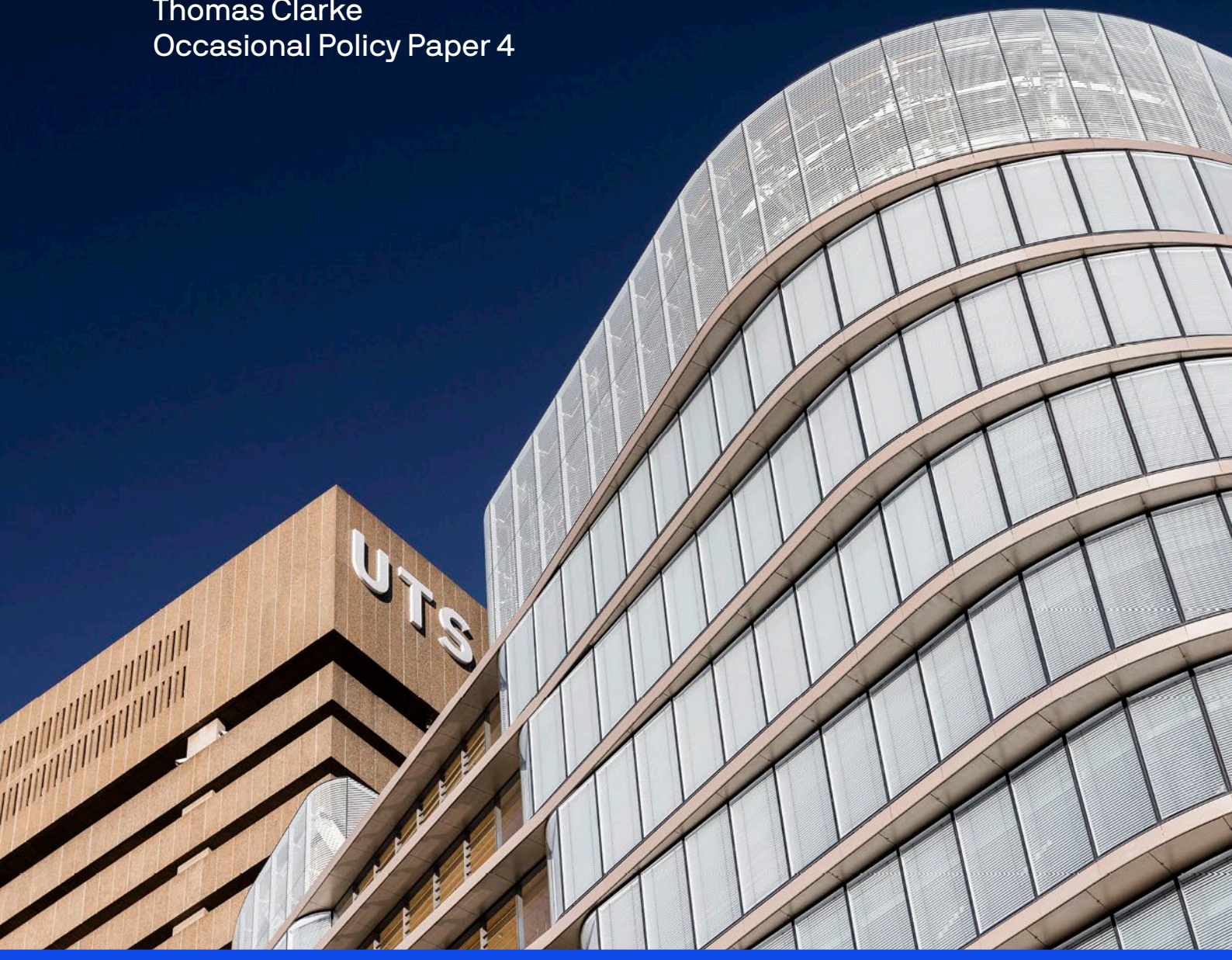
Institute for
Public Policy
and Governance

Sustainability in International Public Policy and Governance

Thomas Clarke

Occasional Policy Paper 4



IPPG Occasional Policy Paper Series

About this publication

This paper has been produced as part of IPPG's Occasional Paper series which is dedicated to bringing relevant issues of public policy and governance to a broad audience. The Institute for Public Policy and Governance is an independent institute of the University of Technology Sydney (UTS) focused on driving excellence in public policy. Excellence in public policy, governance and public administration. Explore our work.

Sustainability in International Public Policy and Governance

Thomas Clarke
Occasional Policy Paper 4

Industrial Fellow at the University of Technology Sydney

January 2025

Published by University of Technology Sydney,
PO Box 123 Broadway NSW 2007 Australia

ISBN 978-1-7635824-3-9

Contents

Introduction **6**

The Stockholm Declaration 6

Our Common Future 6

The Inter-Governmental Panel on Climate Change (IPCC) 7

The Economics of Climate Change 9

The Paris Agreement 2015 11

The Continuous Rise in Annual Emissions 13

Financing the Transition to Sustainability 14

The Impact of Clean Energy Upon Industrial Transformation 16

Priorities for Environmental Transformation 18

References 20

Introduction

Historically human economic activity has increased beyond the capacity of the earth to absorb the environmental impact. The anticipated consequences of climate change range from a gradual to a catastrophic impact on the environment, ecology, economy and society. In recent decades the UN IPCC has highlighted the risks of climate change for people, economies and eco-systems. The integrated and compounding risks of climate change amount to what the former Chief Economist of the World Bank described as "the greatest market failure the world has ever seen" (Stern 2006). International governmental environmental responses, policies, targets and achievements for emissions reductions and renewable energy are promising yet so far practical results are not reassuring. UN COP Projections, and other international agency environmental energy predictions for climate change and the slow pace of emissions reductions are deeply concerning. The demands upon governments and corporations, and their strategic and operational responses, to lift their performance and results on emissions reductions and sustainability are profound and insistent.

The imminent global consequences of climate change are challenging to contemplate, as are the accompanying extreme risks we all face if we do not find effective solutions. As Naomi Klein insists, *This Changes Everything* (2015). Despite successive rounds of international diplomacy to reduce greenhouse gas emissions the amount of carbon dioxide in the atmosphere continues to rise, heating the earth at an alarming rate. Scientists warn that if this global warming continues unabated, it will bring environmental catastrophes across the world including overwhelming sea level rises, severe droughts, and the widespread loss of animal and plant species. Together these environmental disasters will wreak havoc upon our polities, economies and societies, if they cannot be abated.

While the vast array of climate initiatives taking place world-wide can at times be inspiring, the insistent lag between emissions reductions promises and achievements is almost universal. More threatening still is the continued existence of climate change denial at governmental and corporate levels. The election of President Trump to a second term in the White House potentially will undermine environmental programs not only in America but worldwide. Realizing that once again it is likely that under Trump, the US will experience another era of climate change denial and policy chaos, and that national statistics on climate change will be routinely distorted, US governmental agencies began moving the national data to independent repositories in US libraries and archives in November 2024 (CNN 2024).

And yet, despite efforts to impede progress towards a sustainable future by rogue governments and self-interested corporations, through the ingenuity and determination of a new scientific revolution we do have the potential to deliver a decarbonised, decentralised and digital economy (Fay et al 2015), as governments, universities, corporations, and communities realise the profound possibilities that exist.

The Stockholm Declaration

It is now more than half a century since the dangers to the natural environment and social environment of the world posed by human economic activity became internationally recognized in the 1972 United Nations Conference on the Human Environment. The *Stockholm Declaration* stated:

> *"In our time, man's capability to transform his surroundings, if used wisely, can bring to all peoples the benefit of development and the opportunity to enhance the quality of life. Wrongly or heedlessly applied, the same power can do incalculable harm to human beings and human environment… To defend and improve the human environment for present and future generations has become an imperative goal for mankind" (United Nations 1972).*

Increasingly alert to the common environmental threat the United Nations General Assembly formed the World Commission on Environment and Development which established the *Brundtland Commission* in 1984 headed by the Prime Minister, (and former Environment Minister) of Norway, Gro Harlem Brundtland. She was tasked with building multilateralism that could tackle the global crisis by developing common strategic goals to build a common environmental and economic future.

Our Common Future

The far sighted Brundtland Report *Our Common Future* (1987) graphically highlights how the interdependencies of the world have induced interlocking crises:

"Until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade), and within broad areas of concern (environment, economics, social). These compartments have begun to dissolve. This applies in particular to the various global 'crises' that have seized public concern, particularly over the past decade. These are not separate crises: an environmental crisis, a development crisis, an energy crisis. They are all one" (Brundtland Report 1987: 13: para 11).

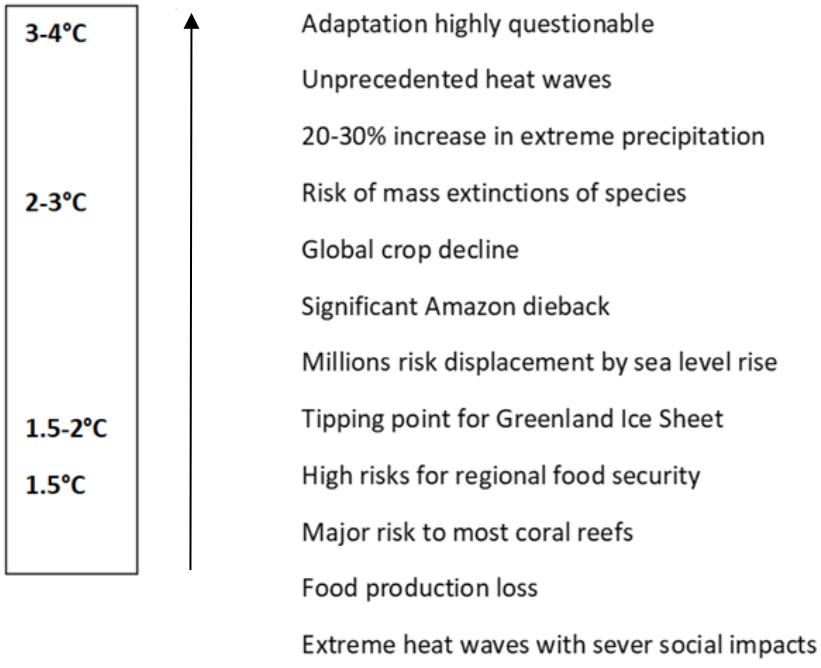
The far-sighted Brundtland Report arrived at an inspiring definition of sustainable development that has endured through the generations:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The Inter-Governmental Panel on Climate Change (IPCC)

The consequences of climate change range from a gradual to a catastrophic impact on the environment, ecology, economy and society (IPCC 2013; Stern Review 2006). In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) established the *Inter-governmental Panel on Climate Change* (IPCC) to provide the world community with the most up-to-date and comprehensive scientific, technical, and socioeconomic information about climate change. The long series of UN IPCC conferences now entering their fourth decade have helped coordinate the international effort across the world to understand and respond to the imminent threat of global climate change (Figure 1.1).

Figure 1.1: The Extreme Risks of the Climate Change Crises



Source: Adapted from the UN IPCC (2014)

The IPCC assessments have played a major role in motivating governments to adopt and implement policies in responding to climate change, including the United Nations *Framework Convention on Climate Change* and the *Kyoto Protocol* (IPCC 2014). The series of COP Conferences from 1992 Rio de Janeiro through to 2024 Baku, Azerbaijan have provided rallying cries of varying intensity and effectiveness for the global environmental movement (Table 1.1). The IPCC issued a risk assessment report in 2014, stating that the effects of climate change are already occurring on all continents and across the oceans. A very large international team of scientists prepared this assessment; the team included 179 lead authors, 66 review editors, 436 contributing authors, and 1,729 individual expert reviewers from 84 countries (IPPC 2014).

Table 1.1: Selected IPCC COP (Conferences of the Parties) and Protocols

Year	Location	Policy Outcomes
1992	Rio de Janeiro	*UN Framework Convention Climate Change* (UNFCCC). Countries agree to reduce emissions with "common but differentiated responsibilities."
1995	Berlin	The first annual *Conferences of the Parties* (COP) committed to the UN *Framework Convention on Climate Change.* The US agrees to exempt developing economies from binding obligations.
1997	Kyoto	At *COP 3* the *Kyoto Protocol* is approved, mandating developed countries to cut greenhouse gas emissions to baseline emission by 2008-2012.
2001	Bonn	*COP 6* reaches agreement on terms for compliance and financing. President Bush rejects the Kyoto Protocol, and the US is only an observer.
2009	Copenhagen	*COP 15* Fails to produce a binding post-Kyoto agreement. Declares the importance of limiting warming under 2 degrees. Developed economies pledge $100 billion to climate aid in developing economies. US President Obama supports initiative.
2010	Cancun	*COP 16* held in Mexico produced the basis for a comprehensive response to climate change to reduce carbon emissions and make countries accountable to each other for the reduction.
2015	Paris	*COP 21* A total of 195 nations sign the *Paris Agreement* providing for worldwide voluntary actions by individual countries. Commitment to "strengthen the global response to the threat of climate change by keeping a global temperature rise well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius"' (UNFCC 2022a).
2021	Glasgow	*COP 26* With clear scientific evidence that net zero emissions had to be reached by 2050 to ensure temperature increases remained below 2 degrees more than 130 countries had signed pledges to reach net zero emissions by 2050. But among the great polluters China, Russia and India had not signed up to the net zero agreement. Other agreements were made at Glasgow to end deforestation, reduce methane gas emissions, and limit coal dependence, as well as exponentially increasing investment in renewable energy.
2022	Sharm El-Sheik, Egypt	*COP 27* held in Egypt lost the momentum exhibited at Paris and Glasgow COPs, with no new steps to achieve the 1.5 degrees target. Saudi Arabia and Russia limited ambitions to reduce further oil and gas production.
2023	Dubai	*COP 28* closed with an agreement signalling "the beginning of the end" of the fossil fuel era, proposing a just and equitable transition, underpinned by deep emissions cuts and scaled up finance for climate action.
2024	Baku, Azerbaijan	*COP 29* was another meeting in an oil-state with more representatives of the fossil fuel industries present than Conference delegates. The pledge to provide $300 billion in different forms of climate relief was regarded as a breakthrough but deemed inadequate by the country's most vulnerable to the impending effects of climate change, including island nations about to disappear into the sea.

Source: UN FCCC COP 2023; SGK Planet 2023.

Successive IPCC COPS have painted an increasingly grim picture of the devastating consequences of rising greenhouse gas emissions (GHG) emissions in the destruction of people's homes and livelihoods, and the dangerous risks if we do not change course (WRI 2023). Among the key findings of the IPCC Sixth Assessment Report (2023) were:

- Human-induced global warming of 1.1 degrees C has spurred changes to the Earth's climate that are unprecedented in recent human history.
- Climate impacts on people and ecosystems are more widespread and severe than expected, and future risks will escalate rapidly with every fraction of a degree of warming.
- Adaptation measures can effectively build resilience, but more finance is needed to scale solutions.
- Some climate impacts are already so severe they cannot be adapted to, leading to losses and damages.
- Global GHG emissions peak before 2025 in 1.5 degrees C-aligned pathways and changing direction will require deep GHG emissions reductions in the near future. (WRI 2023)

The long series of IPCC COPs have attempted to alert the world to the imminent environmental catastrophe we face and attempted to coordinate international action to resist the increasingly apparent consequences we face. The $300 billion in assistance funds to the most affected poorer nations has not impressed critics looking for more remedial intervention (*The Guardian*, 23 November 2024). Now even the IPCC COPs have become discredited for inaction in the face of imminent and global danger, including with several of the leading IPCC COPs founders, and many climate change activists around the world, who have claimed it is "no longer fit for purpose" (BBC 15 November 2024).

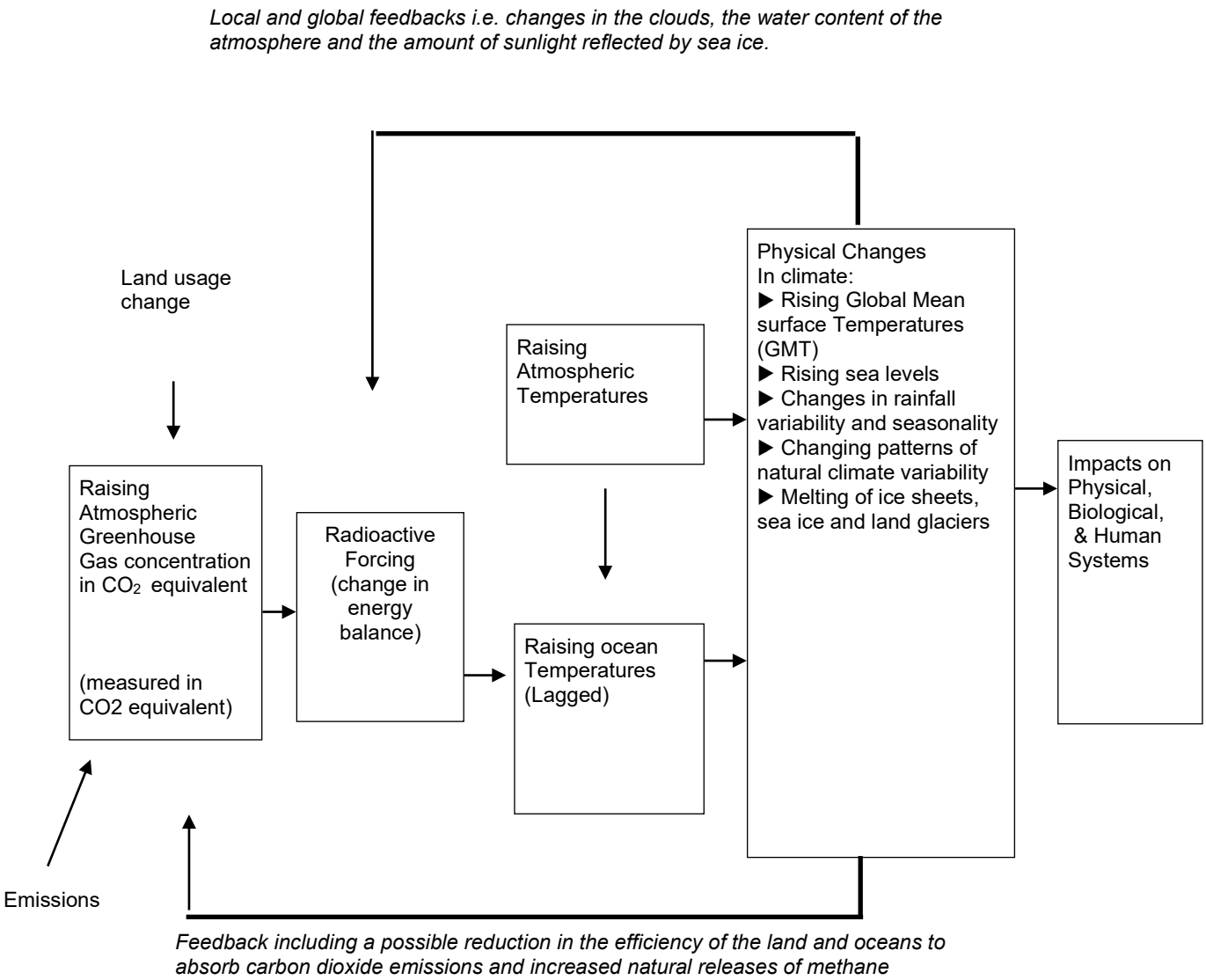
The Economics of Climate Change

In his earlier review Stern proposed that the choice we faced was taking mitigation action now or very expensive adaptation in the future, and he concluded that "there is still time to avoid the worst impacts of climate change, if we take strong action now" (Stern 2006: vi). Stern insisted:

> *"The scientific evidence that climate change is a serious and urgent issue is now compelling. It warrants strong action to reduce green-house gas emissions around the world to reduce the risk of very damaging and potentially irreversible impacts on ecosystems, societies and economies. With good policies the costs of action need not be prohibitive and would be much smaller than the damage averted" (Stern 2006: iv).*

Stern highlighted how the effects of climate change are global, intertemporal, and highly inequitable. Climate change is a result of the externality associated with greenhouse gas emissions entailing costs that are not paid for by those who create the emissions (Figure 1.2). Stern distinguishes a number of features of climate change that together distinguish it from other externalities: it is global in its causes and consequences; the impacts are long-term and persistent; uncertainties and risks in the economic impacts are pervasive; and there is a serious risk of major, irreversible change with nonmarginal economic effects (Stern 2006: 23).

Figure 1.2: The Cause and Effects of Climate Change



Source: Stern (2006)

The Paris Agreement 2015

Whatever progress was made in earlier UN IPCC COP agreements, there was a prolonged apparent incapacity to reach agreement on how this body of policy might be effectively and equitably implemented across the planet, as manifest in the limits of the 2009 Copenhagen Framework Convention on Climate Change (UNFCCC 2009; BBC 2009). Following extensive rounds of international negotiations over four years in preparation for the 21st Session of the Conference of the Parties to the United Nations FCCC (COP 21) in Paris in November 2015 a total of 196 countries reached an historic moment in global diplomacy with a universal climate agreement more rigorous and ambitious than conceived possible earlier (UNFCCC 2015).

The Paris agreement aimed to substantially "strengthen the global response to the threat of climate change" while maintaining sustainable development and efforts to eradicate poverty. Critically the agreement commits to more demanding long-term mitigation efforts in Article 2 (a):

> *"Holding the increase in global temperatures to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" (UNFCCC 2015:22)*

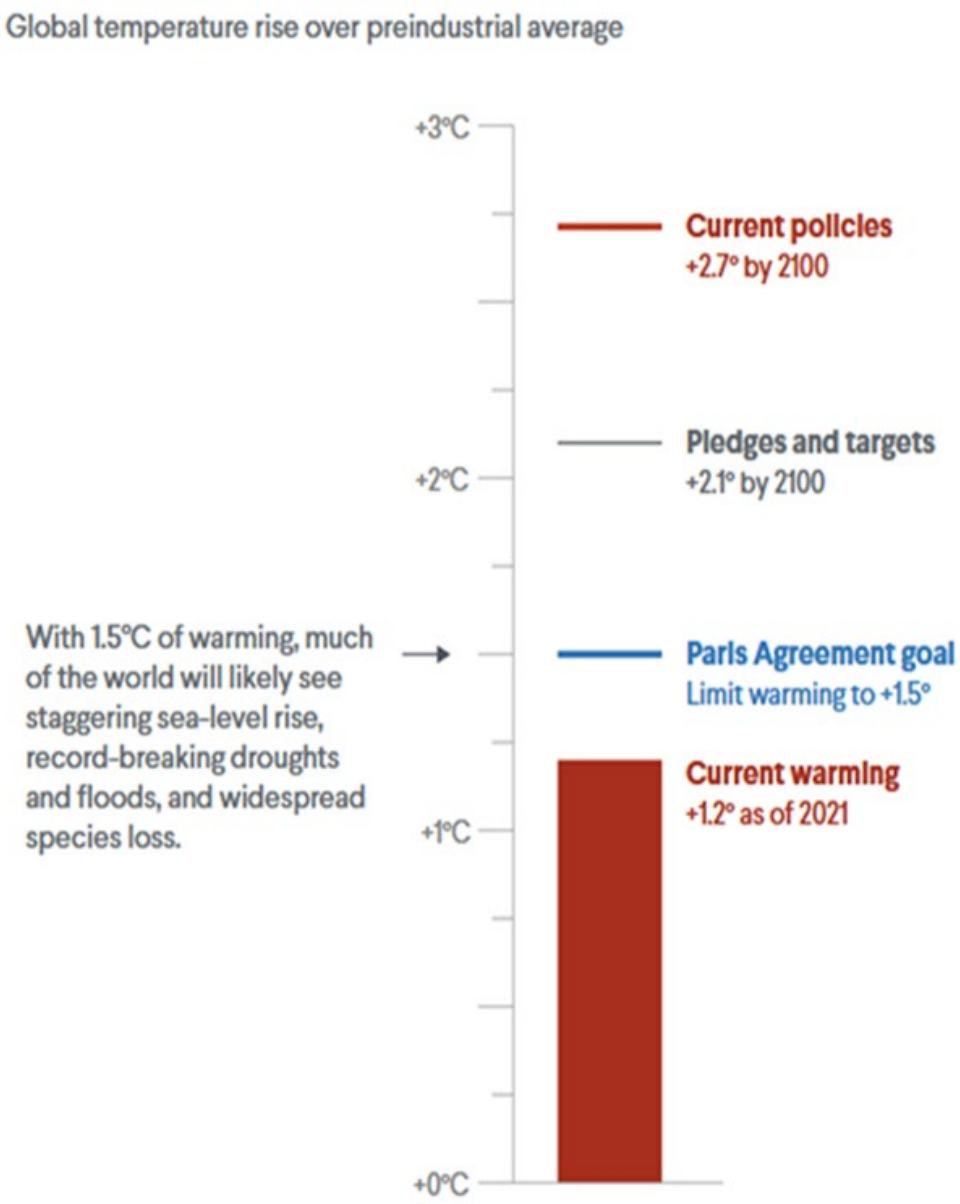
Reinforcing this commitment is the agreement to a robust transparency framework for emissions reductions with common accounting standards, national reporting, and independent expert review. The Paris agreement established binding commitments of all parties to make "nationally determined contributions" (NDCs) and to pursue the necessary domestic emissions reductions measure to achieve these (C2ES 2015). In addition to annual reporting, every five years countries are expected to develop new NDCs that represent a significant progression on previous targets. While it is possible that some countries may breach the caps on emissions, over time there is the possibility of negotiating to renew and increase emissions reductions (UN IPCC 2014).

Achieving The Aims of the Paris Agreement

The central thrust of the Paris Agreement emissions policy was to reduce and eliminate the global carbon emissions that are badly damaging the earth's atmosphere and delivering with increasing force and frequency the environmental catastrophes associated with global warming (Figure 1.3). Under the 2015 Paris Agreement 197 countries agreed to keep temperature rises to "well below" 2° C to prevent the worst impacts of climate change. Ahead of the Glasgow COP 26 held in 2021 countries were asked to revise their pledges made at Paris. The scientific evidence was clear that net zero emissions had to be reached by 2050. Since all the necessary emissions reductions could not be reduced in this time, the excess emissions remaining needed to be offset by other measures to capture carbon, including the planting of trees, and new technologies for carbon capture.

In this period more than 130 countries signed the UN pledge to reach net zero emissions by 2050. However, among the greatest polluters China, Russia and India with the largest populations had not signed up to the net-zero agreement. Many other agreements were made at Glasgow in 2021 to end deforestation, reduce methane gas emissions, and limit the dependence on coal (traditionally the cheapest but most polluting source of energy). Meanwhile on the exciting positive side of the energy ledger there was the exponentially increasing investment in renewable technologies, able to generate electricity at much lower cost, and rapidly making coal and other fossil fuels less competitive.

Figure 1.3: Glasgow 2021 COP 26 Pledges and 2015 Paris Agreement



Source: Adapted from IPCC (2021)

The Glasgow 2021 COP set a new agenda for tackling climate change over the following decade. As current pledges on emissions reductions would only limit global warming to a dangerous 2.4°C, it was agreed to meet the following year at COP27 in Egypt, to plan further cuts in emissions of carbon dioxide to renew the attempt to keep global temperature rises below 1.5°C, that scientists insisted was required to prevent a catastrophic change in climate (Figure 1.3). The UN goal remains to continuously keep on cutting emissions worldwide until net-zero emissions is reached by 2050. But how to translate this essential ideal into a practical reality is the greatest technical and political challenge humanity has ever faced.

The International Energy Authority *World Economic Outlook 2023* proposes a global strategy for getting the world on track by 2030 with emissions reductions that consists of five key pillars which supported the debate at the COP28 climate change conference. They are:

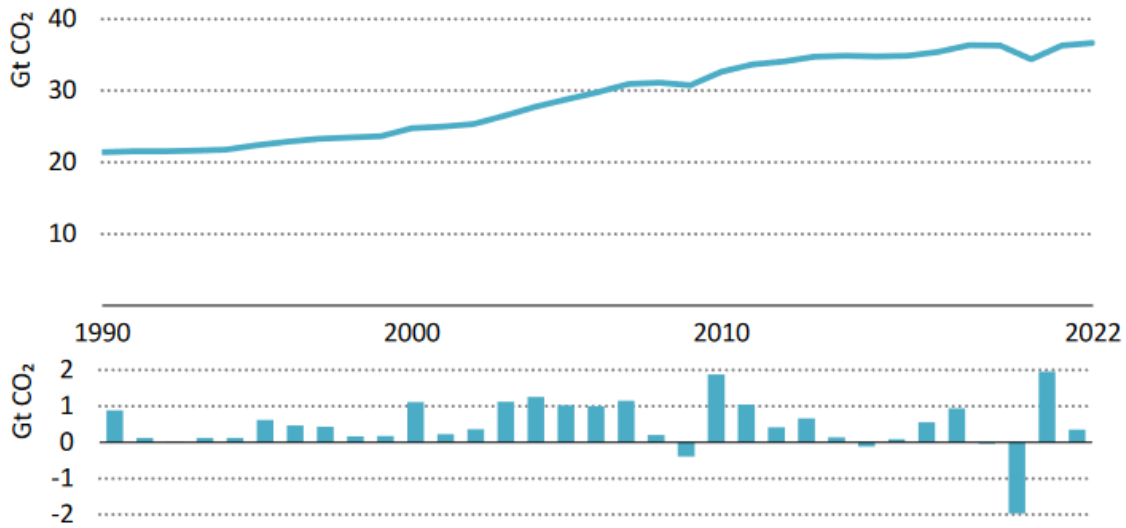
- tripling global renewable capacity;
- doubling the rate of energy efficiency improvements;
- slashing methane emissions from fossil fuel operations by 75%;
- innovative, large-scale financing mechanisms to triple clean energy investments in emerging and developing economies;
- and measures to ensure an orderly decline in the use of fossil fuels, including an end to new approvals of unabated coal-fired power plants (IEA 2023).

To this might be added the possibilities of CO_2 removal as a critical tool for achieving net zero by 2050. With significant (and as yet unproven) scientific and technological development it may be possible to neutralize residual carbon emissions (IPCC 2022; McKinsey 2023)

The Continuous Rise in Annual Emissions

As the International Energy Agency (2023) demonstrates in great detail all of the good intentions, pledges, and promises offered at successive COPs have not stopped the almost continuous increase in annual emissions between 1990 and 2022. The only significant fall in emissions during these two decades was caused by the COVID pandemic and the resulting widespread shutting down of a number of industries and overall decline in economic activity (Figure 1.4). The idealism concerning the need to reduce greenhouse gas emissions often manifest at successive COPS and translated into real purpose in Paris in 2015, still needs to be made into binding commitments, and reinforced by stronger and more effective regulation.

Figure 1.4: Annual Change in global Co2 emissions from energy combustion and industrial processes, 1990-2022



Source: IEA (2023)

The COP 27 at Sharm El-Sheik sadly lacked the sense of purpose and direction that were exhibited in Paris 2015, and still evident in Glasgow 2021 (though even at Glasgow, the young Swedish environmental activist Greta Thunberg refused to take part in the official proceedings, and protesting from outside dismissed the proceedings as more "Blah, Blah, Blah..". (She found an unlikely ally in the elderly British Queen who was overheard to say on television "Now is a time for action rather than words..") But at COP 27, there was no agreement on new steps to maintain the 1.5°C limit, to reduce emissions or further phase down fossil fuels as Saudi Arabia and Russia - both with economies based largely on fossil fuels - managed to limit further ambitions to reduce oil and gas production.

However, despite a lack of procedural and substantive coherence, still important principles were established. With the background of recent monsoon floods in Pakistan that left more than 1,700 dead and $30 billion of damage to rural communities, there was a commitment to a loss-and-damage fund that will send aid to vulnerable countries wrecked by global warming (a deal that took decades to achieve). This fund targeted "developing countries particularly vulnerable to the adverse effects of climate change." But there was widespread deep disappointment that the opportunity was not seized to further limit emissions from the powerful fossil fuel economies (Bloomberg 2022).

The environmental damage caused by inaction is becoming increasingly apparent as the scientific evidence increases that we are on the edge of darkness (Ripple et al 2024):

> *"We are on the brink of an irreversible climate disaster. This is a global emergency beyond any doubt. Much of the very fabric of life on Earth is imperilled. We are stepping into a critical and unpredictable new phase of the climate crisis. For many years, scientists, including a group of more than 15,000, have sounded the alarm about the impending dangers of climate change driven by increasing greenhouse gas emissions and ecosystem change (Ripple et al. 2020). For half a century, global warming has been correctly predicted even before it was observed—and not only by independent academic scientists but also by fossil fuel companies (Supran et al. 2023). Despite these warnings, we are still moving in the wrong direction; fossil fuel emissions have increased to an all-time high, the 3 hottest days ever occurred in July of 2024 (Guterres 2024), and current policies have us on track for approximately 2.7 degrees Celsius (°C) peak warming by 2100 (UNEP 2023)".*

Financing the Transition to Sustainability

Among the preparations for the COP 28 Meeting in Dubai in 2023 was a consideration of the finances required to protect against the worst impact of climate change and achieve net-zero greenhouse gas emissions. The Glasgow Financial Alliance for Net Zero, a coalition of leading international financial institutions project that reaching net-zero emissions requires at least $125 trillion investment by 2050, approximately $5 trillion every year. McKinsey (2022) suggests global capital spending for the transition to net zero cumulatively could rise to $275 trillion by 2050, approximately $9.2 trillion per year, or about 7.5% of global GDP across 2021-2050. If these figures sound astronomic in scale, in fact Bloomberg's estimates are not dissimilar: Bloomberg suggests it could cost $196 trillion (subsequently raised to $266 trillion) in investment in fossil-fuel alternatives to reach zero carbon emissions by 2050, and that annual green investments need to triple to $6.9 trillion by 2030 if we are to hit net zero by 2050.

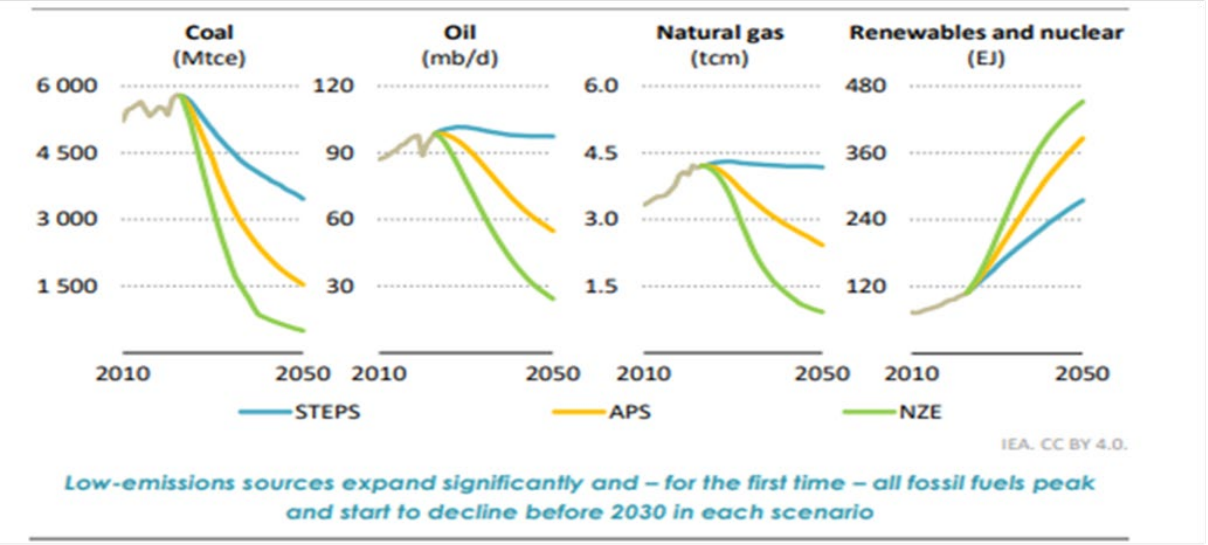
If we do not make these huge investments in zero emissions, the consequences will be more serious. The international insurance company Swiss Re calculates that out-of-control global warming could cost $23 trillion per year from global GDP, reducing the US economy by 7% and other developed economies by as much as 10% (Swiss Re 2021). S & P Global has estimated that climate change could reduce global GDP by 4% by 2050, amounting to losses of $13 trillion per year (S & P Global 2022). These losses would fall disproportionately upon the global South (Gongloff, 2023a and 2023b).

As high-emissions assets are ramped down, and low-emissions assets ramped up, the transition risks will be rising energy prices, energy supply volatility, and asset impairment. The fossil fuel industries are facing over $2 trillion in stranded assets by 2050.

Meanwhile the future will be rich with opportunities (Figure 1.5) in a net-zero world for business and economies who make the transition with:

- Decarbonising processes and products
- Replacing high emissions products and processes
- New offerings to aid decarbonization in supply chains, infrastructure and support services. (McKinsey 2022; 2023).

Figure 1.5: IEA Global Total Energy Demand Fuel and Scenario 2020-2050



Note: Mtce = millions of tons of coal equivalent; mb/d million barrels per day; tcm = trillion cubic metres; EJ= exajoules Source (IEA 2023:104)

The International Energy Authority has projected a *Global Energy and Climate (GEC) Model*, which is a large-scale modelling framework matching energy demand and supply across multiple countries and regions, taking account of a very wide range of fuels and energy technologies, including not only those that are widely available today, but also those that are judged to be approaching commercialisation. The GEC Model is a simulation model that reflects the real-world interplay between policies, costs and investment choices and which provides insights into how changes in one area may affect others.

The International Energy Agency examines three potential scenarios in working through the potential prospects for reducing emissions:

Stated Policies Scenario (STEPS)

This scenario is designed to provide a sense of the prevailing direction of energy system progression, based on a detailed review of the current policy landscape. Whereas the APS reflects what governments say they will achieve, the STEPS looks in detail at what they are actually doing to reach their targets and objectives across the energy economy.

Announced Pledges Scenario (APS)

This scenario assumes that governments will meet, in full and on time, all of the climate-related commitments that they have announced, including longer term net zero emissions targets and pledges in Nationally Determined Contributions (NDCs), as well as commitments in related areas such as energy access.

Net Zero Emissions by 2050 Scenario (NZE)

This normative scenario portrays a pathway for the energy sector to help limit the global temperature rise to 1.5 °C above preindustrial levels in 2100 (with at least a 50% probability) with limited overshoot. Power sector decarbonisation advances more rapidly than end-user electrification in each scenario, but both are key pillars of the transition to a clean energy economy.

None of the scenarios included in the IEA *Outlook* should be considered a forecast. The intention is not to offer a guide towards a single view of the future, but rather to promote a deeper understanding of the way that various levers produce diverse outcomes, and the implications of different courses of action for the security and sustainability of the energy system. This is intended to promote a deeper understanding of the way that various levers produce diverse outcomes, and the implications of different courses of action for the security and sustainability of the energy system.

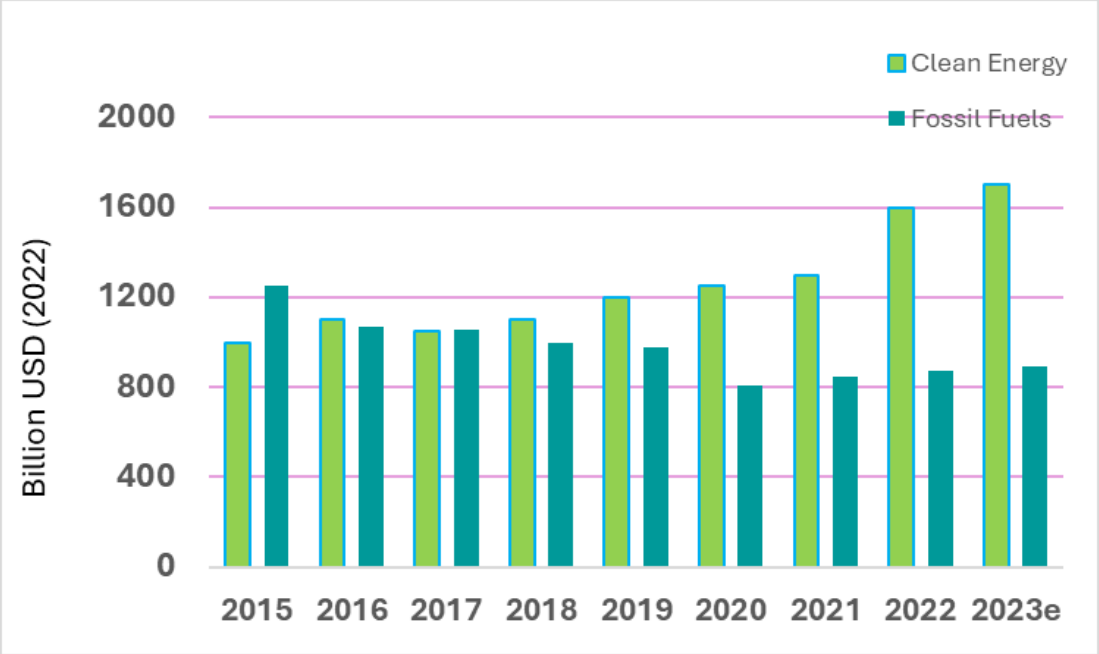
An important element of the IEA (2023) *Outlook* is that all scenarios now take into account not only energy and climate-related policies but also *industrial strategies that affect the rate at which different technologies might enter the mix*. This means that the scale and location of manufacturing capacity for various

components of the clean energy system have become important variables in scenario construction and design. As energy technology is transformed, analysing the path of transition of a range of industry and product sectors can be illuminating regarding the potential for change.

While each IEA scenario indicates some decline of the fossil fuel industries, and a rapid increase in the take up of renewable technologies, it is concerning that the STEPS scenario, an assessment of what governments are actually *doing*, is rather disappointing. Failing to implement espoused policies (the APS) is worrying. The fact that governments are not making sufficient commitments to achieving net zero emissions (NZE) is very disturbing. The reality is that behind the rhetoric of governments they are taking climate change seriously, their actions in practice are consistently more limited than this crisis demands.

But accelerated scale up of the clean energy transition means there is very little runway left for growth in fossil fuels: for the first time, demand for oil, natural gas and coal each peak in the three IEA *World Energy Outlook-2023* scenarios before 2030. The share of fossil fuels in primary energy demand declines from 80% over the last two decades to 73% in the STEPS by 2030, 69% in the APS and 62% in the NZE Scenario. In each of the scenarios in the *World Energy Outlook*, demand for each of the main fossil fuels – coal, oil and natural gas – reaches a peak before 2030 before falling back Though the energy transformation in reality appears much slower and more halting that it needs to be, what is clear from the IEA projections is that by 2050 the fossil fuel industries will be significantly smaller, and the renewable energy industries will be growing rapidly reflected in increased investment (Figure 1.6). The installed capacity of all renewable power sources more than doubles in the STEPS and the APS by 2030. In the NZE Scenario, the installed capacity of renewables triples by 2030 – a key milestone in the drive to keep the 1.5 °C goal within reach (IEA 2023:105).

Figure 1.6: Global Energy Investment in Clean Energy and Fossil Fuels



Source IEA: 2023

The Impact of Clean Energy Upon Industrial Transformation

As the IEA (2023) suggests the most dynamic developments in industrial strategy are driven by the potential of clean electrification. Extensive investment in low-emissions technologies have delivered an annual global renewable energy addition set to rise to more than 500 gigawatts (GW) in 2023, the largest absolute increase ever. Low emissions (renewables and nuclear) reached 40% in 2023. Solar capacity accounts for two-thirds of the estimated increase in global renewable capacity.

Solar is leading the charge: solar PV capacity, including both large utility-scale and small distributed systems, accounts for two-thirds of the 2023 estimated increase in global renewable capacity. Solar manufacturing has expanded remarkably in the last decades increasing by ten-fold to meet increasing demand, a trend which will continue with investments in the pipeline to raise solar module manufacturing

capacity from 640 GW in 2022 to over 1,200 GW, which will accelerate transitions to clean energy around the world (IEA 2023).

The 26% annual growth in solar generation in 2022 was aligned with the near-term rates required in the Net Zero Emissions Scenario, and planned additions provide confidence that high growth can be sustained. Solar, wind, and hydroelectric power are becoming increasingly available and produce little greenhouse gas emissions. With the rapid advances in battery technology it is possible to store renewable energy more efficiently, making it a more viable option for powering homes and businesses (IEA 2023:85).

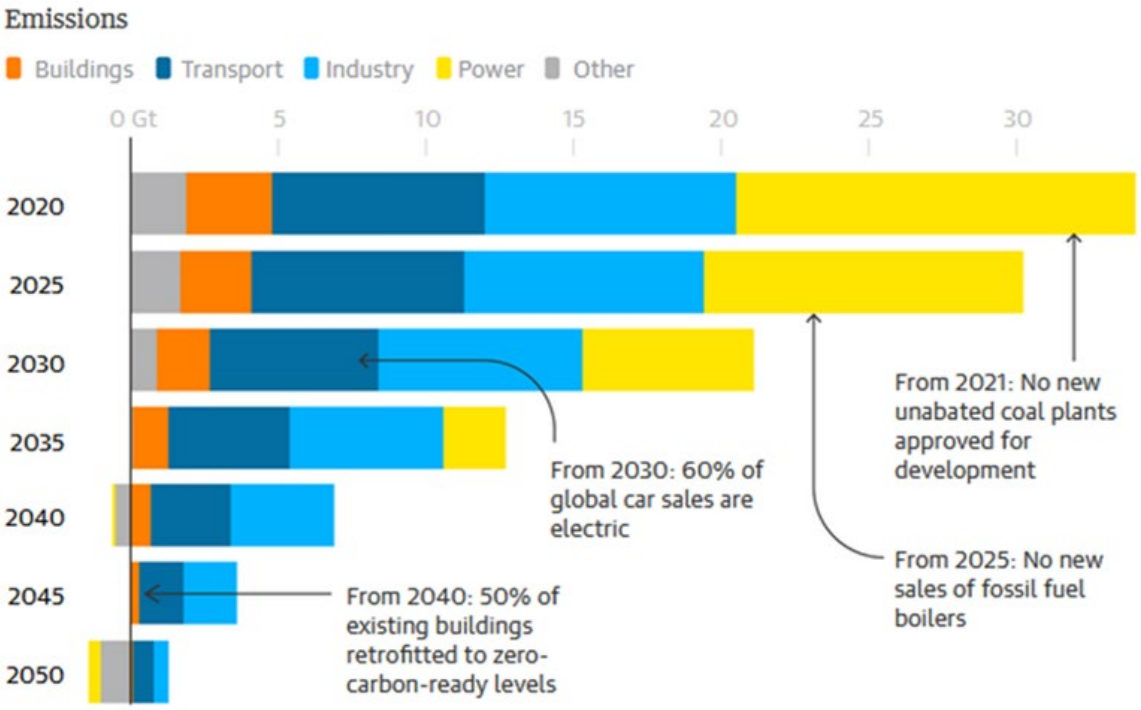
Clean electricity is supplying new end-users at scale with mobility and heat. The sale of electric vehicles (EVs) increased by 50% in 2022 reaching global sales of more than 10 million. The deployment of battery storage jumped by 90% in 2022, and the sale of heat pumps increased by 11%. In this context of increasingly available and affordable electricity internationally there has been a renewed focus upon energy efficiency in Europe, the United States, China and India (IEA 2023: 84), as the cost reductions in selected clean energy technologies have been sustained over the last decade.

However, the International Energy Agency (2023) records uneven progress with the trends for the deployment of some clean energy technologies on track with the Net Zero Emissions Scenario, but many technologies are not. Of the 50 technologies surveyed in the IEA Tracking Clean Energy Progress only three Solar PV, Electric Vehicles and efficient lighting were fully on track:

> *"Most technologies require additional efforts to get on track: these include wind power, grids and storage, electrolysers, efficiency, innovation and digitalisation. And some are definitively off track, including those needed for long-distance transportation by truck, air and ship and those needed by many large industrial sub-sectors" (2023:89).*

Figure 1.7 indicates the complex interplay as across industries legislation on emissions reductions impacts upon industrial strategies and technological innovation.

Figure 1.7: Emissions Reductions Across Industry Sectors Leading to Net Zero



Source: IEA (2023)

Despite geopolitical friction, volatile commodity prices and uncertainty around costs, transformative changes in parts of the global energy system are coming into view. Electric vehicles (EVs) accounted for around 15% of car sales in 2023 and are on course to reach a share of 40% by 2030 in the Stated Policies Scenario (STEPS). A record 220 gigawatts (GW) of solar capacity was added in 2022, and deployment levels are projected to more than double, while heat pumps more than double their share of heating equipment sales in the STEPS by 2030. The planned boost in the manufacturing capacity of these clean energy technologies, if fully realised, appears able to meet many of the deployment milestones in the Announced Pledges Scenario (APS) and, in the case of solar and batteries, also to provide what is required in the Net Zero Emissions by 2050 (NZE) Scenario.

Priorities for Environmental Transformation

Today leading governments and international corporations are engaged in transforming strategies and practices towards a decarbonized, decentralized, and digital future. New technologies are changing the management of the traditional linear economy towards a circular economy, in which waste is effectively eliminated, and the economy is restorative rather than depletive of eco-systems (European Commission 2015a; World Economic Forum 2014).

The maintenance of the natural capital of the Earth which forms the bedrock of the human economy and life-support system of the planet's species necessitates decoupling of economic growth from further environmental impact (Hackman and Boulton 2016). Human ingenuity and innovation can achieve a greening of the economy and corporation in which pollution is eliminated, green products and process technologies do not continuously create waste, and renewable energy technology and emissions free transport bring balance between the economy and the ecology (Kemp and Pontoglio 2011). We can transform manufacturing operations, enhance transparency in global supply chains, accelerate technological transformation, and link business value and environmental value Table 1.2 (UNIDO 2024).

Table 1.2: Key Policy Issues for Environmental Transformation

Key Priorities	Key Issues	Public Sector Priorities	Private Sector Priorities
Achieving environmental sustainability of manufacturing operations, production and supply chains	• Decarbonising within and across supply chains • Reconceptualising Product design, business models and industrial processes towards • Circularity and resource efficiency • Energy efficiency	• Data standardization • Regulations • Informing consumers • Risk offsetting • Bolstering affordability in developing economies	• Increasing resource efficiency • Supply chain partner selection • In-house innovation hubs • Sharing solutions and data across the sector

Enhancing supply chain transparency and resilience	• Improving the understanding and end-to-end visibility of supply chains • Long-term viability of demand • Regulation frameworks on business transparency	• Strengthening international coordination and collaboration • Restructuring essential supply chains • Long term viability of demand • Regulatory frameworks on business transparency • Supporting technology adoption	• Information sharing • Adopting resilience • Enhancing technology • New profit models • Long term perspective • Grounded risk assessment
Accelerating the scale-up and adoption of industrial technologies	• Fostering numerous robust collaboration linkages • Integrating industry perspectives • Interlinking workforce skills development and technology	• Consultative bodies • Data gathering and benchmarking • Experimenting spaces • International collaboration • Mission setting	• Linking with academia • Integrated approach to skills and technology development • Defining technology priorities • Technology adoption advocacy • Developing learning networks

Source: Adapted from UNIDO (2024:5)

The maintenance of the natural capital of the Earth which forms the bedrock of the human economy and life-support system of the planet's species necessitates decoupling of economic growth from further environmental impact (Hackman and Boulton 2016). Human ingenuity and innovation can achieve a greening of the economy and corporation in which pollution is eliminated, green products and process technologies do not continuously create waste, and renewable energy technology and emissions free transport bring balance between the economy and the ecology (Kemp and Pontoglio 2011). We can transform manufacturing operations, enhance transparency in global supply chains, accelerate technological transformation, and link business value and environmental value Table 1.2 (UNIDO 2024).

There is a great deal of policy and practical work to be done if the goal of a sustainable world is to be achieved.

References

Bloomberg (2022) How a Flawed But Historic Climate Deal Emerged from COP Chaos, 21 November 2022, https://www.bloomberg.com/news/articles/2022-11-21/how-cop27-ended-with-success-on-climate-justice-and-failure-on-emissions?srnd=green-united-nations-climate-summit

Brundtland Commission (1987) *Our Common Future,* United Nations

Clarke, T. (2024) *International Corporate Governance,* London: Routledge

Evans S, Vladimirova D, Holgado M, Van Fossen K, Yang M, Silva EA, Barlow CY (2017) Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models.

Business Strategy Environment 26(5):597–608. https://doi.org/10.1002/bse.1939

Fay, M., S. Hallegatte, A. Vogt-Schilb, J. Rozenber, U. Narlock, T. Kerr (2015) *Decarbonising Development: Three Steps to a Zero-Carbon Future,* World Bank

IEA (2023a) *World Energy Outlook,* International Energy Agency, https://www.iea.org/reports/world-energy-outlook-2023

IEA (2023b) The energy world is set to change significantly by 2030, based on today's policy settings alone, IEA *News,* 24 October 2023 https://www.iea.org/news/the-energy-world-is-set-to-change-significantly-by-2030-based-on-today-s-policy-settings-alone

IPCC (2013) *The Physical Science Basis 1450*, Intergovernmental Panel on Climate Change, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_ALL_FINAL.pdf

IPPC (2022) *Climate Change 2022: Mitigation of Climate Change,* Summary for Policymakers, IPCC Inter-Governmental Panel on Climate Change

IPPC (2024) UN Climate Change Conference Baku November 2024 https://unfccc.int/cop29

Klein, N. (2015) *This Changes Everything: Capitalism vs The Climate,* Penguin

McKinsey (2023) *Carbon Removals: How to Scale a New Gigaton Industry,* *https://www.mckinsey.com/capabilities/sustainability/our-insights/carbon-removals-how-to-scale-a-new-gigaton-industry#/*

NSW Government (2020) Net Zero Plan Stage 1: 2000-2030, NSW Department of Planning, Industry and Environment
https://www.energy.nsw.gov.au/sites/default/files/2022-08/net-zero-plan-2020-2030-200057.pdf

NSW Government (2023) The Climate Change (Net Zero Future) Act 2023, NSW Government
https://www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/climate-change-net-zero-future-act-2023

Ripple, W., C. Wolf , J. Gregg, J. Rockström, M. Mann, N. Oreskes, T. Lenton, S. Rahmstorf, T. Newsome, Chi Xu, J.C. Svenning , C. Pereira, B. Law and T. Crowther (2024) The 2024 State of the Climate Report:

Perilous Times on Plant Earth, *BioScience, 0, 1-13 https://doi.org/10.1093/biosci/biae087*

SGK Planet (2023) *Brief History of the COP Conferences on Climate Change* (2023) SGK Planet https://sgkplanet.com/en/brief-history-of-the-cops-un-framework-convention-on-climate-change/

Stern Review (2006), *The Economics of Climate Change*, Stern Review, UK Government

United Nations United Nations Conference on the Human Environment. The *Stockholm Declaration*

United Nations (1972) *Report of the Conference, UN Conference on the Human Environment,* 5-16 June 1972, Stockholm, United Nations https://www.un.org/en/conferences/environment/stockholm1972

UNEP] United Nations Environment Programme. 2023. *Emissions Gap Report 2023: Broken Record: Temperatures Hit New Highs, yet World Fails to Cut Emissions (Again).* UNEP

UNFCCC (2015) Adoption of the Paris Agreement, United Nations Framework Convention on Climate Change, FCCC/CP/2015/L.9/Rev.1 (Dec. 12, 2015), http://unfccc.iresource/docs/2015/cop21/eng /l09.pdf

UN FCCC COP (2023) Conference of the Parties, https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop

UNIDO (2024*) Industrial Development Report 2024: Turning Challenges Into Sustainable Solutions, The New Era for Industrial Policy, https://www.unido.org/news/unido-publishes-industrial-development-report-idr-2024*

UN IPCC (2014) *Framework Convention on Climate Change* and the *Kyoto Protocol* (IPCC 2014)

UN IPCC (2021) Climate Change 2021, Intergovernmental Panel on Climate Change, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

WRI (2023) 10 Big Findings from the 2023 IPCC Report on Climate Change, World Resources Institute https://www.wri.org/insights/2023-ipcc-ar6-synthesis-report-climate-change-findings