Introduction

This book comes at a critical point in the transition to a low-carbon future. The global scientific consensus evidenced in the most recent Intergovernmental Panel on Climate Change (IPCC) report warns of the need to make purposeful reductions in global greenhouse gas (GHG) emissions urgently over the next decade, trending to net zero emissions globally by 2050, to avoid the worst forms of dangerous climate change. Yet, global GHG emissions have risen again in 2019, at the end of the hottest decade on record, and temperature rises continue largely unabated. The good actions of some countries, regions and cities are to be commended but do not yet add up to a solution for our planet. How do we turn this around?

Profound changes are called for to reduce GHG emissions and, as this book points out, these changes are achievable. Not only can these measures slow and eventually stop dangerous climate change and its impacts, but they can also unlock new sources of economic growth, enabling this transition to be achieved in ways that build a solid foundation for economic prosperity in the twenty-first century, while delivering huge benefits for economies, communities and the natural environment. Carbon-free energy generation can entirely replace coal, oil and (fossil) natural gas over a decade or two, reducing not only GHG emissions, but also the dangerous air pollution that affects millions of people in many countries, including some of the most populous and the most impoverished, thus improving public health.

Huge opportunities for profitable businesses and well-paid jobs beckon in this new environment. Economists show how the transition to carbon-free economies will drive increases in GDP, if properly handled. Reputable economic modelling shows that transition to low-carbon economies will bring more rapid growth than 'business as usual'. Two highly regarded studies have been the OECD's *Investing in Climate, Investing in Growth* (2017), and the Global Commission on Climate and the Economy's *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times* (2018). These have followed the landmark Stern Review, *The Economics of Climate Change* (2006). But 'proper handling' means that the transition must be managed in a way that ensures those employed in carbon-intensive industries are able to secure new and valued jobs and lead satisfactory lifestyles in a decarbonised economy.

The outlook for the alternative future – that is, taking no or insufficient action to drive the transition to a carbon-free economy – is grim. Higher temperatures that can cause heatwaves, droughts and wildfires, as well as other extreme weather events, will disrupt economies, reduce productivity and displace populations. Sea-level rise will threaten coastal cities, industries, infrastructure and communities. The costs of climate impacts will rise, as will the cost of adapting to those impacts. In this uncertain future, humanity will have passed over the great benefits of a carbon-free economy and will face new adversities that may include lower real incomes, fewer options for development and less comfortable lifestyles.

More seriously, the displacement of populations may precipitate conflict as people in the most affected areas struggle to survive amid rising temperatures and sea levels, more severe droughts and water shortages, deepening poverty and food insecurity. Such displacement may reach tipping points beyond which established laws and social arrangements catastrophically fail, precipitating millions of desperate refugees to look for new homes.

The challenges are daunting but are surmountable with existing technologies and systems. The priority must be a fair transformation that simultaneously responds to the urgency of the challenge, and the need to be sensitive to populations' aspirations for the future. The fundamental change that is required is not without precedent, but the urgency with which it must be achieved is, and this will make the transformation significantly more difficult.

The Aim of This Book

This book originates in a global environment with a cacophony of voices offering differing solutions and conflicting priorities for addressing climate change. It is intended to clarify the policy reform and complementary actions needed for the transformation, and be a practical 'how-to' guide for decision makers to achieve the commitments made in the Paris Climate Change Agreement:[1] to keep global warming as close as possible to 1.5 °C and well under 2 °C to avoid the worst of dangerous climate change.

Throughout the book, the authors have highlighted climate strategies and responses that can achieve both mitigation and adaptation outcomes, an approach that provides many potential co-benefits, including enhanced prosperity and well-being. The book is written to be accessible to non-experts, to provide a source of wide-ranging information for the community at large about how the world can manage the transformation to a prosperous, resilient, carbon-free economy.

How the Book Is Organised

The book incorporates studies of each economic sector, indicating sectoral challenges and the available strategies for both climate mitigation and adaptation. The political and

[1] *Paris Agreement Under the United Nations Framework Convention on Climate Change*, opened for signature 16 February 2016. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

institutional frameworks within which action on climate change must proceed are described, and the barriers to change are discussed.

Decarbonising the energy and electricity sectors is essential for the rapid mitigation of climate change, and enables emissions reductions in the buildings, transport, industry and agricultural sectors through electrification. Chapter 1 discusses the complexity and challenges inherent in developing climate policy through the lens of the energy sector. It provides a comprehensive analysis of the technological and institutional complexities of decarbonising the energy sector, and explores strategic options based on different political and administrative models. More public-sector-driven models such as those in France and Germany are contrasted with the market-based models of the USA, the UK and Australia. It also discusses the decarbonisation of the electricity sector as a 'litmus test' for decarbonisation of economies. Barriers to changing to new dominant technologies are also explored.

Chapters 2–8 then lay out the main technologies available for the transition to low-carbon energy: wind, solar photovoltaics (PV), solar thermal, nuclear and hydropower, as well as energy storage and the role of hydrogen.

The next section reviews two decarbonisation studies, projecting the effects of deployment of the new technologies on climate change and economies. Chapter 9 compares 16 countries but focuses particularly on Australia, noting that Australia can maintain 2.4% annual GDP growth while transitioning to a low-carbon economy without problematic structural change. In Chapter 10, a country study of an emerging giant economy – Indonesia – shows how developing countries are addressing climate change, including a cameo example of how renewable energy is being encouraged in India.

The next group of chapters (Chapters 11–16) take the reader from the global and national levels to the sectoral and city scales. They explore how cities, and precincts within them, can mitigate GHG emissions while adapting to changes in the climate that cannot be avoided. Chapter 13 considers issues around water: its changing patterns of availability, its relationship to food production and the need for more efficient use and conservation, especially in regions experiencing reduced rainfall as a consequence of climate change. This is followed by a discussion of transport and industry – key sectors with very significant GHG emissions. Opportunities for electrification based on renewable energy are presented: for example, the replacement of gas heating with heat pumps that are more efficient, cost-effective and emissions-free. In transport, electrification can extend to sea and air transport as electric and hybrid models are developed.

The next theme is land use, forests and agriculture, covered in Chapters 17–19. The natural carbon cycle is explained and pressure on land resources for human exploitation, deforestation, the need to conserve carbon-rich native forests, and mitigation strategies are explored. Agriculture, with its related value chains, is a major source of emissions, but emissions reduction is challenging, and population growth with associated increased demand for food implies even greater challenges in the future. Nevertheless, there are possible win–wins that can be achieved.

Transitioning the mining, metals, oil, gas and petrochemicals industries is then reviewed in Chapter 20, noting that mining has a major role in producing the raw materials necessary for the transformation, while reducing its own emissions. This can be achieved by

electrification of mines, for example by replacing diesel trucks with electrically powered conveyor systems. Oil and gas will have diminishing roles in economies but can reduce emissions from their operations, including through controlling fugitive emissions and flaring.

The last section of the book revisits themes from the first chapter and looks at the issues posed by current institutional arrangements and trading systems. Chapter 21 discusses the role that international trade will play in the global transition to low-carbon economies. In particular, this chapter examines the impact of investor–state dispute settlement clauses in international agreements, which enable corporations to sue states over perceived discriminatory action, which can include environmental regulation. Conflicts arising from global trade arrangements that have focused on open markets and 'competitive economies' – sometimes to the detriment of national action on important environmental matters including climate change – are also analysed in the trade chapter, which then discusses the opportunities presented by the Paris Climate Change Agreement, and offers some recommendations to successfully support the low-carbon agenda.

The need for good governance and the elimination of corruption is discussed in Chapter 22, while Chapter 23 looks at how the transformation can be financed, noting that financial institutions are not only increasingly taking into account climate risk in their investment decisions and that climate-friendly investments generally show superior returns, but also that financing the operation and expansion of fossil fuel industries continues to take a large share of available funds. New and encouraging developments in the finance sector that support environmental, social and governance-focused enterprises are highlighted.

The final chapter, Chapter 24, discusses bottom-up social movements that can help drive the transformation to carbon-free and resilient economies.

Reasons for Optimism

According to many reports, global negotiations at the 25th Conference of the Parties (COP 25) in Madrid ended with disappointment on many fronts, highlighting the growing gap between the stronger action needed to avert climate disaster and the sluggish responses of most major economies. In addition, the International Energy Agency (IEA) *World Energy Outlook 2019* reports (IEA 2019):

> Current country commitments, the Nationally Determined Contributions (NDCs) made under the Paris Agreement and domestic energy policy plans fail to bring about the rapid, far-reaching changes required to avert dangerous and irreversible changes in the global climate system. These are assessed in our Stated Policies Scenario and lead to total global energy-related CO_2 emissions growing steadily from today's levels before plateauing around 36 Gt after the mid-2040s. This trajectory is consistent with limiting the temperature increase to below 2.7 °C above pre-industrial averages with a 50% probability(or below 3.2 °C with a 66% probability).

So, are there reasons for optimism? The answer is yes. The widespread adoption of renewable energy has far outstripped earlier predictions, and the steep fall in costs of solar PV technology, wind-powered energy and batteries, as well as energy- and fuel-efficient

technologies, such as LED (light-emitting diode) lighting, heat pumps, electric vehicles, e-buses and e-bikes, have greatly surprised and are continuing. There have also been significant advances in the development of new business and financing models, as outlined in Chapter 23, which can be complemented by proven and effective climate change policies at the national, subnational and city levels (as covered in Chapters 1 and 11 to 23). And, as discussed above, implementing effective climate change policy reform can enable significant economic and employment growth – a fact that has become more evident in recent years and which lies at the heart of many of the economic stimulus measures being developed to support post-COVID-19 economic recovery.

Notwithstanding some failings of COP 25, there is a growing consensus among communities that climate change is real and action is needed urgently. This is reflected in growing concern about policy stasis at the global level and in some countries. The community consensus needs to translate into political will and effective government policies that can overcome barriers to both climate mitigation and adaptation.

Communities also have to be convinced that life in a transformed economy will be good; even better than the present. Studies indicate that deep decarbonisation processes are consistent with continuing economic growth. Change is often hard and frequently resisted until the new paradigm becomes 'normal'. For example, the adoption of electric vehicles has been particularly slow, but many predict that there will soon be a 'tipping point' and rapid take-up will follow as the cost savings in operation are realised.

Ensuring that the transition is just and fair is critical, and structural adjustment packages will be needed to retrain and support affected workers. Some governments, notably Germany, are already developing transition plans for vulnerable communities where former industries such as coal mining and coal-fired generation are shutting down. The move away from coal by major miners, BHP and Rio Tinto, and direction of investment away from fossil fuels by some financial institutions, show growing momentum behind decarbonisation, but on close inspection those shifts are, in the main, modest, conditional and not yet mainstream.

The broad consensus among populations and businesses about the need to act urgently on climate change is growing, as the benefits of carbon-free energy generation and decarbonising the wider economy become ever more obvious, along with the need for immediate and strategic climate adaptation. Yet as consensus emerges around the 'why' of decarbonisation and climate adaptation, decision makers and political leaders are still grappling with the 'how' – particularly, how best to achieve climate change mitigation and adaptation goals while simultaneously growing jobs and economies.

This book responds to that challenge.

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