An Introduction to the Principles of Morals and Legislation</i>). The consequentialist approach was embodied in much of Sections 1 and 2 above and we argued that its application to climate pointed clearly towards strong and urgent action.

Aristotle’s ideas of virtue, moral character, and asking “what sort of person should we be” have a foundation in our ability to recognise and describe good behaviour. An analogy might be our ability to recognise good playing of the flute or kindness to others. The applications under examination here involve decisions in relation to our duties to future generations and the implications of our actions for their lives and livelihoods. If we are examining and discussing what is virtuous, then I would suggest that we would want to include ideas of integrity, compassion, and courage, and that we would not give that description to actions which would put future generations at great peril. We would likely see recklessness in relation to future generations as “unvirtuous.”

A central formulation of Immanuel Kant’s ‘categorical imperative’ is “act only according to the maxim whereby you can, at the same time, will that it should become universal law.” Acting to reduce emissions fits that imperative very well, as one would indeed wish others to act in the same way. This imperative would see “free-riding” on a public good (contributing nothing in the hope that others will act nonetheless) as clearly contrary to the maxim. Kant also counsels against treating humanity as an instrument for our own ends. That maxim would surely see acting in a way that is grounded in a narrow view of self-interest and which would radically diminish prospects for future generations as wrong.

Let us take John Rawls as a key modern example of the contractarian approach. Whilst the environment was not the primary focus of Rawls’ work, the “veil of ignorance” as applied, in this context, to the question of what codes of behaviour we would agree to if we did not know which generation we would be born to, would point to a wish that each generation would not leave

⁴⁶ Consequentialism encompasses both act and rule consequentialism. The former evaluates the consequences of each act and the latter sees actions as justified if they conform with rules which lead, overall, to good consequences if generally followed.

⁴⁷ It is important, in the context of consequentialism, to mention Derek Parfit’s work – both his earlier *Reasons and Persons* (1984), and *On What Matters* (2011a, 2011b, 2017). Although in the former Parfit defends act consequentialism, he treats it as a criterion of moral rightness rather than a decision procedure for everyday moral choices, i.e. commonsense morality. In *On What Matters* (2011/2017), he sought to establish a “Triple Theory,” combining what he deemed to be the best aspects of Kantianism, contractarianism, and rule consequentialism, and the way their combination is coherent with common-sense moral intuitions. One of Parfit’s most renowned contributions, the non-identity problem, is particularly relevant to climate change. It creates a paradox, whereby our polluting behaviour seems clearly wrong and harmful to future generations, yet standard person-affecting moral principles struggle to explain why, since no particular future person is necessarily made worse off than they would otherwise have been.

⁴⁸ How that specification takes place is itself an issue that must be examined carefully, and will usually involve normative issues.

future generations worse off than themselves. That corresponds here to embracing sustainability. That is, in this context, a “just savings principle” as Rawls described it, in other words, leaving capital, of all kinds (see below), sufficient to give opportunities to the next generation at least as good as our own (assuming they behave in the same way towards generations that follow them).

Jürgen Habermas’ notion of “universalism” whereby we seek, through public discussion, codes which we would wish all would follow, would likely lead to broadly similar conclusions as the Kantian approach. However, in this case, the conclusion might be weaker as there would be particular vested interests which might seek to undermine shared commitment. His emphasis on the importance of informed “public discourse” might go some way to reduce problems of vested interests, but probably would not eliminate them. On public discourse, see section 3.4 below.

On the great religions, see Table 3.2, I do not have the space to treat the perspectives they offer with the attention they deserve. It is striking that religious leadership from the Abrahamic religions, Christianity, Islam, and Judaism, have all seen their holy scriptures as pointing to a duty of stewardship towards the creator’s work (see, for example, their appeal to Genesis 2.15). The statements of the late Pope Francis, *Laudato Si* (2015) and *Laudate Deum* (2023), have been particularly powerful, including on the urgency of action and the importance of our behaviours as individuals, communities, and nations.

Hinduism, Buddhism, and Taoism all embody a respect for nature and humankind as embedded in and part of a system of nature. These perspectives imply a duty of care for other living things and for the key elements of that system, such as water and air. Indigenous religions, belief systems, and codes often embrace the rights of “mother nature,” as embodied, for example, in the Ecuadorian constitution.⁴⁹ Other instances where ‘non-human’ entities have been recognised as legal subjects include the 2017 *Te Awa Tupua* Act in New Zealand that established the Whanganui River in Aotearoa New Zealand as a legal person. The great religious traditions, from the Abrahamic faiths to Buddhist and indigenous cosmologies, embody the idea that nature carries an intrinsic worth that goes beyond usefulness to us. And so, from such perspectives, it would follow that we must be careful not to frame its protection only in utilitarian or welfarist terms. And I hope that most of us would recognise that, for many, wonder at our natural world goes far beyond the merely functional.

“Commonsense pluralism” (see e.g., Fesmire, 2020; Light, 2002; Palmer, 2014) is not presented here as a single philosophical or religious perspective. I take this notion to mean an attempt to crystallise everyday moral beliefs as a set of guiding principles. One perspective in this approach is to suggest that these have evolved in a way that is beneficial to society as a whole and to its future. Recklessness with the environment would unlikely be part of such an evolution of principles. But we should note that the kinds of possibilities which could occur with negligence toward climate change could be way outside past human experiences.⁵⁰

Taken together, a brief analysis of how major philosophies and great religions would or should treat the questions and issues of climate change surely points to strong action. It is hard to envisage plausible ethical perspectives which would justify taking large-scale risks with the wellbeing of future generations. Those advocating inaction would need to marshal other arguments. It is hard to imagine how such arguments could both respect the science, the technology, and the economics and be convincing from an ethical and practical perspective.

These conclusions from the strands of thinking reviewed here are in harmony with the conclusions that we have argued, and will argue below, follow from consequentialism and the approaches based on a right to development.

⁴⁹ See also the arguments expressed in Robert MacFarlane’s *Is A River Alive?*. And the exploration of indigenous perspectives towards nature in Robin Wall Kimmerer’s *Braiding Sweetgrass* (2013), and Jessica Hernandez’s *Fresh Banana Leaves* (2022).

⁵⁰ I am grateful to Charles Stafford for the following observation: As we consider the ethics of climate action from the point of view of the philosophical traditions, we should remind ourselves that *all of us* are philosophers in everyday life, engaging routinely in what some anthropologists refer to as ‘ordinary ethics’, something very much seen on the ground in all human societies (see e.g., Lambek, 2010).

3.2. Rights to development and sustainability

We turn now to some key ideas of rights, originating in Western traditions largely in the 18th century. Rights here contrast with the notion of duties emphasised in the philosophical approaches just examined. Human rights were strongly articulated politically by Thomas Paine and Mary Wollstonecraft, and in the US Declaration of Independence, for example. The notion of rights is now a prominent part of moral and political philosophy, national and international law, and society and politics more generally.

Our focus here is on a right to development (and see Table 3.3). This right, or “freedom to pursue a life that you have reason to value,” has been argued powerfully and rigorously by Amartya Sen, for example, in his book *Development as Freedom* (1999). The idea was at the core of his Tanner Lectures of 1979 and much of his writings in the years following (see e.g., “Rights and Agency,” 1982). That freedom is shaped by the individual’s ability to act, or their agency, and that is in turn shaped by “capabilities.” That concept of capabilities concerns not just resources but the ability to act and take decisions in the context of the community and society. Sen (*private communication* and clear from his works) has always seen rights and agency as the primary concepts and capabilities as a means or instrument to agency. In his seminal book *The Idea of Justice* (2009), Sen argues that we can and should approach the idea of justice by recognising that the denial of rights or entitlements should be regarded as injustice. That shifts the discussion towards a focus on the meaning of and basis for rights and towards how the injustices caused by denying them arise and can be confronted.

The right to development was formalised in the 1986 UN Declaration on the Right to Development as “an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized” (UNGA, 1986, Article 1.1).⁵¹ Climate change and the biodiversity crisis undermine fundamental human rights in a number of ways. Climate change kills and maims people, increases the incidence of disease, compromises health and threatens food security, among other harms. This undermines the right to life, the right to health, and to subsistence, for example (see Caney, 2010). The right to development must thus be seen as composite in nature, and as encompassing these and other individual rights, while extending beyond them to capture more fully the freedom to pursue a life one has a reason to value and the agency inherent in doing so.

This understanding emphasises a fundamental link between the right to development and human agency. What is at stake is not merely the right not to be harmed, as a negative liberty, which many or most philosophers, legal systems, and people widely accept. What is also at stake is the freedom and agency that are central to human self-realisation. This is the positive liberty identified in Isaiah Berlin’s (1958) influential distinction. Agency in this context requires both negative freedoms, such as protection from harm and other freedoms from obstruction, and positive freedoms, the opportunities for self-realisation in the pursuit of a valued life.

Individual freedoms are deeply dependent on how communities and societies function and the constraints and opportunities they embody (see e.g. Sen, 1999). But there is another civic dimension to freedom, which is important to our conception of the right to development. Freedom is sometimes conceived in fairly narrow terms: the ability to satisfy one’s desires without violating others’ rights. However, the notion of “civic” freedom offers a richer conception, holding that individuals are only truly free insofar as they have “a meaningful voice in shaping the forces that govern the collective project” (see e.g. Michael Sandel in Sandbu 2026; also Sandel, 1996, 2005). Indeed, this is central to Sen’s conception of freedom too (Sen, 1999). Civic freedom requires that citizens be able to deliberate with one another on their conceptions of the good and

⁵¹ It was adopted on December 4, 1986, by a vote of 146 member states in favour, one against (the USA), and eight abstentions (Denmark, Finland, the Federal Republic of Germany, Iceland, Israel, Japan, Sweden, and the UK). I cannot refrain from noting that this was at the height of Thatcherism in the UK and Reaganism in the USA. Margaret Thatcher famously asserted “There is no such thing as society.” (in an interview for *Woman’s Own* magazine in 1987).

the good of the community, and how it can be pursued, as well as actively participating in the common good.

The deliberative dimension finds support in Jürgen Habermas' conception of the public sphere, in which legitimate political outcomes emerge not simply from the aggregation of private preferences but from reasoned discourse among citizens (Habermas, 1991, 1996). For Habermas, the public sphere is the space in which individuals, whilst recognising their exclusively private interests, engage in communication oriented towards mutual understanding. This is not merely a procedural point. It speaks to the substantive conditions required for genuine civic freedom, because deliberation of this kind presupposes and, in turn, reinforces, the capacities for agency that both Sandel and Sen place at the heart of freedom. As well as bringing different perspectives to the table, such discussions can share and test relevant evidence. This understanding of civic freedom and participation is crucial for linking freedom to agency.

In his 2020 book, *The Tyranny of Merit*, Sandel raises the idea of "contributive justice," as important alongside distributive justice. He argues that we should recognise and embrace the idea that citizens seek and appreciate opportunities to make a contribution to the common good, which is central to human flourishing. That could include, for some, the social recognition that can come from such contributions. This idea emphasises the importance of community. The "unencumbered self" of some liberal philosophical approaches is not only empirically dubious as a description of who we are but has also often proved destructive.

These shared freedoms, rights associated with development, constitute a central element in ideas of common humanity. They are embedded in the statement of the US Declaration of Independence "all men are created equal, that they are endowed by their Creator with certain unalienable rights, that among these are life, liberty, and the pursuit of happiness" (1776, para. 2). And the Declaration goes on to indicate that a key purpose of government is to "secure these rights" (1776, para. 2).

While it is individuals that are the focus in defining and understanding the freedom and the agency inherent in the right to development, there is a sense in which this right can also be conceptualised as a collective right of groups, communities or nations, of which individuals are constituent parts. Since states are one of the central actors capable of taking action on climate, on behalf of their people, they play a central role in realising this right. These complementary roles of individuals and states, extend to discussions of responsibility, as we will examine in the next section. States are key actors in tackling climate change.

Indeed, because of their powers to act in a comprehensive way, on a set of issues which cover the whole of economy and society, the state is at centre stage. Because of their past emissions, which have damaged the rights to development of others, and because, through their wealth, they are in a position to help others in difficulty, richer states bear a responsibility to help poorer states in taking such action, and securing their right to development. Thus, the relationships between states, their mutual responsibilities and how they collaborate will be crucial.

Moreover, recent philosophical literature has explored the conditions under which corporate entities can be seen as having agency and their own responsibilities and choice-making capacity (see List and Pettit, 2011). Private firms have their own responsibilities to examine the consequences of their actions for environment and society. They are part of the community. And increasingly, legal systems are recognising and enforcing such responsibilities.⁵²

⁵² In *Milieudefensie et al. v. Royal Dutch Shell* (District Court of The Hague, 26 May 2021), a Dutch court ruled that Shell had a duty of care under tort law and the European Convention on Human Rights to reduce its CO₂ emissions by 45% by 2030. On appeal (Hague Court of Appeal, 12 November 2024), the specific target was set aside, but the court reaffirmed that major emitters bear a legal duty to contribute to climate mitigation. The EU's Corporate Sustainability Due Diligence Directive (2024/1760) now requires large companies to adopt and implement a climate transition plan aligned with the 1.5°C goal. For an overview of the rapid growth of climate-related litigation, including against private firms, see Setzer et al. (2026) and UNEP and Sabin Center for Climate Change Law (2025).

The practical meaning of the right to development, as embodied in, e.g., Sen's overarching definition, is clearly important. It has been articulated or calibrated through measured indicators in various ways in international discussion, including via the Human Development Indicators (see UNDP, 2025), the Millennium Development Goals (2000), and the Sustainable Development Goals (2015). These indicators or goals do not reflect the full content, thrust or subtlety of the right to development, but they do identify in a useful way some key dimensions.

The idea that our common humanity points to each of us having a right to development takes us, when applied intertemporally, to the idea of sustainability. A good working definition is that "this generation offers the next generation opportunities at least as good as its own, assuming the next generation behaves in a similar way to those that follow" (see e.g. Stern, 2025).⁵³ Opportunities are shaped by the endowments that our generation passes on, particularly in terms of physical, human, natural, and social capital (see sections 2.1 and 2.2).

Sustainability is a weaker concept than the idea of sustainable development. Sustainable development involves generating, in a sustainable way, *better* opportunities for development over time, rather than simply leaving the next generation no worse off than now. To illustrate, we should surely strive for air pollution next year in Delhi not simply to be no worse than now, but to reduce it to give the next generation better opportunities and a less harmful environment. Sustainability as a concept points to conservation or preservation; that is indeed of great importance. Sustainable development is more dynamic and, whilst embracing sustainability, emphasises the creation of opportunities for improvement, and the expansion of future generations' right to development.

Poverty and inequality are core ethical issues. They are strongly connected to the growth story particularly through the processes of growth which are followed and policies which foster growth and shape the fruits of growth. Many of the arguments on the growth story, including that there is no horse race between climate action and growth, also apply to discussions of climate in relation to poverty and inequality. Indeed, climate action, as our growth story here presents it, is about sustainable development. That story should have within it the tackling of poverty. And we must emphasise that inaction is the most unequal of all possible responses to the challenge of climate change. Climate change can exacerbate existing vulnerabilities, and it is poor people who are hit earliest and hardest.

Making the growth story a reality can help overcome poverty and help overcome some of the more troublesome inequalities. I would argue that realising the new growth story is a political imperative, given the tensions that poverty and inequality generate, and given the moral imperative to overcome poverty; particularly given the dangers of populism, as highlighted above.

Public policy in promoting the new growth story would have to take explicit account of inequality and poverty, including in acting so that the transition is just. Investing in people and places that face dislocation is of special importance. Social protection will be required when necessary, but the first priority would be the creation of new opportunities.

An overarching conclusion of these lectures is that climate action constitutes an ethical imperative. Most of the major strands of moral philosophy and the great religions point to the duty to act. Such action is essential for realising the right to development and sustainable development, which is in turn necessary for enhancing human agency and freedom. And climate action is a key requirement for fighting poverty.

3.3. Justice and equity

In thinking about justice in relation to climate, biodiversity, or the environment, we should examine a number of relevant dimensions. Justice across individuals in different locations or occupations. Justice across individuals with different levels of well-being, including in relation to income, wealth, education, health or disability. Justice across social groups in relation to gender,

⁵³ See also the Brundtland report of 1989 which offers a similar definition, although it speaks of "needs" rather than "opportunities."

race, language, religion. Justice across countries. Justice across generations. Climate justice is a term often used, but the above examples show that it will inevitably have interpretations which will vary across dimensions. And it can have and has had different interpretations within a dimension.

Justice must be distinguished from equity or fairness. Whereas the former asks whether someone has been treated properly in relation to their rights (in the sense described above), the latter asks whether they have been treated in a similar way to others, or in a way that takes appropriate account of relevant differences. The practicalities that follow from equity and fairness considerations are thus inherently concerned with distribution. Those of justice are more absolute, as opposed to relative, and do not necessarily have to involve comparisons.⁵⁴

As Sen argues in *The Idea of Justice* (2009), it is much more straightforward, practically and persuasively, to identify injustice as a right or entitlement which is denied than it is to offer a general theory of justice. Of course, there have been impressive efforts on the latter (for example, John Rawls, *A Theory of Justice* (1971), as discussed above). The Rawlsian approach envisions what a just society looks like and the processes and institutions that shape and support it, whereas Sen's approach is rooted in the practical realities that people face in their lives, in their capabilities and realisations. In large measure, in discussing issues of justice, I will follow Sen's approach based on the description of rights and of injustice as rights denied. The discussion of rights and justice across states and communities will be pursued from a similar perspective.

There are important injustices across peoples and nations which should influence both our actions and our notions of mutual obligation. Richer economies have followed paths of growth and development which have damaged the rights to development of currently poorer nations. Richer countries and groups have and do emit far more per capita than poorer; it is poorer countries and groups which are generally hit earliest and hardest by climate impacts, and which have weaker capabilities of building resilience or to recover from damage.

What follows from these important injustices across nations and groups? We should be immediately clear about what does not follow. As Prime Minister Meles Zenawi, and one of Africa's most distinguished leaders of modern times, said at COP17 in Durban in December 2011, on Africa Day (I was with him on the platform), "It is not justice to foul the planet because others have fouled it in the past." He fundamentally, and rightly in my view, rejected the idea that because rich countries became rich the dirty way, then poor countries can, or even should, do the same. I have maintained, with many others, and following a distinguished philosophical tradition, that there is a right to development. But that does not imply a right to emit. Development needs energy, but energy does not need carbon. Indeed, I argued in Section 2, and in my book *The Growth Story of the 21st Century*, that the clean route to development is strong, resilient, and inclusive. There is no horse-race between development and poverty reduction, on the one hand, and environment or climate, on the other.

Similarly mistaken is the idea that equity or justice requires an equal per capita right to what remains of the "carbon space" (see section 1.1). Or that because rich countries have used up so much of the carbon space, poorer countries have a greater right to what remains. Such reasoning has often been reflected in the philosophical literature, where the broad and well-founded consensus that poor countries have a right to develop sometimes translates into support for equal per capita emissions rights or for subsistence emissions rights as a practical means of upholding the right to development (see, for example, Baer et al., 2010). That is a mistake.

For many, this argument on rights to carbon space appears attractive. But emissions kill and maim, and it is difficult to argue on any ethical perspective that there is a right to do so. The relevant right, and one which we think of as embodied in our common humanity and freedoms, is the right to development. Unless the "right to carbon space" is derived explicitly from other more fundamental, and more broadly accepted rights, it is hard to give it credence. It has no serious

⁵⁴ See also Sudhir Anand (2026) on this distinction in the realm of health justice.

ethical foundation, in my view. The inference that the right to development must imply rights to the carbon space arises from an incorrect understanding of the structure of the problem, namely from asserting that there is an inherent horse-race between climate action and development. However, once we understand the growth story as I have outlined, we must embrace the possibility that the link between growth and development, on the one hand, and emissions, on the other, can be broken.

We must recognise that the transition to net zero will take time and there will be emissions along the way. And we can and should argue that past history, plus access to wealth and technology should imply that rich countries have a responsibility to reduce emissions quickly and to support the new sustainable paths of development for poorer countries. If they are sensible, they will do that by strong investment in the new and clean. But that does not alter or undermine the argument that the clean route to development is both the most effective and the most responsible, for developing countries.

In combining consequentialist and rights-based approaches, I argue that the central concept of justice under consideration is the right to development. As noted above, justice and fairness are often conflated, though the philosophical literature typically distinguishes them: justice concerns rights-claims, while fairness concerns distribution; in particular here, how access to rights might vary in the population. Taking fairness to be, in core elements, a distributive concept, we must identify the appropriate perspectives on, or dimensions of, distribution. However, it is far from clear that such a dimension should be the carbon space.

The constructive approach to fairness here relates to resources and opportunities for development; and that focuses on the right to development. By taking the right to development as the central concept at issue, we can reject the right to emit. If fairness concerns how different people fare relative to one another, then the use of the carbon space as an idea would matter only instrumentally, insofar as access to carbon space is critical to development opportunities and well-being. However, to reiterate, development requires energy, but energy does not require carbon. In the shorter run and the earlier periods of the energy transition, growth in all countries will imply some emissions. The key question, however, is not the justification of such emissions, but the delivery of an effective transition and a strong new sustainable and resilient path of development.

The primary issue or question around fairness then concerns the distribution of development opportunities, including how best to support the transition, including via finance, sharing technologies, and investment – not the allocation of the carbon budget. Claims concerning rights to and the distribution of carbon budgets should be, if valid, derived from higher levels of rights and the logical structure of the problems, but, given the structure of the problem, carbon budgets should not be seen as the sole or even primary means to the goal of strong, sustainable and resilient development.

From a consequentialist perspective, tackling the damage done by emissions should be through pricing, regulation, standards, and investment. The fairness dimension concerns how the global community initiates and drives forward processes of sustainable, resilient, and inclusive growth and development, particularly in developing countries. From this perspective, there is a strong relevance of the historical responsibility of rich countries for past emissions and the harm they have caused and from the current capacity of rich countries to make a difference. It encompasses not only mitigation support but also adaptation investments, which are often intertwined with opportunities for growth. To place the emphasis on carbon space as the central fairness issue is to misunderstand the structure of the problem, the economics of the response, and the relevant notion of rights.

The injustices we highlighted that are embodied in this history have strong ethical implications. These lie in taking forward, and helping others take forward, the responses and solutions that we know can offer a much safer world environmentally and higher and more resilient living standards. And doing so in a way that reduces poverty across the world. The responsibilities of rich countries are ethical, given the history, and they are supported by their own self-interest. Their

historical emissions have driven the damages now bearing down most heavily on those least responsible; they owe it to poorer countries to both support the transition and to lead by cutting their own emissions. But as we have seen, the case for action does not rest on ethics alone. Rich and poor countries alike have a powerful self-interest in driving the new growth story across the world, rooted in reaping the opportunities that the transition opens up for their own economies, and in the shared imperative to avoid the profound risks that unmitigated climate change would impose on all. It is up to the developing countries, within this context of opportunity and responsibility for all, to choose and formulate their own plans for sustainable and resilient growth and create the policy and institutional environment for the new investment. Richer countries can work, particularly with international institutions, to help both with the practicalities and especially with promoting affordable and accessible finance.

Some might raise, in this context, the issue of compensation for past damages. Compensation is a standard perspective in law and philosophy. That argument does indeed have some ethical foundation in this context. But there are, however, at least two major problems which make its application politically infeasible or unwise: the calculation of relevant damage and the achievement of agreement.⁵⁵ Basically, the pursuit of compensation, of a specific bill or invoice for past harm, notwithstanding its ethical justification would divide and would hinder collaboration and inhibit agreement.⁵⁶ Attempting to insist on the formality of a specific payment “due” would likely create push-back, and divisiveness when what is needed is collaboration. I have argued that rich countries do indeed have responsibilities towards poor countries in relation to climate and that the appropriate way to take on those responsibilities is to support them in achieving the growth story. In particular that could and should be through fostering investment and supporting its finance. But that is very different from an attempt to calculate the specific “bill for past harm” and trying to enforce payment. The responsibilities of rich countries to poor countries are much better fulfilled in terms of helping in investment and making the new growth story happen. That is an approach that focuses on the key actions necessary to promote development, tackle poverty, and manage climate in a constructive, sustainable, lasting and collaborative way.

Thus, my reservations about moving compensation to centre stage are from a political economy and practical standpoint. It is impractical and potentially counterproductive for three main reasons: (1) it is difficult to calculate the damage done; (2) it is difficult to determine who is historically responsible; and (3) it is difficult to ascertain to what extent people knew of the consequences of their actions for the environment at the time these actions took place (and note that the IPCC was created in 1988).

When there is a duty to respond, and we know how to respond, there is surely an obligation for those who both played a greater role in the creation of the problem and are better able to respond to take a lead. What does that mean? Rich countries should invest strongly to advance sustainable and resilient growth and rapidly reduce emissions: thus, embrace the new growth story. And they should help create the conditions, and foster low-cost finance for investment in building the new growth economy in poorer economies. Further, we saw (section 2.2) how good policies and the sharing and reduction of risk could do exactly that and at low cost to their budgets: essentially by reducing the cost of capital flows and increasing their availability.

⁵⁵ Attempts at agreement on responsibilities for the past are further complicated by the fact that many generations, far in the past, acted without knowledge, or without full knowledge, of the climate consequences of their emissions. And that peoples and countries have complex identities, antecedents, and histories.

⁵⁶ John Kerry, Secretary of State, then climate envoy, said that the US would not pay climate reparations to developing countries during a congressional hearing. According to Climate Home News, Kerry was asked by a Republican if he was “planning to commit America to climate reparations,” where the US would have to “pay some other country because they had a flood or they had a hurricane” (Lo, 2023). Kerry answered: “No. Under no circumstances” (Lo, 2023). It seems that some interpreted this as a refusal to contribute to a new loss and damage fund scheduled to be established at COP28. But others indicated Kerry wanted to reject formal liability. He has been and is a great champion of climate action and has worked indefatigably over many decades to promote it.

The advancement of both the consequentialist and the rights approaches in the ethics of climate action raises the question of how they should be combined and whether there are difficulties in so doing. If we can find ways to advance the welfare of this generation and future generations which benefit all, then each of the two ethical approaches would recognise improvement. Indeed, they are mutually supportive. And I have argued that in terms of generations, we can indeed advance the welfare of both this and future generations by embracing the new growth story. But there will be occasions, particularly within generations, when climate action advances the welfare of many, but may infringe the right to development of some. For example, those whose livelihoods depend on carbon-intensive industries could be affected, especially in the absence of strategic action and planning and of action for a just transition. For example, strategic action in China on EV development has given the Chinese EV industry a significant competitive advantage relative to electric car industries elsewhere, such as in the US. The consequentialist approach, at least in its utilitarian form, would measure and weigh the costs and benefits on different dimensions and in different places and flowing to different people, and signal “go ahead” if the latter exceeds the former. But a rights approach may limit that.

Processes matter. Let us take a very simple, if colourful example to illustrate the point. If I get great pleasure from punching someone on the nose and he suffers only minor pain, then a utilitarian calculation might suggest that the benefits outweigh the costs, and I should go ahead with the punch. Nevertheless, there is a right not to be assaulted which should be respected. Variants of this may occur with climate action. For example, Person A may think that she has a right to prevent a new transmission line near her house. In such circumstances, we may take the view that, provided Person A has been consulted and helped, that due process has been followed, and that the benefit to this and future communities is large, we should go ahead. There is no formal algorithm for combining the two approaches.

3.4. Public discussion and the role of the state

The policies and actions we have described, which are necessary to respond to the investment imperative and opportunity created by the urgency of the climate crisis, require proactive and purposeful action by the state. Examples include, as we saw in section 2.2, support for R and D and innovation, fostering the building of critical infrastructure such as city metros and new grid structures, enabling the financial system to provide for greater risk-reduction and sharing, setting standards on pollution and information. And, importantly, setting carbon prices. Indeed, all of the above. And we saw in sections 2.2 and 2.3 that the urgency of climate action could provide a spur to overcoming relevant market failures which could inhibit action. Further, overcoming such failures could have broader benefits.

The growth story works largely through markets and private investment, but it is public policy and the state that have to set strategies to mark the sense of direction and to give confidence both in the direction of movement and in policies to foster the necessary investment and change. We have seen how powerful that can be in the extraordinary advance in low-carbon technologies following the Paris Agreement of 2015. It could be still more powerful if the credibility and substance of policy were still stronger. Thus, this is no time to return to the misguided market fundamentalism of the 1990s, where it was argued that growth would come if the government simply steps out of the way. The investment for the new growth story should indeed be mostly private, but it is for the government to help create the investment environment in which entrepreneurship can flourish and, crucially, to help guide investment towards sustainable and resilient outcomes. As the US Declaration of Independence describes, it is the role of government to “secure these rights” of the people to the freedom to flourish, that is to exercise their “unalienable right” to “life, liberty, and the pursuit of happiness.” In this case, this means the right to a future of sustainable and resilient development for them and their descendants.

Whilst we can now see the necessary sense of direction and how action can be effective, there is no pretence that it will be easy. Strong investment is needed, and there will be dislocation associated with structural and technological change. This new growth story cannot be delivered without public understanding and support. Proactive state action must identify the potential

challenges that might arise for different stakeholders during the transition, including ordinary citizens, and act to address and manage risks; while also identifying potential benefits and making sure they are leveraged through strategy and action. A just transition involves both managing potential impacts and making change desirable by harnessing the new economic and social benefits it can bring.

That is why public discussion is so important. And it should be informed and open public discussion; it is the well-informed public discourse which the moral and political philosopher Jürgen Habermas championed. It is not only an ethical requirement of public action and core to democracy; it also gives a sense of legitimacy to public action which is critical to its success. This is why fostering public discussion and discourse is part of the role of the state; both ethically and practically. Its importance is illustrated by the current political backlash against environmental action in the US and other rich countries. This is being driven by a difficult combination of diminishing social capital, including erosion of trust, diminishing respect for evidence and science and for logic in argument, and partisan tribal politics. And by a resentment of elites, which are seen to have failed ordinary people in the past. Building social capital through well-informed and evidence-based public discourse and discussion, as well as effective communication about and delivery of the benefits of the growth story, will be crucial to taking the story forward. Interestingly, outside countries with big oil and gas endowments, the developing world shows much less backlash. Positive examples and tangible early benefits from the new strategic directions will be crucial to the support for and success of the transition.

Institutions, particularly those that can support confidence in strategic direction and basic policies, will matter in the key tasks of creating a strong, stable, and credible investment environment. So too to the enabling of public discussion. Institutions for learning, for science and technology, and for their dissemination will also play a central role. Our universities have special responsibilities. Legal institutions, clarifying both duties and accountability in relation to climate action and for trusted dispute resolution, are also part of the story. So too religious and societal organisations as places where responsibilities and mutual support can be discussed or manifested. As argued early in these lectures, the main barriers to effective climate action and to realising the new growth story are economic, social, and political. Tackling them is critical to our future.

In our discussion of the science in section 1.1 and, given the certain overshooting of 1.5°C and likely overshooting of 2°C, I highlighted the critical need for technologies and investment for carbon dioxide removal, including via natural capital. The scale likely to be necessary will require international collaboration over action and cost. There will also be discussion of, and pressure for, geoengineering such as solar radiation management, or the restriction of the inflow of solar energy through, for example, putting particulates into the atmosphere. That would likely be very risky in terms of potential consequences, unintended or otherwise. For example, if CO₂ concentrations continue at high, indeed rising levels, the acidification of the oceans that would occur could be extremely damaging. And there could be, hitherto, unknown or not yet fully understood, further consequences (Armstrong McKay et al., 2022; IPCC, 2021; IPCC, 2023; Rahmstorf, 2024). There is also the danger that such actions (e.g., the injection of particulates into the atmosphere) could be pursued by individuals, enterprises or nations acting alone or in small groups. That raises fundamental questions in moral and political philosophy of their right to do that, or indeed, the absence of such a right given the possibly profound consequences for so many. And, further, the practical difficulties of controlling and regulating such actions. Research on the possible consequences of geo-engineering and public discussion of the political ethics are crucial tasks.

Concluding comments

The climate and biodiversity crises we face today have the bulk of their origins in the dirty and destructive methods that powered the extraordinary growth in income, and the associated poverty reduction and increase in life expectancy, since the end of the Second World War. These achievements have been fundamental to great advancements in poverty reduction and in global prosperity. But they were driven in large measure by energy from burning fossil fuels. That process both brought immensely damaging pollution, rises in GHGs, and the undermining and destruction of critical natural capital, that is biodiversity, land, forests, water, and oceans. It is clear that we must now follow a very different path than in the past, if we are to avoid catastrophic climate change and biodiversity loss.

The opportunities embodied in the new growth story, set out in the Tanner lectures and this paper, show that climate action and growth are not in competition. There is no horse-race between sustainability, on the one hand, and development, on the other. Indeed, sustainable development should be the objective of public policy. The potential is rich. Climate action will drive this new form of growth. Its achievement will need major investment and strong structural change. Further, we saw that the next two decades were decisive and that the bulk of the necessary investment for climate action and sustainable and resilient growth would take place in the developing world. That investment, part of a broader strategy for sustainable development, can yield great advance across all the dimensions of the Sustainable Development Goals.

Our conclusions for economics, ethics, and politics are set out in turn. *The economics necessary* to help chart and guide the growth story is rather different from that which was applied in the early days of the economics of climate change. It should now focus on the new story of growth and development. The economics that can guide this new story is far more dynamic and structural, than much of the received analysis of the economics of climate change. It must specify objectives, both over time and within and across communities and nations, clearly, including those beyond simply aggregate output. It must engage with structural change. It must recognise the centrality of investment and innovation. It must address a range of market failures beyond the GHG externality, work to understand behavioural change, and help build institutions for action. In so doing, it must understand discounting more clearly than the cavalier and misguided analyses that have been all too common. It must develop new approaches to immense risks and engage thoughtfully with ethics.

This new economics, together with the scientific structure of the problem, and the technological advance of the last two decades, framed our discussion of *ethics*, and the conclusions that follow from that discussion. Our first lesson here is that understanding the ethics that we can or should bring to a problem requires clarity on the structure of the problem itself. That structure includes the science, which tells us about the urgency, and the economics and technology, including AI, which reveal the opportunity and the growth story. At the centre of this story, in addition to the urgency of action, is the opportunity that lies in that action. Its realisation requires substantial and innovative investment, and structural change. There is no horse-race or inevitable trade-off between climate and the environment, on the one hand, and growth and development, on the other, which has to be resolved by the ethics. Formulating the problem badly leads to the wrong choice of focus in the ethics.

Second, on the ethics, an understanding of the foundations of the problem demands not only that we bring consequentialist ethics but also basic notions of rights and justice. The particular right at issue here, as we have argued, is the right to development, which embodies the freedom to lead a life one has reason to value. That right is being damaged for so many by weak action on climate change. However, that right to development is not one that implies the right to pollute and damage the rights to development of others. It does encapsulate the right not to be harmed. This right to development embodies our common humanity, as the thinkers of the 18th century and authors of the US Declaration of Independence emphasised so clearly. Upholding this right

also serves the consequentialist goal of better lives, benefitting current and future generations, in the context of the new growth story.

Third, on the ethics, the great religions and philosophical traditions of the world point to important duties to others, present and future, and to nature and our lived environment. We can and should marshal all these perspectives from moral philosophy, not only from the point of view of clarity, depth, and breadth in understanding why we are acting, but also in drawing together as strong as possible coalitions.

In making our case for climate action, self-interest and opportunity constitute a very powerful argument, both in terms of action to promote growth and action to promote the reduction of risk. However, the ethical arguments will, for many, provide similarly powerful motivation. We can and should embrace arguments which: focus on the management of extreme risk; highlight the great opportunities in the new growth story; articulate the ethics of responsibility and duty.

These economic and ethical conclusions lead in turn to implications for the *politics and political economy*, the understanding of which will be central for the delivery and sustaining of action. We focus on three lessons here. First, the ethics, together with the basic foundations of the problem, point us to recognising that collaboration and mutual support across communities and nations must be at the heart of the action that can realise the great opportunities and tackle the great risks. That is different from a focus on the division of burdens. The latter is not only inconsistent with the structure of the problem; it is politically divisive. Building that political spirit of collaboration and purpose in tackling great risk and embracing the new opportunities will depend on a clear articulation of the economics and ethics.

Second, on the politics, this new path requires an active state in setting strategy and giving stable and credible incentives for investment.

Third, the state has a crucial role in fostering inclusive public discussion and understanding. Such participation is not only a democratic requirement of public decision and action, it also gives a sense of legitimacy to public action, which is critical to its success.

Fourth, leadership across society will be core to political commitment. That will require clarity on the arguments, understanding pushback and bringing justice to the transition, including investing in people and places that suffer dislocation. It will require courage and the building of coalitions. It will require the creation and communication of good examples. In all this, the support and energy of the young will be crucial. Hence the key role of universities, media, social movements and religious organisations.

This challenge demands insights from all disciplines: science, engineering, economics, history, economic history, politics, sociology, anthropology, psychology, international relations, geography, and particularly moral and political philosophy, and more. Our research and universities are vital. The next decade is critical, not only because of the immense and proximate risks of climate change but also because of the opportunities in climate action. Obstacles must be examined and overcome through serious research and political and public engagement if opportunities are to be grasped and these immense risks avoided.

The new growth story is an economic imperative, ethical imperative, and a political imperative. And these imperatives require action now. Pursuing the new growth story is urgent to mitigate extreme risks, which could reverse and undermine economic development, support economic and social development rights and justice, and address other perverse dynamics at play, such as social and political tipping points. Thus, it is an economic imperative. It is an ethical imperative to offer development and well-being to the next generations and reduce poverty across the world. That is what the new growth story can deliver. And it is a political imperative in particular, given its importance in combating divisiveness, potential conflict, and the erosion of constitutional democracy.

The conclusions are summarised in Tables 3.4 and 3.5.

Table 3.4. Conclusions – making the case

The new growth story is an urgent ethical, economic and political imperative. The case for strong action is compelling.		
Economic	Ethical	Political
To pivot away from a destructive economic model, mitigate immense risks of climate impacts, and unlock economic growth and development.	To offer development and well-being to the next generations and reduce poverty across the world. Thereby enabling rights to development and justice. And fulfilling duty of stewardship towards the environment.	To help in overcoming political anger around lack of growth, sense of deprivation. Thus, fostering hope and combating divisiveness, potential conflict, and the erosion of constitutional democracy.
The public and political case for action can and should be founded on three arguments: (1) avoidance of extreme risk; (2) the growth story; (3) the ethics.		
I am optimistic about what we can do, but worried about what we will do. Evidence, example, analysis, communication, discussion in and across communities, political and social action, and leadership can transform "can" into "will."		

Table 3.5. Conclusions for economics, ethics, and politics

For economics
The economics necessary to help chart and guide the growth story is rather different from the early, narrow, and misleading contributions with their underlying structures of exogenous growth and only minor perturbations arising from climate change. It is dynamic and structural. It must specify objectives clearly, over time and within and across communities and nations. It must place investment and innovation at centre stage. So too structural change. Pace and scale are crucial. It must address a range of market failures. It must engage with immense risk and understand discounting clearly. It must engage with ethics.
For ethics
1/Understanding the ethics that we should bring to a problem requires clarity on the structure of the problem. It is a story of urgency and immense risk. And it is a story of opportunity. It is not a “zero-sum” game. 2/The foundations of the problem demand not only consequentialist ethics but also basic notions of rights and justice. Of particular importance is the right to development. 3/The great philosophies and religions point to important duties to others, to the environment, and to avoid reckless harm. 4/Self-interest (stronger growth and reduced risks) and ethical arguments together provide a powerful motivation for action for both richer and poorer countries. Special obligations of richer countries (from history and capability) to embrace and to help support new growth story in poorer countries, in particular by helping to foster and finance investment.
For politics and political economy
1/ Collaboration and mutual support must be at the heart of action to realise opportunities and avoid risks. Dislocations that come with change must be understood and tackled, particularly by investing in people and places affected, to enable participation of all in the new story. 2/This new path requires an active state in setting strategy and giving stable incentives for investment. 3/ Fostering the public square and participation in public discussion. Crucial for democracy and for shared public support. 4/ Leadership across society will be central to political commitment. Political, social, and religious movements will be central to leadership.
The new growth story is not only an urgent economic, ethical, and political imperative, it is also a great opportunity. It is “the growth story of the 21st century.”

References

- Abrams, J.F., Hu, S., and Dickenson Bampton, B. (2026). *Recalibrating Climate Risk: Aligning Damage Functions with Scientific Understanding*. University of Exeter and Carbon Tracker.
<https://greenfuturessolutions.com/wp-content/uploads/2026/01/Recalibrating-Climate-Risk-Report-Final.pdf>
- Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power, prosperity, and poverty*. Crown Publishers.
- Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5), 1369–1401.
<https://doi.org/10.1257/aer.91.5.1369>
- Anadon, L. D., Jones, A., Peñasco, C., Sharpe, S., Grubb, M., Aggarwal, S., Barbosa Filho, N. H., Bose, R., Cabello, A., Chaudhury, S., Drummond, P., Farmer, D., Foulds, C., Freddo, D., Hepburn, C., Kapur, V., Kejun, J., Lam, A., Mercure, J.-F., Freitas, L. H. M., Royston, S., Salas, P., Viñuales, J., and Zhu, S. (2022). *Ten principles for policymaking in the energy transition: Lessons from experience*. Economics of Energy Innovation and System Transition (EEIST).
<https://eeist.co.uk/eeist-reports/ten-principles-for-policy-making-in-the-energy-transition/>
- Anand, S. (2026). Health justice. *Lancet*, 407, 1112–18. [https://doi.org/10.1016/S0140-6736\(25\)02163-4](https://doi.org/10.1016/S0140-6736(25)02163-4)
- Aristotle. (2000). *Nicomachean ethics* (R. Crisp, Ed. & Trans.). Cambridge University Press.
- Aristotle. (2011). *Eudemian ethics* (A. Kenny, Ed. & Trans.; Oxford World's Classics). Oxford University Press.
- Armstrong McKay D.I. Staal, A., Abrams, J. F., Winkelmann, R., Sakschewski, B., Loriani, S., Fetzer, I., Cornell, S. E., Rockström, J., & Lenton, T. M. (2022). Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science (American Association for the Advancement of Science)*, 377(6611), 1171–eabn7950. <https://doi.org/10.1126/science.abn7950>
- Armstrong, K. (2022). *Sacred Nature: Restoring Our Ancient Bond with the Natural World*. Bodley Head.
- Arrhenius, S. (1896). On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground. *Philosophical Magazine and Journal of Science*, 41(251).
https://www.rsc.org/images/arrhenius1896_tcm18-173546.pdf
- Arrow, K. J. (1951). *Social choice and individual values*. Wiley.
- Arrow, K. J. (1999a). Inter-generational equity and the rate of discount in long-term social investment. In M. R. Sertel (Ed.), *Contemporary economic issues* (International Economic Association series, pp. 89–102). Palgrave Macmillan.
- Arrow, K. J. (1999b). Discounting, morality, and gaming. In P. R. Portney & J. P. Weyant (Eds.), *Discounting and intergenerational effects* (pp. 13–21). Resources for the Future Press.
- Baer, P., Athanasiou, T., Kartha, S., Kemp-Benedict, E. (2010). Greenhouse Development Rights: A Framework for Climate Protection That is “More Fair” Than Equal Per Capita Emissions Rights. In S. Gardiner, S. Caney, D. Jamieson, and H. Shue (Eds), *Climate ethics: Essential readings*. Oxford University Press.
- BBC Radio 4. (2025, September 10). *Moral Maze: Is ‘net zero’ a moral pursuit?* BBC.
<https://www.bbc.co.uk/programmes/m002j5w6>
- Becker, G. S., Murphy, K. M., & Topel, R. H. (2011). On the economics of climate policy. *B.E. Journal of Economic Analysis & Policy*, 10(2), Article 19.
- Bentham, J. (1789). *An introduction to the principles of morals and legislation*.
<https://www.gutenberg.org/ebooks/2753>
- Besley, T., & Persson, T. (2023). *The political economics of green transitions*. *The Quarterly Journal of Economics*, 138(3), 1863–1906. <https://doi.org/10.1093/qje/qjad006>

- Besley, T., & Persson, T. (2025). *From liberal economic policies to liberal political institutions? Democracy, development clusters and wellbeing*. In T. Besley, I. Bucelli, & A. Velasco (Eds.), *The London Consensus: Economic Principles for the 21st Century* (pp. 535–572). LSE Press. <https://doi.org/10.31389/lsepress.tlc.p>
- Bhattacharya, A., Songwe, V., Soubeyran, E., and Stern, N. (2024). *Raising ambition and accelerating delivery of climate finance*. Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. <https://perma.cc/H6D9-MNSX>
- Bhattacharya, A., Songwe, V., Soubeyran, E., and Stern, N. (2025). *Delivering an integrated climate finance agenda in support of the Baku to Belém Roadmap to 1.3T*. Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. <https://www.lse.ac.uk/granthaminstitute/publication/delivering-an-integrated-climate-finance-agenda-in-support-of-the-baku-to-belem-roadmap-to-1-3t/>
- BloombergNEF. (2024). *Clean Electricity Breaks New Records; Renewables on Track for Another Strong Year*. BloombergNEF. <https://about.bnef.com/insights/clean-energy/clean-electricity-breaks-new-records-renewables-on-track-for-another-strong-year-bloombergnef/>
- Bond, K., Butler-Sloss, S., and Walter, D. (2024). *The cleantech revolution: It's exponential, disruptive and now*. Rocky Mountain Institute. <https://perma.cc/52K8-WHRK>
- Caney, S. (2010). Climate Change, Human Rights, and Moral Thresholds. In S. Gardiner, S. Caney, D. Jamieson, and H. Shue (Eds.), *Climate ethics: Essential readings*. Oxford University Press.
- Caney, S. (2016). The ethics of solar radiation management: Why justice and legitimacy should matter. In C. J. Preston (Ed.), *Climate justice and geoengineering: Ethics and policy in the atmospheric Anthropocene* (pp. 129–144). Rowman & Littlefield.
- Caney, S. (2025). Pluralizing global justice. In I. Robeyns (Ed.), *Pluralizing political philosophy: Economic and ecological inequalities in global perspective* (online ed.). Oxford University Press. <https://doi.org/10.1093/9780191994784.003.0003>
- Carney, M. (2026, January). *Davos 2026: Special address by Mark Carney, Prime Minister of Canada*. World Economic Forum. <https://www.weforum.org/stories/2026/01/davos-2026-special-address-by-mark-carney-prime-minister-of-canada/>
- Carson, R. (1962). *Silent Spring*. Penguin Classics.
- Chichilnisky, G., Hammond, P.J., and Stern, N. (2020). Fundamental utilitarianism and intergenerational equity with extinction discounting. *Social Choice and Welfare*, 54, pp. 397–427. <https://doi.org/10.1007/s00355-019-01236-z>
- Climate Action Tracker. (2023, December). *Climate Action Tracker*. C40 Knowledge Hub. https://www.c40knowledgehub.org/s/article/Climate-Action-Tracker?language=en_US
- Climate Assembly UK. (2020). *The path to net zero*. House of Commons. <https://perma.cc/Y3ET-BEMK>
- Convention Citoyenne pour le Climat. (2021). *Les Propositions de la Convention Citoyenne pour le Climat*. <https://perma.cc/DU72-GSSF>
- Dessler, A.E. (2021). *Introduction to Modern Climate Change*. Cambridge University Press.
- Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859. *Official Journal of the European Union*, L, 5 July 2024. <https://eur-lex.europa.eu/eli/dir/2024/1760/oj>
- Dosio, A., Mentaschi, L., Fischer, E. M., & Wyser, K. (2018). Extreme heat waves under 1.5 °C and 2 °C global warming. *Environmental Research Letters*, 13(5), 54006-. <https://doi.org/10.1088/1748-9326/aab827>
- Drèze, J., and Stern, N. (1987). The theory of cost-benefit analysis. In *Handbook of public economics* (Vol. 2, pp. 909–989). Elsevier. [https://doi.org/10.1016/S1573-4420\(87\)80009-5](https://doi.org/10.1016/S1573-4420(87)80009-5)
- Edvardsson Björnberg, K., Röcklinsberg, H., & Sandin, P. (2020). 'Cornwallism' and arguments against greenhouse gas emissions reductions. *Environmental Values*, 29(6), 691–712. <https://doi.org/10.3197/096327119X15579936382554>

- Ember. (2024). *Electricity data explorer*. Retrieved January 10, 2025, from <https://ember-energy.org/data/electricity-data-explorer/>
- Ember. (2025). *The Electrotech Revolution*. <https://ember-energy.org/latest-insights/the-electrotech-revolution/>
- Energy Transitions Commission (ETC). (2025). *Power System Transformation: Delivering Competitive, Resilient Electricity in High-Renewable Systems*. https://www.energy-transitions.org/wp-content/uploads/2025/07/Power-Systems-Transformation_Main-report_vf.pdf
- European Commission. (2025). *A dedicated governance body for just transition implementation: The Just Transition Institute in Spain*. https://energy.ec.europa.eu/topics/clean-energy-transition/eu-coal-regions-transition/publications_en
- Fesmire, S. (2020). Pragmatist ethics and climate change. In D. Miller and B. Eggleston (Eds.), *Moral Theory and Climate Change: Ethical perspectives on a warming planet*. Routledge.
- Foote, E. (1856). ART. XXXI.--Circumstances affecting the heat of the sun's rays. *American Journal of Science and Arts (1820-1879)*, 22(66), 382.
- Fourier, J. (1824). Remarques générales sur les températures du globe terrestre et des espaces planétaires. In *Annales de Chimie et de Physique* (Vol. 27, pp. 136-167).
- Gardiner, S. M. (2010). Is "arming the future" with geoengineering really the lesser evil? Some doubts about the ethics of intentionally manipulating the climate system. In S. M. Gardiner, S. Caney, D. Jamieson, & H. Shue (Eds.), *Climate ethics: Essential readings* (pp. 284-312). Oxford University Press.
- Gardiner, S.M., Caney, S., Jamieson, D., and Shue, H. (Eds.). (2010). *Climate ethics: Essential readings*. Oxford University Press.
- Global Commission on Adaptation (GCA). (2019). *Adapt now: A global call for leadership on climate resilience*. World Resources Institute. <https://perma.cc/GRY8-C3AP>
- Habermas, J. (1981). *Theorie des kommunikativen Handelns*. Vol I. and II. Suhrkamp Verlag.
- Habermas, J. (1983). *Moralbewusstsein und kommunikatives Handeln*. Suhrkamp Verlag.
- Habermas, J. (1991). *The Structural Transformation of the Public Sphere* (translated by Thomas Burger). MIT Press.
- Habermas, J. (1996). *Between Facts and Norms: Contributions to a Discourse Theory of Law and Democracy* (translated by William Rehg). MIT Press.
- Hansard. (2026, 18 May). *Lord Hennessy of Nympsfield, Valedictory Speech*. <https://hansard.parliament.uk/Lords/2026-05-18/debates/353770A7-17B3-4586-A7C6-8DA45E4E07A4/King%E2%80%99SSpeech#contribution-3C8C3CA2-B86D-414D-B2F7-580F5D45344E>
- Harrod, R. (1948). *Towards a Dynamic Economics*. Macmillan.
- Hennessy, P. and Blick, A. (2019). *Good Chaps no More? Safeguarding the Constitution in Stressful Times*. The Constitution Society. <https://consoc.org.uk/publications/good-chaps-no-more-safeguarding-the-constitution-in-stressful-times-by-andrew-blick-and-peter-hennessy/>
- Hernandez, J. (2022). *Fresh banana leaves: Healing indigenous landscapes through recipes and stories*. University of New Mexico Press.
- Hobbes, T. (1994). *Leviathan* (C. B. Macpherson, Ed.). Penguin Classics.
- Institute for Health Metrics and Evaluation (IHME). (2021). *Global burden of disease: Results tool*. <http://ghdx.healthdata.org/gbd-results-tool>
- Intergovernmental Panel on Climate Change (IPCC). (2018). *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy,

- T. Maycock, M. Tignor, and T. Waterfield (eds.)). Cambridge University Press, Cambridge, UK and New York, NY, USA, 616 pp. <https://doi.org/10.1017/9781009157940>
- Intergovernmental Panel on Climate Change (IPCC) (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC* [Masson-Delmotte, V. et al. (eds.)]. Cambridge University Press.
- Intergovernmental Panel on Climate Change (IPCC). (2023). Summary for policy-makers. In H. Lee and J. Romero (Eds.), *Climate Change 2023: Synthesis report: Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1–34). Cambridge University Press. https://doi.org/10.59327/IPCC/AR6_-9789291691647.001
- International Energy Agency (IEA). (2015). *World Energy Outlook 2015*. <https://www.iea.org/reports/world-energy-outlook-2015>
- International Energy Agency (IEA). (2015). *World Energy Outlook 2015*. <https://iea.blob.core.windows.net/assets/5a314029-69c2-42a9-98ac-d1c5deeb59b3/WEO2015.pdf>
- International Energy Agency (IEA). (2020). *Evolution of solar PV module cost by data source, 1970–2020*. <https://perma.cc/T3K4-UL4X>
- International Energy Agency (IEA). (2021). *Net Zero by 2050 – A Roadmap for the Global Energy Sector*. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroBy2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
- International Energy Agency (IEA). (2023). *World Energy Outlook 2023*. <https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf>
- International Energy Agency (IEA). (2025). *World Energy Outlook 2025*. <https://iea.blob.core.windows.net/assets/dfe5daf4-dbc1-4533-abeb-fafb1faee0f9/WorldEnergyOutlook2025.pdf>
- International Renewable Energy Agency (IRENA). (2021). *Renewable Energy and Jobs – Annual Review 2021*. <https://www.irena.org/publications/2021/Oct/Renewable-Energy-and-Jobs-Annual-Review-2021>
- International Renewable Energy Agency (IRENA). (2024). *World Energy Transitions Outlook 2024: 1.5°C Pathway*. <https://www.irena.org/Publications/2024/Nov/World-Energy-Transitions-Outlook-2024>
- Ives, M. C., Righetti, L., Schiele, J., De Meyer, K., Hubble-Rose, L., Teng, F., Kruitwagen, L., Tillmann-Morris, L., Wang, T., Way, R., and Hepburn, C. (2021). *A new perspective on decarbonising the global energy system* (Report No. 21-04). Smith School of Enterprise and the Environment, University of Oxford. <https://perma.cc/HT7A-NT6A>
- Jamieson, D. (1996). Ethics and intentional climate change. *Climatic Change*, 33(3), 323–336.
- Jones, L. D., Peñasco, A., Sharpe, C., Grubb, S., Aggarwal, M., Barbosa Filho, N. H., Bose, R., Cabello, A., Chaudhury, S., Drummond, P., Farmer, D., Foulds, C., Freddo, D., Hepburn, C., Kapur, V., Kejun, J., Lam, A., Mercure, J.-F., Freitas, L. H. M., Royston, S., Salas, P., Viñuales, J., & Zhu, S. (2022). *Ten principles for policymaking in the energy transition: Lessons from experience* (EEIST report). Economics of Energy Innovation and System Transition. <https://eeist.co.uk/eeist-reports/ten-principles-for-policy-making-in-the-energy-transition/>
- Kant, I. (1785). *Grundlegung zur Metaphysik der Sitten*. Verlag von L. Heimann.
- Kelbessa, W. (2010). *Indigenous and modern environmental ethics: A study of the indigenous Oromo environmental ethic and modern issues of environment and development: Ethiopian philosophical studies I*. Council for Research in Values and Philosophy.
- Keynes, J. M. (1936). *The general theory of employment, interest, and money*. Macmillan.
- Kimmerer, R. W. (2013). *Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants*. Milkweed Editions.
- Kouamé, A. T. (2024). *Gearing up for India's Rapid Urban Transformation*. World Bank Group. <https://perma.cc/62JF-9KUN>

- Lambek, M. (Ed.). (2010). *Ordinary ethics: Anthropology, language, and action*. Fordham University Press.
- Lenton, T. (2025). Presentation at Royal Society event, London, September 2025.
- Lenton, T. M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., and Schellnhuber, H. J. (2019). Climate tipping points—Too risky to bet against. *Nature*, 575(7784), 592–595. <https://doi.org/10.1038/d41586-019-03595-0>
- Light, A. (2002). Contemporary environmental ethics: From metaethics to public philosophy. *Metaphilosophy*, 33(4), 426–449. <https://doi.org/10.1111/1467-9973.00238>
- List, C. and Pettit, P. (2011). *Group Agency: The Possibility, Design, and Status of Corporate Agents*. Oxford University Press.
- Llewellyn, O., & Khalid, F. (2024, February). *Al-Mizan: A covenant for the Earth*. Islamic Foundation for Ecology and Environmental Sciences. <https://wedocs.unep.org/20.500.11822/44949>
- Lliuya v. RWE AG, Case No. 2 O 285/15 (LG Essen Dec. 15, 2016), appeal filed, Case No. I-5 U 15/17 (OLG Hamm).
- Lo, J. (2023, July). Kerry rejects “climate reparations” but praises loss and damage fund. *Climate Home News*. <https://www.climatechangenews.com/2023/07/14/loss-and-damage-john-kerry-climate-reparations/>
- Locke, J. (1988). *Two treatises of government* (P. Laslett, Ed.). Cambridge University Press.
- Macfarlane, R. (2025). *Is a River Alive?* Penguin.
- Matias, Y. (2024). *How we are using AI for reliable flood forecasting at a global scale*. Google Blogs. <https://blog.google/technology/ai/google-ai-global-flood-forecasting/>
- Mendelsohn, R. O. (2008). Is the Stern Review an economic analysis? *Review of Environmental Economics and Policy*, 2(1), 45–60.
- Milieudefensie et al. v. Royal Dutch Shell plc, Case No. C/09/571932/HA ZA 19-379 (District Court of The Hague, May 26, 2021).
- Milieudefensie et al. v. Shell plc, Case No. 200.302.332/01 (Hague Court of Appeal, November 12, 2024).
- Mirrlees, J.A. (1967). Optimum Growth when Technology is Changing. *Review of Economic Studies* 34(1): 95–124.
- Neubauer et al. v. Germany, BvR 2656/18 (Federal Constitutional Court [Germany], 29 Apr. 2021).
- Nordhaus, W. (1992). The ‘Dice’ Model: Background and Structure of a Dynamic Integrated Climate-Economy Model of the Economics of Global Warming. Cowles Foundation Discussion Papers. 1252. <https://elischolar.library.yale.edu/cowles-discussion-paper-series/1252>
- Nordhaus, W. D. (1991). To slow or not to slow: The economics of the greenhouse effect. *The Economic Journal*, 101(407), 920–937. <https://doi.org/10.2307/2233864>
- Nordhaus, W. D. (2007). A Review of the Stern Review on the Economics of Climate Change. *Journal of Economic Literature*, XLV, pp. 686–702. <https://doi.org/10.1257/jel.45.3.686>
- Nordhaus, W. D. (2018, December 8). *Climate change: The ultimate challenge for economics* [Nobel Prize lecture]. Nobel Prize. <https://www.nobelprize.org/prizes/economic-sciences/2018/nordhaus/lecture/>
- O’Donnell, J. (2024, May). Google DeepMind’s new AlphaFold can model a much larger slice of biological life. *MIT Technology Review*. <https://perma.cc/9488-ZC5R>
- Oreskes, N. and Conway, E. M. (2010). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. Bloomsbury Press.
- Othman Llewellyn, Fazlun Khali, et al. (2024). *Al-Mizan: Covenant for the Earth*. The Islamic Foundation for Ecology and Environmental Sciences.

- Our World in Data (2025). *Greenhouse gas emissions, 2024*. https://ourworldindata.org/grapher/total-ghg-emissions?tab=discrete-bar&time=latest&country=OWID_UMC~OWID_HIC~OWID_LMC~OWID_LIC
- Paine, T. (1791). *Rights of man*. <https://www.gutenberg.org/ebooks/3743>
- Palmer, C. (2014). Contested frameworks in environmental ethics. In R. Rozzi, S. Pickett, C. Palmer, J. Armesto, and J. B. Callicott (Eds.), *Linking ecology and ethics for a changing world: Values, philosophy and action* (pp. 191–206). Springer.
- Parfit, D. (1984). *Reasons and persons*. Oxford University Press.
- Parfit, D. (2011a). *On what matters* (Vol. 1). Oxford University Press.
- Parfit, D. (2011b). *On what matters* (Vol. 2). Oxford University Press.
- Parfit, D. (2017). *On what matters* (Vol. 3). Oxford University Press.
- Pigou, A. C. (1920). *The economics of welfare*. Macmillan and Co.
- Pope Francis. (2014). God forgives: Nature does not. *L'Osservatore Romano; Weekly Edition in English*. <https://perma.cc/XL9J-CKBF>
- Pope Francis. (2015). *Laudato Si': On care for our common home*. Vatican City: Vatican Press. <https://perma.cc/A443-2K5R>
- Pope Francis. (2023). *Laudate Deum: to all people of good will on the climate crisis*. Vatican City: Vatican Press. https://www.vatican.va/content/francesco/en/apost_exhortations/documents/20231004-laudate-deum.html
- Preston, C. J. (2013). Ethics and geoengineering: Reviewing the moral issues raised by solar radiation management and carbon dioxide removal. *Wiley Interdisciplinary Reviews: Climate Change*, 4(1), 23–37. <https://doi.org/10.1002/wcc.198>
- Rabbi Kahn. (2023). *The Sacred Earth: Jewish Perspectives on Our Planet*. CCAR Press.
- Rahmstorf, S. (2024). Is the Atlantic overturning circulation approaching a tipping point? *Oceanography*, 37(3), 16–29. <https://doi.org/10.5670/oceanog.2024.501>
- Ramsey, F.P. (1928) "A Mathematical Theory of Saving" *Economic Journal* 38 (4): 543–549.
- Rawls, J. (1971). *A Theory of Justice*. Harvard University Press.
- Rawls, J. (1980). Kantian Constructivism in Moral Theory. *The Journal of Philosophy*, 77(9). <https://www.jstor.org/stable/2025790>
- Rocky Mountain Institute (RMI). (2024). *Powering up the global south*. Rocky Mountain Institute. <https://perma.cc/9HGP-6W77>
- Rogelj, J. (2025). Presentation at Royal Society event, London, September 2025.
- Rogelj, J., Shindell, D., Jiang, K., Fifita, S., Forster, P., Ginzburg, V., Handa, C., Kheshgi, H., Kobayashi, S., Kriegler, E., Mundaca, L., Séférián, R., & Vilariño, M. V. (2018). Mitigation pathways compatible with 1.5°C in the context of sustainable development. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), *Global warming of 1.5°C: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (pp. 93–174). Cambridge University Press. <https://doi.org/10.1017/9781009157940.004>
- Roser, M. (2019). *Which countries achieved economic growth? And why does it matter?* Our World in Data. <https://perma.cc/8FEY-RUNB>
- Rousseau, J.-J. (1973). *The social contract* (G. D. H. Cole, Trans.). Everyman's Library.
- S&P Global. (2024, 19 November). *Sustainability insights: Rising curtailment in China power producers will push past the pain*. <https://www.spglobal.com/ratings/en/research/articles/241119->

- Sandbu, M. (2026). The pessimist who became a prophet. *The Financial Times*.
<https://www.ft.com/content/7804e304-2604-4376-9d3f-2310386c20e7?syn-25a6b1a6=1>
- Sandel, M. (1996). *Democracy's Discontent: America in Search of a Public Philosophy*. Harvard University Press.
- Sandel, M. (2005). *Public Philosophy: Essays on Morality in Politics*. Harvard University Press.
- Sandel, M. (2020). *The Tyranny of Merit*. Penguin Books.
- Schuck, T. J., Degen, J., Hintsa, E., Hoor, P., Jesswein, M., Keber, T., ... & Engel, A. (2024). The interhemispheric gradient of SF 6 in the upper troposphere. *Atmospheric chemistry and physics*, 24(1), 689-705. <https://doi.org/10.5194/acp-24-689-2024>
- Sen, A. (1970a). *Collective choice and social welfare*. Holden-Day.
- Sen, A. (1970b). The Impossibility of a Paretian Liberal. *Journal of Political Economy*, 78(1).
- Sen, A. (1982). Rights and agency. *Philosophy & Public Affairs*, 11(1), 3-39.
- Sen, A. (1999). *Development as Freedom*. Oxford University Press.
- Sen, A. (2009). *The idea of justice*. Belknap Press of Harvard University Press.
- Setzer, J., Higham, C., and Chan T. (2026). *Global trends in climate change litigation: 2026 snapshot*. Grantham Research Institute on Climate Change and the Environment, and LSE.
<https://www.lse.ac.uk/granthaminstitute/publication/global-trends-in-climate-change-litigation-2026-snapshot/>
- Singh, N. K. and Summers, L. (2023a). *Strengthening multilateral development banks: The triple agenda MANDATES / FINANCE / MECHANISMS* (Report of the Independent Experts Group, Vol. 1). G20 India. <https://perma.cc/6BCU-PG3P>
- Singh, N. K. and Summers, L. (2023b). *Strengthening multilateral development banks: The triple agenda: Better, Bolder and Bigger MDBs* (Report of the Independent Experts Group, Vol. 2). G20 India <https://perma.cc/QY4T-23KA>
- Singh, N.K., and Stern, N. (2025, December). History doesn't end today, our old compass has run its course. Here's a new one for India. *The Indian Express*.
<https://indianexpress.com/article/opinion/columns/history-doesnt-end-today-our-old-compass-has-run-its-course-heres-a-new-one-for-indi-10447513/>
- Solow, R. (1995). An almost practical step toward sustainability. *Ekistics*, 62(370), pp.15-20.
<https://www.jstor.org/stable/43623526>
- Stafford, C. (2010). The punishment of ethical behaviour. In *Ordinary Ethics: Anthropology, Language, and Action*. Fordham University Press.
- Stern, N. (2006). *The Economics of Climate Change: The Stern Review*. HM Treasury.
https://webarchive.nationalarchives.gov.uk/ukgwa/20100407172811/https://www.hm-treasury.gov.uk/stern_review_report.htm
- Stern, N. (2008). *The economics of climate change* (Richard T. Ely Lecture). *American Economic Review: Papers and Proceedings*, 98(2), 1-37. <https://doi.org/10.1257/aer.98.2.1>
- Stern, N. (2009). *A blueprint for a safer planet: How to manage climate change and create a new era of progress and prosperity*. Bodley Head.
- Stern, N. (2014a). Ethics, equity, and the economics of climate change paper 1: Science and philosophy. *Economics and Philosophy*, 30(3), 397-444.
<https://doi.org/10.1017/S0266267114000297>
- Stern, N. (2014b). Ethics, equity, and the economics of climate change paper 2: Economics and politics. *Economics and Philosophy*, 30(3), 445-501. <https://doi.org/10.1017/S0266267114000303>
- Stern, N. (2015). *Why are we waiting?: The logic, urgency, and promise of tackling climate change*. MIT Press.

- Stern, N. (2025). *The Growth Story of the 21st Century: The economics and opportunity of climate action*. LSE Press. <https://doi.org/10.31389/lsepress.tgs>
- Stern, N., Romani, M., Pierfederici, R., Braun, M., Barraclough, D., Lingeswaran, S., Weirich-Benet, E., and Niemann, N. (2025). Green and intelligent: The role of AI in the climate transition. *npj Climate Action*, 4(56). <https://doi.org/10.1038/s44168-025-00252-3>
- Stern, N., Stiglitz, J. E., and Taylor, C. (2022). The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. *Journal of Economic Methodology*, 29(3), 181–216. <https://doi.org/10.1080/1350178X.2022.2040740>
- Steyer, T. (2024). *Cleaner, Faster, Better: How We'll Win the Climate War*. Spiegel & Grau.
- Swanson, A., and Rappeport, A. (2024, June 6). U.S. adds tariffs to shield struggling solar industry. *The New York Times*. <https://www.nytimes.com/2024/06/06/business/economy/tariffs-solar-industry-china.html>
- Systemiq. (2020). *The Paris Effect: How the Climate Agreement is reshaping the global economy*. <https://perma.cc/A953-7VJZ>
- Systemiq. (2025). Returns on Resilience: Investing in Adaptation to Drive Prosperity, Growth and Competitiveness. <https://www.systemiq.earth/wp-content/uploads/2025/10/FULL-REPORT-FINAL-Returns-on-resilience-Oct-2025.pdf>
- Systemiq. (2026). *Accelerating the Breakthrough of Climate Technologies: Driving exponential growth in climate technologies with positive tipping points (forthcoming – working title)*
- Thatcher, M. (1987, September 23). Interview for Woman's Own. Interview by D. Keay. *Margaret Thatcher Foundation*. <https://perma.cc/2A8A-3HM7>
- Tomasello, M. (2009). *Why we cooperate*. MIT press.
- Trading Economics. (2026). *EU Carbon Permits*. <https://tradingeconomics.com/commodity/carbon>
- Turner, A. (2026). *Abundant energy for all* [transcript]. <https://www.lse.ac.uk/global-school-of-sustainability/events/the-adair-turner-lecture-series-limiting-climate-change-while-growing-prosperity-technologies-costs-and-policies>
- Tyndall, J. (1859). Note on the Transmission of Radiant Heat through Gaseous Bodies. *Proceedings of the Royal Society of London*, 10, 37–39. <http://www.jstor.org/stable/111604>
- United Nations Development Programme (UNDP). (2025). *Human Development Index*. <https://hdr.undp.org/data-center/human-development-index#/indicies/HDI>
- UNEP & Sabin Center for Climate Change Law. (2025). *Global climate litigation report 2025: Status review*. United Nations Environment Programme.
- United Nations General Assembly (UNGA). (1986). *Declaration on the Right to Development* (GA Res 41/128).
- United Nations. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. <https://www.brundtland.co.za/wp-content/uploads/2022/08/Brundtland-Report-1987-Our-Common-Future.pdf>
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. <https://digitallibrary.un.org/record/803352?ln=en&v=pdf>
- United Nations. (2024). *Life expectancy at birth – Alls, period, estimates* [Dataset]. World Population Prospects 2024. Processed by Our World in Data. <https://ourworldindata.org/grapher/life-expectancy-at-birth-including-the-un-projections>
- Urgenda Foundation v. State of the Netherlands*, ECLI:NL:HR:2019:2007 (Hoge Raad [Supreme Court of the Netherlands] 20 Dec., 2019).
- US Continental Congress. (1776). *The Declaration of Independence*. In *U.S. National Archives and Records Administration*. <https://www.archives.gov/founding-docs/declaration-transcript>
- Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., and Mickley, L. J. (2021). Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environmental Research*, 195. <https://doi.org/10.1016/j.envres.2021.110754>

- Warren, R., Price, J., Graham, E., Forstenhaeusler, N., and VanDerWal, J. (2018). The projected effect on insects, vertebrates, and plants of limiting global warming to 1.5°C rather than 2°C. *Science*, 360(6390), pp. 791-795. <https://doi.org/10.1126/science.aar3646>
- Watene, K. (2016). Valuing nature: Māori philosophy and the capability approach. *Oxford Development Studies*, 44(3), 287-296.
- Weitzman, M. L. (2009). On modeling and interpreting the economics of catastrophic climate change. *The Review of Economics and Statistics*, 91(1), 1-19. <https://doi.org/10.1162/rest.91.1.15>
- Wollstonecraft, M. (1792). *A vindication of the rights of woman: With strictures on political and moral subjects*. <https://www.gutenberg.org/ebooks/3420>
- World Resources Institute. (2025). *Strengthening the Investment Case for Climate Adaptation: A Triple Dividend Approach*. <https://doi.org/10.46830/wriwp.25.00019>