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G7 leadership for sustainable, resilient and inclusive economic recovery and growth

An independent report requested by the UK Prime Minister for the G7

Nicholas Stern

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This is an independent report led by Nicholas Stern, I.G. Patel Professor of Economics and Government and Chair of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science. He was supported by a team at the Grantham Research Institute, coordinated by Josué Tanaka and including Amar Bhattacharya, Hans Peter Lankes, Roberta Pierfederici, James Rydge, Charlotte Taylor and Bob Ward.

This report sets out core elements of an overarching and integrated strategy for recovery and growth as a contribution to the preparation for the Carbis Bay G7 Summit. While it is an independent contribution from outside government, the team has consulted with officials involved in the preparation of the G7 meetings so that it can be as useful as possible to the deliberative for and the outcome of the Summit. A summary report published on 10 May 2021 generated valuable feedback.

This report is supplemented by the following background papers, which provide additional analytical insight:

- Ehtisham Ahmad, *Financing sustainable investments: national and subnational considerations for building back better.*
- Nicholas Stern and Dimitri Zenghelis, *Fiscal responsibility in advanced economies through investment for economic recovery from the COVID-19 pandemic*.
- Julia Turner, Mark Meldrum, Veerle Haagh, Oscar Ibsen and Jeremy Oppenheim (SYSTEMIQ), *Investments for green recovery and transformational growth 2020–30: Technical Note*.

These papers and the summary report are available at www.lse.ac.uk/granthaminstitute/publications/

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OVERVIEW

Challenge, vision and overarching strategy at a critical moment in history

The COVID-19 pandemic is a continuing human tragedy. It has exacerbated the risks and vulnerabilities that had been building in the global economy. It follows a decade that was characterised by reduced investment, by slowing growth of productivity, by faltering employment, by weakening social cohesion, by increasing pressure on public finances, and by an accelerating destruction of natural capital.

The world is consequently confronting an **interwoven set of challenges**: the devastating **health and social costs of the pandemic;** the **diminished prospects for economic growth and employment** against a backdrop of **rising public debt;** the mounting threats of **climate change, environmental degradation and biodiversity loss; growing inequality** that has been exacerbated by the pandemic; and **disrupted education** for 90% of the world's children. A failure to act on any of these dimensions will weaken progress on the others.

The Carbis Bay Summit offers a unique opportunity for the G7 to take bold action to 'build back better' – to realise the **growth and jobs story of the 21st century and ensure environmental sustainability.** The transition to a net-zero emissions, climate-resilient world represents not a cost or a burden but the greatest of economic, business and commercial possibilities in modern times. If the world fails to seize this opportunity, the dangers and fragilities of the old economic model that were mounting before the COVID-19 crisis will become ever more severe. There could be a lost decade for development in poor countries and weak or stuttering recovery and growth for the world as a whole. This is therefore a special moment in history, offering the chance, indeed duty, for the G7 to lead **a globally coordinated recovery, driven by sustainable investment and innovation by both the private and public sectors.**

At the heart of the proposed vision for the economic response to the pandemic and the climate crisis is a coordinated global programme of investment for recovery, reconstruction and transformation that can boost all forms of capital – human, physical, natural and social – and create strong and sustainable growth. This programme of investment, involving sustainable infrastructure development, the preservation and restoration of nature, and greater focus on innovation and skills, can provide strong economic multipliers to increase activity and jobs in the shorter run, and unleash discovery and productivity growth in the medium term.

The programme of investment will be **inclusive** in its new job opportunities and stronger growth, in its attention to the management of change, in its reduced pollution, and in its internationalism. And the growth and revenues will enable the strong investment in education and health that are central to justice and well-being and are critical to sustained recovery and growth.

Delivery of the requisite scale and quality of investment will require a **broad commitment and concerted actions on policy measures and on finance.** These include:

- A **supportive** but **prudent macroeconomic framework** that enables a strong recovery in investment, while at the same time responsibly managing debt and deficits over the medium term, including through enhanced international tax cooperation.
- **Structural policies that set expectations and a clear sense of direction.** These must include making faster progress on carbon pricing, the phasing out of fossil-fuel subsidies, introducing supporting regulations that accelerate the drive to net-zero emissions, valuing natural capital, and building climate and environmental resilience into all policies.
- **Innovation will be central** to change and can be directly supported through well-oriented and creative R&D and innovation institutions such as Mission Innovation and the International Solar Alliance. **Standards and regulations** can play a powerful role in complementing innovation policy. So too the **design of cities** and the development of **circular economies** and similar frameworks that are crucial to innovation at both individual and system levels. The key systems are cities, energy, transport, and land.

- Labour market and other policies to foster a **just transition** to a net-zero emissions and climate-resilient economy will also be crucial as rapid change will involve dislocation, in both production and consumption, requiring investment in and support for people and places.
- **The realignment of the financial system** to support sustainable growth, climate action, and responsibilities towards the environment and biodiversity**.**
- An urgent, concerted and enhanced international effort to **tackle the debt, fiscal and financing constraints of emerging market and developing countries.**

Acting together, based on a shared vision and strategy, will be critical in an interconnected world. Strong international cooperation around stimulating demand for goods and services, job creation, policy directions, technology and finance is an integral part of this vision. By acting together, the world will benefit from stronger demand expansion and investment recovery, economies of scale, learning by doing, lower costs for new technologies and the necessary collective actions on climate and biodiversity that are urgently needed. **Global collaboration** on tackling the health, economic and financial **challenges of COVID-19, including on vaccines and debt/finance**, particularly in support of the poorest countries, will be both crucial to the recovery and a key test of the multilateralism that is vital to the transformation to new forms of growth. Much of the action in this strategy will be greatly enhanced by, or require, **more effective use of international institutions**, which must be enabled to act on the necessary, and sustained, scale; they will be crucial catalysts and vehicles for building a better world.

Priorities for action

The Carbis Bay Summit provides a crucial opportunity to set **specific priorities and targets as part of an integrated global agenda.** It must give momentum to a shared international vision for strong recovery and sustainable growth; provide policies for delivery; and mobilise finance for action.

Shared international vision for strong recovery and sustainable growth

- Ensure a **timely, effective and global roll-out of vaccines and treatments** based on principles of common humanity, mutual responsibility and self-interest. An immediate priority is **closing the $20 billion funding gap of COVAX** and providing adequate support to developing countries so that **effective vaccines and treatments would be available everywhere no later than the end of 2022**.
- **Deliver credible pathways to meet the stepped-up commitments** made by the G7 at President Biden's Leaders Summit on Climate and the Major Economies Forum on Energy and Climate on net-zero emissions by 2050 and emission reduction targets by 2030. This must include: the **preparation and submission of well-specified nationally determined contributions (NDCs) ahead of COP26;** and putting in place **sufficiently strong and green recovery programmes** for delivery; recognising the dangers from attempts to 'backload' action.
- Support **a global target for nature with the protection of 30% of land and ocean areas by 2030**, accompanied by appropriate domestic targets.
- Set **a collective goal to raise annual investment by 2% of GDP above pre-pandemic levels for this decade** and **improve the quality of investment** to support a strong recovery and transformational growth. For the seven countries, this would amount to an additional investment of around $1 trillion per year from now until 2030. That investment, if well executed, would have high returns in terms of productivity, new opportunities and the environment.

Policies for delivery

- **Commit to putting the right price on carbon and to eliminating fossil-fuel subsidies no later than the target date of 2025**. This could include consideration of an international carbon price floor among large emitters such as the G20, and border adjustments for energy-intensive trade-exposed sectors.
- **Lead in the global energy transition by setting targets for zero-carbon power and road transport; investing strongly in clean energy and energy efficiency** at home and in developing countries; phasing out **unabated coal power generation domestically by 2030; ending overseas support for**

fossil fuel investments, starting with coal power generation; and defining a **clear phase-out strategy for fossil fuels** other than coal, in line with the goals of the Paris Agreement. Foster and share research and development in energy and beyond.

- **Commit to a 'just transition';** ensure that the benefits and opportunities are shared widely; protect those that are most vulnerable to economic losses.

Finance for action

- **Strengthen international tax cooperation** to help bolster public finances and provide clarity on the global tax regime, including through the consideration of a minimum tax rate on corporate profits of 21%.
- **Accelerate the shift in the financial system by working together and with the private sector to improve the availability of consistent, comparable, and reliable information on climate-related financial risks,** including by supporting mandatory disclosure, strengthening risk management, supporting efforts to identify opportunities for green investments, and encouraging financial institutions to align their portfolios with the Paris Agreement goals.
- Act strongly to **alleviate the debt constraints of low-income and vulnerable countries.** This could include **extending the Debt Service Suspension Initiative**, requiring comparable treatment of the private sector and tackling over-indebtedness by **strengthening the G20 Common Framework for Debt Treatments,** reprofiling and reducing the cost of official debt, and considering the potential of debt-for-nature and debt-for-climate swaps.
- Make a **collective commitment to double climate finance, improve its quality, and raise the proportion of grants, to deliver on and go beyond the $100 billion per year target** that is critical to the success of COP26 and adequate support for climate action by developing countries.
- **Following the agreement of a new allocation of Special Drawing Rights of $650 billion, support re-allocation mechanisms** that can widen financing options for recovery programmes in low-income and vulnerable countries, support effective vaccination and health campaigns, and promote green transitions.
- **Enable the multilateral development banks (MDBs) to scale up support for a green recovery, the drive to net-zero emissions and climate adaptation/resilience, and the fight against biodiversity loss** through: an **accelerated IDA replenishment** in 2021; **more effective use of MDB balance sheets**; enhanced **private-sector finance mobilisation**; accelerated **alignment with the Paris Agreement**; and proactive **MDB capital increases** within a requirement to work better together.

The clarity of vision, the credibility and coherence of policies, the availability of appropriate finance and international cooperation have never been more important. Delay is dangerous. Ambition will be less risky than caution and strong progress will require decisive leadership and effective collaboration. There has never been a more crucial moment for leadership from the G7.

The G7 has the opportunity now to chart a **clear course of action for the next three years**, working closely with the Italian G20 Presidency and reaching out to the G7 and G20 presidencies that will follow in 2022 and 2023. **2021 can be a turning point towards a more prosperous and sustainable future.**

About this report

An independent report requested by the UK Prime Minister and prepared for the 2021 G7 Presidency by the London School of Economics and Political Science

This report sets out an **overarching and integrated strategy for recovery and growth** as a contribution to the preparation of the G7 Summit to be held in Carbis Bay, Cornwall on 11–13 June 2021:

- Part One highlights the global **challenges** ahead and the significant potential **opportunities** and benefits arising from the transition to a net-zero emissions and climate-resilient economy, including stronger growth, increased employment opportunities across the economy, more robust biodiversity, a healthier population, and reduced risks of pandemics.
- Part Two sets out a **vision** for sustainable, resilient and inclusive recovery and growth, and a **strategic approach** to achieve this vision.
- Part Three identifies the specific components of a strategy driven by **investment and innovation** supported by enabling **economic policy and financial measures**.

PART ONE: Challenges and Opportunities

1.1 Challenges

The pandemic has exacerbated the risks and vulnerabilities that had been building in the global economy, and follows a decade that was characterised by reduced investment, by slowing growth of productivity, by faltering employment, by weakening social cohesion, by increasing pressure on the public finances and by accelerating destruction of natural capital. The world is consequently confronting a complex set of challenges:

- The devastating **health and social costs of the pandemic,** with the global number of reported COVID-19 cases at end-May 2021 exceeding 170 million (31% of these in the G7), resulting in over 3.5 million deaths (31% in the G7), and an additional 150 million people in the world falling into extreme poverty. Mounting hunger is further undermining population health. In 2020, the World Food Programme estimated that the number of people in low- and middle-income countries facing acute food insecurity would nearly double to 265 million by the end of the year. This builds on a worrying reversal of development since the mid-2010s, with the number of chronically undernourished people increasing by almost 60 million between 2014 and 2019. The pandemic has also **disrupted education** for 90% of the world's children.
- The **diminished prospects for economic output and employment** against a backdrop of **rising public debt**. Global output is estimated to have contracted by 3.3% in 2020 (with some countries seeing their biggest contractions on record) amidst what was already a secular slowdown in the G7 associated with declining productivity growth and weak private investment. The unemployment rate in G7 countries is projected to rise from 4.3% in 2019 to 6.7% in 2021. Global government debt rose to 97% of GDP in 2020 for the first time on record, compared with 84% in 2019, according to the International Monetary Fund.
- The rising threats of **climate change, environmental degradation and biodiversity loss,** documented by mounting scientific evidence**,** with the decade from 2011 to 2020 being the warmest on record, increasing severity of losses from extreme weather events and fires, a **loss of natural capital of over 40%** in the last three decades, and **1 million species at risk of extinction.** It is important to note in this context that climate change and environmental degradation have a much sharper impact on poor people and poor countries. Furthermore, the increasing pressure on the natural environment, through land-use change and consumption and production patterns, has been identified as a **leading driver of the risks of infectious diseases**.
- **Growing inequality** that has been exacerbated by the pandemic, with vulnerable workers hit particularly hard, including the informally employed, women, immigrants, low-wage and low-skilled workers. For example, while women hold 39% of global employment, they have accounted for 54% of overall job losses due to the pandemic, according to McKinsey. Inequality has also been exacerbated as a result of assets held by the wealthiest (mostly property and shares) rising in value, while public spending that supports the poorest has been squeezed. There has been substantial divergence between advanced economies and emerging markets and developing countries in terms of impact and capacity to respond, including uneven access to vaccines and treatments. Divergent recoveries also create the potential for unexpected policy reactions and spillovers.

Appendix 1 provides additional information on the challenges ahead in terms of economic output, employment, investment, public debt, health, human capital, poverty, inequality, greenhouse gas emissions, climate change, biodiversity, land use and water.

Forceful urgent action at scale is required to tackle both shorter-term economic, social and health impacts and to set the world on a path of **growth that is economically and environmentally sustainable over the medium and longer term**. The pandemic has highlighted, and in certain cases accentuated, a

range of distributional issues related, for example, to inequality and gender, which will need to be addressed to ensure that the path to recovery and growth is **inclusive**.

As underscored by the Intergovernmental Panel on Climate Change (IPCC), this is the **decisive decade to curb greenhouse gas emissions**. Delay is dangerous and would likely put Paris Agreement targets out of reach. Therefore the task is to identify and pursue policies and actions to achieve a **strong post-COVID-19 recovery** and to embark on the path of **investment, innovation, and structural change** to achieve **strong, sustainable, resilient and inclusive growth**.

International cooperation will be crucial and the G7 can provide leadership and momentum working in a sustained manner with the G20 and other stakeholders over the coming years.

1.2 Opportunities

This section outlines broad opportunities arising from a sustainable, resilient and inclusive recovery. As the world tackles the COVID-19 pandemic, there is a unique opportunity to realise the **growth and jobs story of the 21st century and to ensure environmental sustainability.** It will be defined by the **investments, innovation and policies** that together underpin a sustainable, resilient and inclusive recovery and growth.

Emerging from the pandemic, a range of factors support the **acceleration of the recovery and transformation** to a new global economy:

- A growing number of countries, corporates and financial institutions seek to **align their activity with the goals of the Paris Agreement,** including the setting of net-zero emissions targets
- **Public support for green action** is growing, together with increasing corporate engagement in developing green business strategies
- The financial sector is increasingly **factoring climate-related risk assessments into financing and portfolio decisions**
- The **price of electricity generation from renewable sources**, particularly solar, has **decreased sharply**
- **Innovation and technology** are expanding the range of solutions at a rapid pace, including via digitalisation and digital applications, and through the growth in AI applications to address increasingly complex issues
- Interest rates are expected to remain low over the short- to medium-term horizon, creating a **window of opportunity for investment-driven change**.

Setting the framework for opportunities

Within this context, G7 governments can steer and accelerate this transformation, driving private corporate and financial organisations to power this change. Without this impulse, the transformation would be slow and inefficient, leaving the world and future generations exposed to potentially extreme climate and environmental risks.

Reflecting the above factors, **the transition to a net-zero emissions, climate-resilient world represents not a cost or a burden but the greatest economic, business and commercial opportunities of our time.** Technical progress has contributed to reducing energy costs driven, for example, by the use of digital technologies for improving the environmental performance of industrial processes, by the management of energy demand, and by the ongoing decline of the costs of solar and wind power. This increases the range of sustainable infrastructure projects with a positive net present value driving economic value-added and growth.

The realisation of these opportunities requires fundamental **systemic change and significant investment**, together with **decisive leadership** to manage the transformation in ways that **build social cohesion** and create **greater prosperity and well-being for all**. These are described in Part Three of this report.

In 2018, the Global Commission on the Economy and Climate, and its flagship New Climate Economy project, published its landmark report, *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*. The report highlights that, "We are on the cusp of a new economic era: one where growth is driven by the interaction between rapid technological innovation, sustainable infrastructure investment, and increased resource productivity. This is the only growth story of the 21st century. It will result in efficient, liveable cities; low-carbon, smart and resilient infrastructure; and the restoration of degraded lands while protecting valuable forests. We can have growth that is strong, sustainable, balanced, and inclusive."

The report further notes that, "**The next 10–15 years are a unique 'use it or lose it' moment in economic history**. We expect to invest about US$90 trillion in infrastructure to 2030, more than the total current stock. Ensuring that this infrastructure is sustainable will be a critical determinant of future growth and prosperity. The next 10–15 years are also essential in terms of climate: unless we make a decisive shift, by 2030 we will pass the point by which we can keep global average temperature rise to well below 2°C."

Furthermore, the report estimates that, "Transitioning to this low-carbon, sustainable growth path could deliver a direct economic gain of US$26 trillion through to 2030 compared to business-as-usual." It also finds that taking ambitious climate action could generate over 65 million new low-carbon jobs by 2030, equivalent to today's entire workforces of the UK and Egypt combined, as well as avoiding over 700,000 premature deaths from air pollution compared with business-as-usual.

This historic growth opportunity is acknowledged in the stimulus and recovery packages of individual G7 countries:

- **Canada** launched in December 2020 its strengthened climate plan *A Healthy Environment and a Healthy Economy*, to "create jobs and support people, communities and the planet". Its Budget 2021 "proposes to provide CAN$17.6 billion towards a green recovery that will fight climate change, reduce pollution, invest in world-leading clean technology, protect nature, and create good middle class jobs".
- **The EU** launched its Green Deal before the pandemic, and in 2020 formulated Next Generation EU as a new €750 billion recovery instrument including the strengthening of the Just Transition Fund to address the distributional impact of policies and assist Member States in accelerating the transition towards climate neutrality. EU expenditures will have to comply with the EU's 2050 climate neutrality objective, the EU's 2030 climate targets and the Paris Agreement, with 30% of total expenditure from the multiannual financial framework 2021–2027 and Next Generation EU targeting climate-related projects. This will be complemented by a regulatory and taxation framework to meet the 55% carbon emissions reduction target by 2030.
- In **France**, the ecological transition accounts for one third of its €100 billion recovery package, mainly allocated to energy efficiency in buildings, enhancement of the railways and hydrogen R&D in aviation and maritime transport.
- **Germany**'s €130 billion package includes over €50 billion for investment in future-proof and green technologies with a focus on the transport sector and the development of green hydrogen production as a key component of the energy transition.
- **Italy**'s €221.5 billion Recovery Plan was approved by the government in April 2021 with 30% allocated to the ecological transition and another 13% to support infrastructure for sustainable mobility.
- **Japan** adopted the 'Comprehensive Economic Measures to Secure People's Lives and Livelihoods toward Relief and Hope' worth $700 billion to contain COVID-19, promote structural change and positive economic cycles and secure safety and relief with respect to disaster management. Specific measures include $19.2 billion for a fund to promote carbon neutrality by 2050, and $9.6 billion to accelerate the digital transformation.

- The **United Kingdom** launched its Ten Point Plan for a Green Industrial Revolution in November 2020, mobilising £12 billion of government investment, and potentially three times as much from the private sector, to create and support up to 250,000 green jobs.
- Through an Executive Order on 27 January 2021, **United States** President Biden set a range of specific measures "putting the climate crisis at the centre of the United States foreign policy and national security". The US Administration introduced a $2 trillion infrastructure plan which includes significant investment in electric vehicle incentives, electric grid and clean energy, public transit, railways and water systems with dedicated investments to enhance infrastructure resilience to climate change impacts.

The world has already committed to ambitious **Sustainable Development Goals** (SDGs) for 2030, and a growing number of countries are setting **net-zero emissions targets** for their greenhouse gas emissions. These targets are mutually reinforcing and provide a **strong signal to markets and businesses** to align their strategies and investments with the SDGs and the Paris Agreement goals. Businesses are already taking advantage of opportunities and working together to accelerate action. Momentum is building. The SDGs and bold climate action can be **principal drivers of investment and innovation** in the decades ahead, providing better jobs and driving profits. There is increasing recognition that change, which might have looked difficult or impossible a few years ago, is not only achievable but also full of reward for individuals, businesses and society.

To date, **132 countries have net-zero emissions goals** that are reflected in law, in proposed legislation, in policy documents or are under discussion. Among the G7, the UK has adopted a **legally binding net-zero emissions target** by 2050 and a target reduction in greenhouse gas emissions of 78% by 2035 relative to 1990. The EU has also set a legally binding net-zero emissions target by 2050 with a net greenhouse gas emissions reduction target of at least 55% by 2030 relative to 1990. Japan has announced a net-zero emissions target by 2050 while in April 2021 the US announced a carbon emissions reduction target of 50–52% by 2030 relative to 2005. Both Canada and Japan further strengthened their 2030 carbon emissions reduction targets in 2021.

Major G20 countries have also emphasised the need to remain focused on the climate challenge while addressing the pandemic. President Xi of China stated in September 2020 that China will peak emissions in 2030 and reach carbon neutrality by 2060. He then announced in December 2020 that China would seek to reduce emissions per unit of GDP by at least 65% by 2030 compared with 2005 levels. At the April 2021 Leaders Summit on Climate, President Xi stated that China will gradually reduce its coal use from 2025.

Prime Minister Modi of India stated during the G20 meeting in November 2020 that, "Today, we are focused on saving our citizens and economies from the effects of the global pandemic. Equally important is to keep our focus on fighting climate change. Climate change must be fought not in silos but in an integrated, comprehensive and holistic way." India is expected to reach its goal of generating 175 GW of renewable energy before the target date of 2022 and has a 450 GW target by 2030. It also aims to restore 26 million hectares of degraded land by 2030.

In the G20, Korea and South Africa aim to achieve net-zero emissions by 2050 with Argentina and Mexico, both part of the UNFCCC Climate Ambition Alliance, working towards net-zero emissions by 2050.

Innovation

Clear targets provide a strong impetus for technological innovation and enhanced productivity. This is achieved both through the **accelerated deployment of existing proven technologies**, as in the case of energy efficiency, and the **development of new technologies** which allow, for example, to significantly decrease the carbon footprint of 'hard-to-abate' sectors.

Technological innovation is highlighted across a range of important initiatives. For example, the Mission Possible Partnership is developing initiatives including the public and private sectors to enable industries to achieve net-zero CO_2 emissions by mid-century in aviation, circular cars, heavy-duty road transport, shipping, aluminium, chemicals, cement and concrete, and iron and steel. This partnership builds on work by the Energy Transitions Commission which develops transition roadmaps to net-zero emissions

and specific recommendations for their implementation. Bill Gates's recent book *How to Avoid a Climate Disaster* highlights the crucial importance of accelerating green technology innovation. A recent PwC report shows that venture capitalists invested $60 billion in over 1,200 climate technology start-ups between 2013 and 2019 – an 84% compound annual growth rate (PwC, 2020).

Technological innovation can bring major benefits in environmental and financial terms. For example, CDP reports that energy consumption per tonne of steel over the last 30 years has decreased by 50%, with steel companies reporting low-carbon investments between 2012 and 2013 with an average internal rate of return (IRR) of almost 25% and average annual carbon emissions reductions of around 7 million tonnes in both developed and emerging economies. CDP further finds that, "globally, the average IRR for improving the energy efficiency of industrial processes is 23%. In the US, where this is the biggest source of emission savings, companies make a much higher return of 81%."[1]

It is relevant to note that **technological innovation is occurring in both developed countries and in emerging markets and developing economies (EMDEs)**. For example, while LKAB of Sweden is planning to invest €46 billion in emissions-free steel production through its HYBRIT project (Blank, 2020), Vale of Brazil has acquired a Brazilian pig iron technology company to reduce CO_2 emissions from the pig iron production process (Madsen, 2011). LKAB will use hydrogen instead of coal as the reducing agent whereas Vale estimates that using 100% biomass with the new technology could lead to a zero-emissions pig iron production process.

The private sector is increasingly aware of the major opportunities arising from the transition to a net-zero, climate-resilient resilient economy. Goldman Sachs considers: "the transition towards a low carbon economy [is] an extraordinary opportunity for our clients to define and participate in a global energy market in transformation. This market is poised to become one of the largest global emerging markets and is critical to securing a more sustainable future" (Goldman Sachs, 2010).

Cities play an increasing role in the development and implementation of actions supporting a sustainable, resilient and inclusive future. They are key to the achievement of the SDGs and provide a broad range of opportunity in terms of economic and environmental impact. Recent analysis across the close to 100 cities of the C40 network estimates that a green and just recovery from COVID-19 could create over 50 million jobs, reduce greenhouse gas emissions by more than half, decrease air pollution by as much as 29% and prevent over 270,000 premature deaths over the next decade (C40 Cities, 2021).

Market development opportunities

A recent report from the International Finance Corporation (IFC) estimates that COVID-19 recovery funding focused on **10 low-carbon investment areas in 21 emerging markets could generate investment opportunities of $10.2 trillion**, creating 213 million jobs and reducing greenhouse gas emissions by 4 billion tons by 2030 (IFC, 2021). Investment areas cover the decarbonisation of existing and future infrastructure, support to climate-smart cities and the transition of key industries to greener production.

In a survey by CDP of the 215 biggest global companies, **climate business opportunities were estimated at $2.1 trillion**, most of which are highly likely or virtually certain, with a potential value almost seven times the cost of realising them (CDP, 2019). **Financial companies forecast $1.2 trillion in potential revenue from low emissions products and services.** The survey also showed that these companies report almost $1 trillion at risk from climate impacts, many of which were expected in the five years following the survey (from 2019).

An illustration of the potential market opportunities arising from the transition to net-zero emissions can be found in the electric vehicles (EV) market. The global number of EVs increased significantly over the decade from 2010, from a very low level of 17,000 vehicles in 2010 to 7.2 million by 2019. EV sales reached 2.1 million in 2019, accounting for 2.6% of global car sales. Only five countries in the world had an EV stock share over 1.5% in 2019 (with Norway at 13% and China at 1.6%), which indicates considerable market development potential.

[1] CDP analysis in We Mean Business Coalition (2014).

The International Energy Agency (IEA) has developed two EV market development potential scenarios to 2030. In the 'Stated Policies Scenario' based on current and announced policies, the EV sales share is projected to reach 30% in Europe, the UK and Canada and 20% in Japan. The share is projected at 35% in China and 15% in India. **In the 'Sustainable Development Scenario', which assumes sharp reductions in emissions of air pollutants and alignment with the Paris Agreement goals, the EV sales share is projected to reach close to 50% in Europe and the UK, 30% in the US and 40% in Japan, China and India** (IEA, 2020a).

The average sales-weighted lithium battery price decreased from $1,100/kWh in 2010 to $156/kWh in 2019. The 2019 Battery Price Survey by Bloomberg New Energy Finance (BNEF) predicts that EVs will be reaching price parity with internal combustion engine vehicles globally by 2024. Once this is achieved, the above projections may be exceeded as EVs could quickly account for a high share of new sales. In Norway, where a government incentive programme has closed the cost parity gap, the EV share of sales is already 50% (Transport and Environment, 2020). Once a tipping point is reached, the consumer shift can be exponential. In the Netherlands, the Battery EV (BEV) share of new sales shot up to 70% in December 2020 compared to an average of 20% during 2020. Other countries are following a similar trajectory, with the share of new sales rising from an average of 17% during 2020 in Germany and the UK to 14% and 17% respectively in December 2020 (Mock et al., 2021). Recognising the exponential nature of this shift, forward-leaning market forecasters such as BNEF continually correct and increase their projections.

Beyond vehicles, the development of the EV market is also associated with **significant growth in charging infrastructure and automotive battery production**. The number of private charging points is projected to grow from 6.4 million in 2019 to 135 million under the IEA Stated Policies Scenario and 240 million under its Sustainable Development Scenario. The number of publicly accessible charging points is projected to grow from 0.87 million in 2019 to 11 million and 21.2 million under the respective scenarios.

The above market development prospects are reflected in the EV development plans of major car manufacturers:

- BMW Group targets 15–25% of its sales to be EVs in 2025 with 13 new EV models by 2023
- Daimler targets 25% of group sales to be EVs by 2025 and over 50% by 2030
- Ford announced that all its cars on sale in Europe will be electric by 2030
- General Motors intends to phase out gasoline- and diesel-powered vehicles globally by 2035
- Renault plans 12 new EV models and 20% of the brand's sale by 2022 to be fully electric
- Toyota targets sales of 5.5 million electrified vehicles around the world, including more than 1 million zero-emission vehicles (battery electric and fuel cell electric vehicles) by 2030
- Volvo targets 50% of group sales to be fully electric by 2025.

Opportunities arising from the transition to a low-carbon and resilient economy are present across regions of the world and across economic sectors. Section 3.2 of this report covers a range of investment opportunities across sectors in G7 countries and EMDEs.

The G7 Summit in Carbis Bay offers a unique opportunity for the G7 to take bold action to 'build back better'. The large gains to be had from determined action, however, do not imply that the task is easy. If the world fails to seize this opportunity, the dangers and fragilities of the old economic model that were mounting before the COVID-19 crisis will become ever more severe. There could be a lost decade for development in poor countries and weak or stuttering recovery and growth in the world as a whole.

This is therefore a **special moment in history**, offering the chance, indeed duty, for the G7 and the world to lead **a global, coordinated recovery, driven by sustainable investment and innovation by both the private and public sectors**.

PART TWO: Vision and Strategy

2.1 Vision

This section defines the main elements of a proposed **three-year G7 vision to drive a strong and sustained global recovery linking growth, resilience, inclusiveness, and environmental sustainability**. It is prepared as an overarching and strategic contribution to the 'Carbis Bay Action Plan' being developed by the G7.

Seven decades of growth since the Second World War saw output per head multiply by around four and population by around three, with overall output increasing around 12 times, largely fossil-fuelled. The scale of environmental damage has been immense in terms of climate, biodiversity, oceans and pollution. Natural capital has been radically reduced. On the other hand, poverty has fallen sharply and life expectancy has risen by around 30 years.

Much has been learned about rising incomes and life expectancy and their causes, in terms of public policy and investment climate, investment in physical and human capital, the role of the private sector, and internationalism. Furthermore COVID-19 shows that environmental degradation, global linkages and population density make pandemics more likely.

The world now faces two intense crises, COVID-19 and the associated economic and social stress, and the environment in terms of climate and nature. Both require urgent and strong action. Long-term unemployment, loss of education and damage to health from COVID-19 could have profound implications, economically, socially and politically. The debt stress is intense for many developing countries, with the world risking a lost decade for development. If strong action on climate is not taken in this decade, the world could be headed for a temperature increase of 3°C or more with the devastation, existential for many, this could bring. Furthermore, the economic model of the last decades has also generated increasing inequality and precariousness which need to be reversed to build economic and social resilience. This has been further accentuated by the impact of the pandemic.

Considering the nature of the crises at hand and lessons learned, the world cannot go back to the 'old normal' and the future it is leading to. It is dangerous, fragile and polluted. And it has undermined social cohesion.

Accordingly, the world must act forcefully on **four interrelated priorities** to overcome the impact of the COVID-19 crisis and set a path to sustainable, resilient and inclusive growth:

- Overcoming the pandemic and strengthening **health** systems
- Restoring **economic growth and delivering the jobs of the future**
- Confronting inequality and fostering **social cohesion, inclusion and gender equality**
- Tackling at scale the immense threats of **climate change, biodiversity loss and environmental degradation.**

Much will be shaped by governments, but the private sector will be critical to the response to all four priorities.

An integrated vision

Pursuing these interrelated priorities will require major initiatives and action at scale, with urgency, and in an integrated and well-coordinated way. Given the growing COVID-19 crisis in many emerging market and developing countries, international cooperation is first and foremost required to ensure a timely, effective and global roll-out of vaccines and treatments, based on principles of common humanity, mutual responsibility and self-interest. Unless this is achieved, the likely development of virus variants will prolong the pandemic and delay the shift to recovery. As the communiqués of the Development Committee, International Monetary and Financial Committee (IMFC) and G20 Finance Ministers all stressed in April 2021, strong international cooperation is needed "to accelerate vaccine production and

support affordable and equitable distribution to all", including "support to the work of the World Health Organization, the Access to COVID-19 Tools (ACT) Accelerator collaboration, and its COVAX Facility." An immediate priority is closing the $20 billion funding gap of COVAX and providing adequate support to developing countries so that effective vaccines and treatments are available everywhere no later than the end of 2022.

There has been a much better understanding in the last few decades of the meaning of well-being and of a more cohesive society. These key dimensions of development are embodied in the **Sustainable Development Goals (SDGs)** agreed by more than 190 countries at the UN in 2015. They embody: income, employment and good health; education; environment (including climate, water, oceans, biodiversity); reducing inequalities, including gender; peace, security and co-operation. They are a significant advance, in terms of sustainability in particular, on the Millennium Development Goals adopted in 2000, which were themselves a major advance over a narrow GDP focus. These overarching notions of well-being, development, a good society and sustainability are the guides to set a vision for a better world with data being collected to chart progress on the key dimensions of these goals.

The definition of sustainability is for each generation to offer to the next generation opportunities at least as good as they benefited from. These opportunities depend on the assets created and left from one generation to another. It is helpful to think of these assets in terms of **human, physical, natural and social capital**. Human capital is focused on health and education, natural capital on environment, climate and biodiversity. Social capital refers to the strength and quality of institutions, trust, social cohesion and (in)equalities. These forms of capital are integrated across all of health, employment, income, security, trade and technology. Advances or regress on one will benefit or damage the other. They are **integrated across geographies, reflecting rising mutual dependency, and require an integrated response**.

As the UK Prime Minister Johnson has underscored: *"We cannot stop climate change without protecting the natural environment and we can't restore global nature without tackling climate change."* And pandemics cannot be tackled without acting on climate and the natural environment. Critical for recovery and transformation and for effective action on climate and biodiversity will be sustainable infrastructure, both physical and natural. The productive use of global savings, the job opportunities created and investments in health and education will be drivers to reduce inequalities of all kinds, including income, geography, gender, health, education and so on.

Accordingly, at the heart of our proposed vision for the economic response to the pandemic is a coordinated global programme of investment for recovery, reconstruction, and transformation that can boost all forms of capital – human, physical, natural and social. This programme of investment aiming at supporting a global green recovery through the development of sustainable infrastructure, the preservation and restoration of nature, and a greater focus on innovation and skills, can provide strong economic multipliers to increase activity and jobs in the shorter run, and unleash discovery and productivity growth in the medium term. It constitutes **the only credible path to longer-term sustainable growth that can deliver for people and the planet.** It is indeed the growth story of the 21st century.

That programme will be **inclusive** in its new job opportunities and stronger growth, in its attention to the management of change, in its reduced waste and pollution, and in its internationalism. And the growth and revenues it generates will enable the strong investment in education and health that are central to justice and well-being.

Investments in physical and natural capital are the immediate focus of this strategy for sustainable recovery and growth, but they are interrelated with and not separate from efforts to improve human and social capital. The strategy embodies and enables actions on these issues. Thus, **education and health** are crucial priorities for the fiscal space created within a medium-term framework, and for policies to incentivise private investment. Investment in health systems will be vital for managing and containing the future impacts of COVID-19 and relaunching the economy. **Retraining and the learning of new skills** are both necessary to create and drive an enhanced knowledge economy and innovation, and to managing dislocation arising from structural change. Further complementary work should be undertaken to identify specific actions in education and health, including a focus on skills development and innovation to support the proposed path to sustainable recovery and growth.

The investments and innovations necessary for the recovery and rebuilding will require a **substantial increase in the investment rate**. To both raise growth and accelerate the drive to net-zero emissions, global investment needs to be **increased and sustained above pre-pandemic levels by around 2% of GDP p.a.** (see section 3.1). The increase in investment rate in low-carbon solutions does not imply higher overall costs as higher upfront investments in sustainable solutions are often associated with lower operating costs.

Reflecting their increasing economic role and rising environmental footprint, a **renewed emphasis should be placed on the role of cities** as key implementing actors both in terms of climate action and management 'on the ground' of a just transition. This will require engagement both from national governments and cities, as described in the work of the Coalition for Urban Transitions (2019). Furthermore, a strong involvement of cities will provide a connection between G7 actions and the daily lives of citizens to breathe, work and move in cities across the world.

A global vision

Acting together, based on a shared vision and strategy, will be crucial in an interconnected world. Strong international cooperation around stimulating demand for goods and services, technology and finance is an integral part of this vision. By acting together the world will benefit from stronger demand expansion and investment recovery, economies of scale, learning by doing, lower costs for new technologies and the necessary collective actions on climate and biodiversity that are urgently needed. The returns to **collaboration and innovation are uniquely powerful** at this moment in history, with high unemployment following the pandemic, the need to ensure global access to vaccines, the risk of a lost decade of development, and the threats of climate change, biodiversity loss and environmental damage.

As mentioned by Prime Minister Johnson in the run-up to the Carbis Bay G7 Summit*: "As the most prominent grouping of democratic countries, the G7 has long been the catalyst for decisive international action to tackle the greatest challenges we face."* G7 countries have strong resources, skills, R&D and innovation and policy and analytical strengths. Their actions together, on real scale, serve as powerful examples. They are major shareholders in the leading international institutions and thus crucial in shaping their strategies and capacities. Together the world can build a new form of growth and development that is far more attractive than what went before. But this requires investment across a whole range of activities and across the globe. Recovery, growth, innovation, climate and environmental benefits all will be much stronger if the world acts together.

Accordingly, while this action agenda is primarily focused on the G7, it is important to consider the **implications for emerging markets and developing countries** (EMDEs), including working with the G20. EMDEs have accounted for about 75% of global growth over the past decade and were key drivers of the global recovery in the aftermath of the 2009 financial crisis. This time around these countries are much more constrained in their ability to embark on recovery programmes and long-term transformation. There is a major risk of a lost decade for much of the developing world, which would be deeply damaging for them and the world economy and environment.

Given their importance in future global investment and population, and the future of well-being and environment for all the people on the planet, it is imperative that **EMDEs are also creators of and fully share in the new growth agenda** and, further, that they have the means to adopt similarly ambitious investment and transformation programmes. **The G7 working with the G20, and in partnership with the UN and the international financial institutions, should set out a new global investment programme.** Some have referred to this type of programme as a Marshall Plan for our times. It shares with the original plan a core of international collaboration and investment at scale, particularly infrastructure, to drive recovery and revive growth. It is different, however, in that this time investment and action must be truly global and that the world is multi-polar, much more integrated, including digitally, with much more advanced technology and investment primarily driven by the private sector.

The G7 can create a grand bargain for the world which can, if the world acts together and sustains its efforts, deliver the four wins of rapid recovery in health and economics, stronger growth for this decade, innovations and lower-cost technologies for a sustainable future, and tackling the immense threats from climate change, destruction of biodiversity, and environmental damage. Failure on any one dimension will weaken progress on the others.

Reflecting the significant shift involved, the vision highlights the importance of structural change, technological innovation, entrepreneurship and managing a just transition, recognising the fragility, inequities and dangers of the old model. **Not moving forward on implementing this vision is costly and risky** as, for example, the types of jobs generated during the 19th and 20th centuries will become increasingly insecure (stranded jobs will accompany stranded assets). The drivers of action are clear. **Urgency and scale are of the essence. Delay is dangerous**.

Ambition will be less risky and yield far greater returns than caution. But strong progress will require decisive leadership. The G7 has the opportunity now to chart a clear course of action for the next three years, working closely with the Italian G20 Presidency and reaching out to the G7 and G20 presidencies that will follow in 2022 and 2023. **2021 can be a turning point towards a more prosperous and sustainable future.**

2.2 Strategy

Taking account of the vision to address the challenges and build on the opportunities ahead, this section outlines a strategy to tackle both the short-term impact of the COVID-19 economic and employment crisis and the challenges arising from the climate and biodiversity crisis. **This strategy sets up a framework for action over the next three years for consideration by the G7 to track progress, support implementation and make adjustments where necessary.**

The **immediate emphasis must be placed on collaboration around health** (vaccine, treatment, equipment, testing), both to reduce the toll on families and individuals, and to set a path to recovery as quickly as possible.

Beyond this immediate emphasis, it is important to **further enhance the green component of stimulus and recovery programmes**. Accordingly, the strategy is oriented to drive the recovery and the growth of employment with a particular focus on jobs supporting the transition to a low-carbon economy and environmental protection and resilience. Private sector investment and finance need to be engaged and play a vital role. As mentioned in section 1.2, a number of countries, including G7 countries and the European Union Member States, have already included important green objectives and components in their stimulus and recovery programmes.

In the **longer term,** the strategy is about **positioning the world on the trajectory to a net-zero emissions and climate-resilient economy** by 2050 **while arresting environmental degradation and restoring natural capital.** Well designed and implemented, such a strategy would promote inclusiveness and social cohesion and strengthen human and social as well as natural capital, while ensuring growth with long-term environmental sustainability.

The task now is to move from rescue to sustained economic recovery. A clear and coherent strategy for coordinated action to 'build back better' includes the following six components, which drive the **scale and quality of the investment programme**:

1. **Anchoring plans for growth and investment strategies in the SDGs and environmental sustainability (drive to net-zero emissions, climate adaptation/resilience and nature/biodiversity targets), starting with a strong and coordinated green recovery.**

All G7 members have now committed to net-zero emissions of greenhouse gases by 2050, and all have increased ambition on commitments on emissions targets by 2030 at President Biden's Leaders Summit on Climate and the Major Economies Forum on Energy and Climate. The G7 should lead an ambitious global commitment to net-zero emissions of greenhouse gases by 2050, working in synergy with the G20, which includes other major emitters, among them China, India and other emerging markets and developing economies. The G7 can lead in setting out long-term strategies towards this collective goal, and in putting in place **credible pathways to meet stepped-up commitments**. This must include: the **preparation and submission of well-specified nationally determined contributions (NDCs) ahead of COP26;** putting in place **sufficiently strong and green recovery programmes** for delivery; and recognising the dangers from attempts to 'backload' action. G7 countries should also set out **climate adaptation/resilience and nature/biodiversity strategies**. The valuation of natural capital must go beyond its contribution to carbon sinks and reflect the full range of associated environmental, health and

economic benefits. Of special importance to a sustainable future will be the G7 contributions in support of the most vulnerable countries and those with the greatest endowments of natural capital (see section 3.5).

2. Scaling-up quality investments to boost output and jobs in the short term and positioning the world on a new growth trajectory consistent with the above targets.

Such investments in sustainable infrastructure and natural capital will be critical for economic recovery and transformation, and for action on climate, biodiversity and environmental degradation. Particular attention needs to be given to establishing **policy frameworks that unlock investments in sustainable infrastructure**, create market opportunities for **private sector** investment and finance, promote **gender equality**, and support a **just transition** to a net-zero emissions and climate-resilient economy. Significant opportunities can be found across all sectors, but **particularly energy, buildings and transport**.

3. A supportive but prudent macroeconomic framework that enables fiscal stimulus for the recovery and a strong increase in investment, while at the same time responsibly managing debt and deficits over the medium term.

These aims can and should be mutually supportive, with **investment of the right quality and scale** driving growth, jobs and public revenues, and **confidence in medium-term fiscal responsibility** supporting investment. Fiscal policy, on both the revenue and expenditure sides, can promote sustainability and inclusion, and boost investment in all forms of capital. There is significant scope to boost fiscal revenues everywhere through international tax cooperation. Responsible public finances require particular care in managing debt levels, as well as in the proper use of debt with current low interest rates in G7 countries providing an opportunity both to drive investment and growth.

4. Structural policies that set expectations and a clear sense of direction. This must include making faster progress on carbon pricing, phasing out fossil-fuel subsidies, introducing supporting regulations that accelerate the drive to net-zero emissions, valuing natural capital, and building climate and environmental resilience into all policies.

Public policy can foster R&D and innovation and work with markets to accelerate the technical progress needed to achieve climate targets. Labour market and other policies to foster a **just transition** to a net-zero emissions and climate-resilient economy will also be crucial as rapid change will involve dislocation, in both production and consumption, requiring investment in and support for people and places. The changes embodied in the strategy are often necessary and beneficial, but active policy is required to secure the skills and jobs necessary for the 21st century economy. This means supporting workers in acquiring new skills to enable those affected by change to participate in the new economy. Renewed global cooperation on a trade system that is perceived to be fair and that eliminates barriers to shared environmental solutions will be critical for recovery and sustained transformation.

5. The realignment of the financial system to support sustainable growth, climate action, and responsibilities towards the environment and biodiversity.

Private finance is moving in this direction and will be a powerful force for change. The financial system must work to deliver the right kinds of finance rapidly, on the right scale and in the right place, with a clear and transparent assessment of risks. This includes the quantification of corporate and sovereign exposure to zero-carbon transition and climate risks.

6. An urgent, concerted and enhanced international effort to tackle the debt, fiscal and financing constraints of emerging market and developing countries.

Low-income countries, including fragile and conflict-affected states, have been severely harmed by the pandemic and are the most vulnerable to the impacts of climate change, biodiversity loss and environmental degradation. G7 leadership will be critical to the resolution of the debt difficulties of poor and vulnerable countries, to the **delivery of the $100 billion per annum climate finance commitment by developed countries** under the United Nations Framework Convention on Climate Change, and to the scaling up of support from the international financial institutions. Multilateral development banks working with the private sector can play an important role in both **unlocking investment opportunities** and mobilising the finance needed. Low interest rates and 'secular stagnation' **signal that there are more than enough global savings to finance the needed investment.**

A clear connection should be established between the **G7 summit and COP26.** The setting of a strong basis for a sustainable recovery by the G7 will provide a crucially supportive context to an ambitious outcome from COP26. Progress at COP26 will accelerate the transformation to a zero-emissions and climate-resilient economy. **COP26 must be a landmark** in international decision-making and cooperation.

While the transition to a net-zero emissions and climate-resilient economy brings a broad range of economic and environmental benefits, there are **risks and challenges** that need to be understood, addressed and mitigated. For example, governments should avoid the risks of 'picking winners' and instead focus on **creating the enabling environment for innovation**. This includes, for example, providing backbone infrastructure, such as transmission grids, and signalling and establishing demand for solutions that contribute to the creation of new markets, such as alternatives to the internal combustion engine, cleaner and more efficient cooling and heating, and environmentally-friendly agriculture. Furthermore, dislocation challenges resulting from the shift from fossil fuels to zero-carbon energy will require particular attention and a focus on a just transition. The **distributional impacts** of policies related to the transition need also to be carefully understood to ensure equity in terms of both who bears the costs and who accesses the benefits of zero-carbon solutions.

As reflected in the vision outlined in section 2.1, **international collaboration needs to support and drive the development and implementation of the above strategic components**. This applies both across G7 nations and between the G7 and emerging markets and developing economies, considering both their contribution to global economic growth and their central role in getting to a net-zero emissions, climate-resilient world. Where lower-income countries do not have the necessary fiscal space to implement investment programmes for recovery and sustainable growth, the agreed IMF Special Drawing Rights (SDR) issuance should be allocated in line with needs, and debt situations tackled under the Common Framework agreed by the G20 (see section 3.5.2).

Much of the action in this strategy will be greatly enhanced by, or require, **more effective use of international institutions**, which must be enabled to act on the necessary scale. They will be crucial catalysts and vehicles in building a better world. On the whole, the overall international institutions architecture is sufficient and there is no need to create additional institutions. However, if the required recovery, transformation and growth are to occur in time and at scale, international institutions must be significantly strengthened and used much more effectively. Restoring confidence in and resources for the WHO will be crucial to the management of the COVID-19 pandemic, to the reduction of the probability and intensity of further pandemics, and to their management when they occur. The WTO must be strengthened and once again be the place for enabling world trade.

The MDBs and DFIs are vital institutions for **generating the necessary finance for investment in emerging markets and developing economies**. The IMF is key to driving forward a new form of growth as it has rightly stressed climate and infrastructure as macro-critical. **These institutions must work more effectively as a group to build strategic country platforms for investment and strengthen markets and the investment climate. They must prioritise sharing and managing risk with the private sector – thus greatly increasing their 'multipliers', with sustainable infrastructure being a strategic focus.**

Investing in international institutions is crucial to the recovery and building a better world. This is the moment for a grand bargain with the MDBs. Shareholders should be ready to expand their ability to finance and lend in exchange for much stronger collaboration and focus on private sector multipliers. Shareholders in multiple MDBs can play a key role related to specific actions outlined in section 3.5.2.

PART THREE: Investment, Policy and Finance

As described in section 2.2, the overall strategy includes:

- A **focus on sustainable infrastructure investment,** both to catch up on maintenance and improvement and to accelerate the transition to a net-zero emissions, climate-resilient economy.
- A **programme of specific green investments and policies** for recovery and transformational growth to support an effective transformation to a net-zero emissions, climate-resilient economy and to protect nature and biodiversity.
- A **macroeconomic framework,** including a fiscal stance that **will enable a significant step-up of public and private investments**, while **setting a medium-term framework for fiscal sustainability.**

Reflecting this investment-driven strategy for a sustainable, resilient and inclusive recovery and growth, the following topics are addressed in this part of the report:

- Section 3.1 examines overall **investment trends** both over time and across forms of capital.
- Section 3.2 identifies **specific investment action areas** that can drive recovery, promote strong and resilient growth and set the world on a net-zero-carbon trajectory.
- Sections 3.3 and 3.4 describe a set of **supportive macroeconomic and structural policies** that enable the investments and reshape economic incentives.
- Section 3.5 sets out a range of **financial measures** to support the proposed investment-driven strategy.

Building on the analysis and recommendations in sections 3.1 to 3.5 and in Appendix 2, a summary of key specific actions is provided at the beginning of each of the above sections, starting with section 3.2. These actions are provided as an input to the preparation of the G7 Carbis Bay Summit. They include both proposals that are understood to be already under consideration and proposals arising from the work contained in this report.

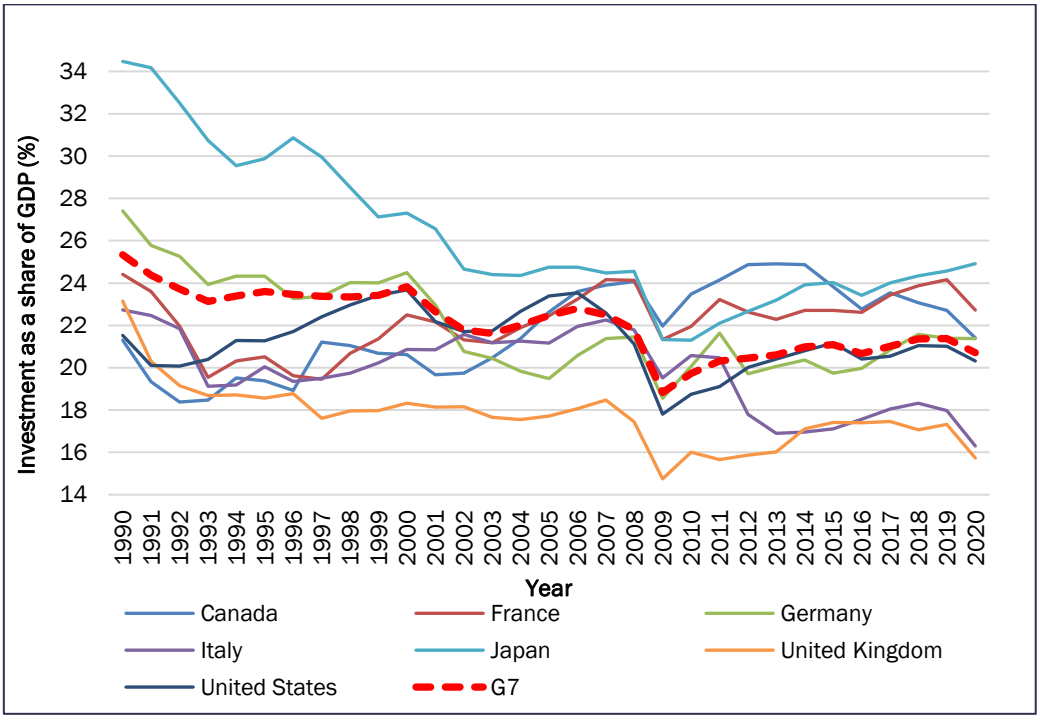
In line with the vision outlined in section 2.1, these proposals could be considered for G7 follow-up and implementation over a period of three years, including an articulation with the G20 on specific themes. The strategy laid out in this report also provides a strong basis for the upcoming COP26.

3.1 Global investment imperative to 2030

3.1.1 The investment imperative

For the recovery to be sustained and strong, it must be driven by investment. In G7 countries, with the exception of Canada where there has been heavy investment in the resource sector, there is a **long-term trend of decline in total investment as a share of GDP** (Figure 3.1). As there is a positive correlation between GDP growth and the investment ratio over the past three decades (Figure 3.2), this decline may have undermined productivity and growth.

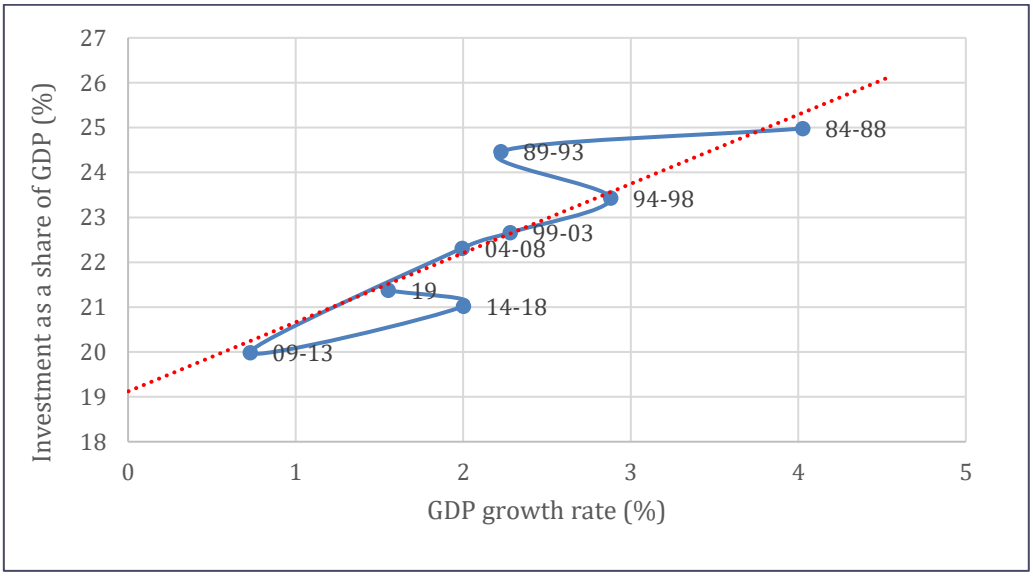
Figure 3.1: Investment rates G7 countries, 1990–2020



Note: 2020 values are estimates. Investment is defined as Gross Fixed Capital Formation.
Source: International Monetary Fund, World Economic Outlook Database, October 2020

The long-run trend decline in the investment ratio partly reflects a measurement issue – lower relative prices of investment goods. Prices of IT equipment have risen much less than the GDP deflator, while the IT share of total investment (in volume terms) has risen (Morkunaite and Huefner, 2014). However, the real investment rate in non-residential structures still exhibits a long-term downward trend, partly reflecting a **decline in public infrastructure investment** (Dobbs et al., 2010).

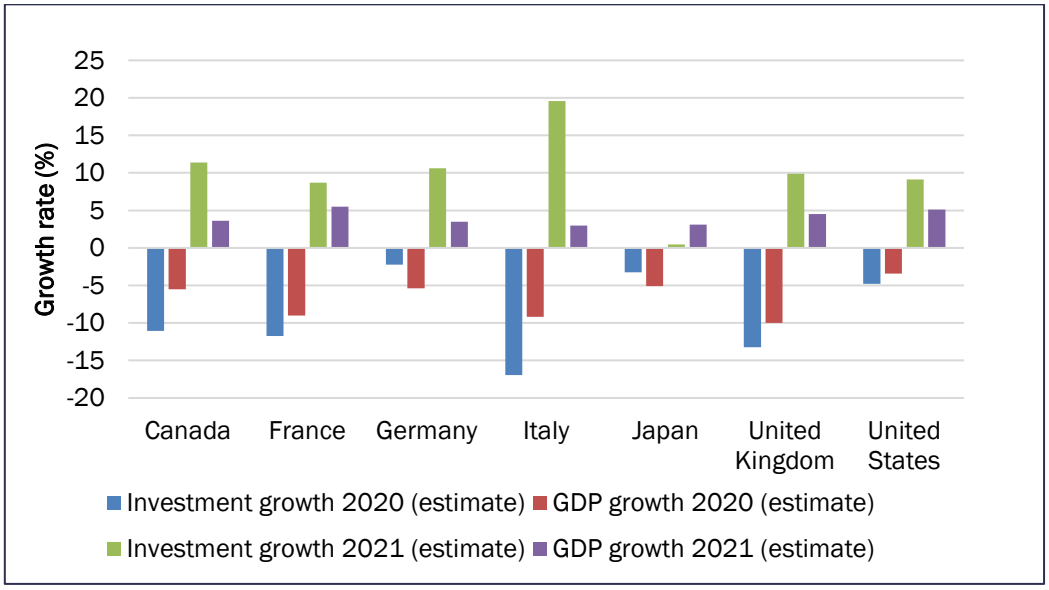
Figure 3.2: G7 investment vs. GDP growth, 1984–2019



NB: Investment and growth rates shown as five-year averages, except for 2019.
Source: International Monetary Fund, World Economic Outlook Database, October 2020

Investment decreased sharply in 2020 due to the pandemic (Figure 3.3), declining by more than GDP in the G7 as an aggregate. Investment is projected to recover more strongly than GDP in 2021 in most G7 countries.

Figure 3.3: Investment and GDP: COVID-19 hit and projected recovery, 2020 and 2021



Sources: International Monetary Fund, World Economic Outlook Database, October 2020 and International Monetary Fund, World Economic Outlook Update, January 2021

Given the long-term reduction in investment, and the additional decline in 2020 due to COVID-19, it is now important to ensure that **investment levels are restored to pre-pandemic levels, and then increased still further** for the augmentation and transformation of all forms of capital. In our assessment, to both raise growth and accelerate the drive to a net-zero emissions and climate-resilient economy, global investment needs to be **increased and sustained above pre-pandemic levels by around 2% of GDP p.a. over this decade**. This calculation takes into account several factors, all of which point to increases of similar orders of magnitude:

- First, **investment growth had been on a secular decline** since the global financial crisis of 2008–09, in both advanced economies and EMDEs, and the investment rebound following the collapse in 2020 is expected to be much weaker in 2021 than in 2010.
- Second, there has been a **persistent gap in infrastructure spending** – key to both growth and transformation – in both developed and developing economies that has been estimated at 2–3% of global GDP.
- Third, as documented in the main report and summarised in Appendix 2, there are **significant opportunities for scaling up sustainable investments** to accelerate the transition to a low-carbon and climate-resilient economy and restore natural capital. This 2% p.a. increase would enable the investments in green physical and natural capital presented in section 3.2 and will involve establishing the right set of expectations, incentives and finance to restore investment levels.

For the G7 countries, a 2 percentage-point step-up would reverse the decline in the investment ratio over the past decade, driven in part by cuts in public investment, and would be much less than the cumulative decline over previous decades. For the seven G7 countries, this would amount to **an additional investment of around $1 trillion per year from now until 2030**. That increment, if well executed, would have high returns in terms of productivity, new opportunities and the environment.

While the majority of investment will be in the private sector, public investment will have to play a key role in the early period, particularly for sustainable infrastructure. For EMDEs, these magnitudes will likely be higher, given the range of investments required to meet the SDGs. For China the main challenge will be to change the composition rather than the level of investment and capital.

Pervasive and persistent infrastructure gaps

It is firmly established that sustainable infrastructure is crucial for growth, development and climate. Infrastructure influences economic growth primarily as an input to the aggregate production function. Increased availability of physical capital as well as flow of infrastructure services such as transport, power supply and use, telecommunications, and so on can help lower production costs and increase productivity (Bhattacharya et al., 2016).

Infrastructure also stimulates short-run demand and supports economic growth during recessions; it is particularly relevant to economic recovery from COVID-19. Sustainable infrastructure that is ready to deploy, labour-intensive, and with strong multipliers, can be delivered across natural and physical capital, and avoid lock-in to a brown recovery. The world's current stock of infrastructure is responsible for around 60% of global emissions (OECD, 2017). Reducing these emissions rapidly through sustainable infrastructure investment will be essential if the world is to set a course for long-term transformation to a new form of growth and development and achieve the goals of the Paris Agreement. The IMF makes the case that policymakers can both mitigate climate change and bolster the recovery from COVID through a comprehensive package that includes a sizable green public infrastructure push (IMF, 2020a).

Despite the crucial importance, the world is not delivering on the scale and quality of infrastructure that will be needed to meet its growth, development and climate goals. There is a longstanding and broad recognition that there are pervasive and persistent sustainable infrastructure gaps across countries, both advanced economies and EMDEs (US Council of Economic Advisors, 2016). Large infrastructure gaps exist in EMDEs due to a range of factors, including incomplete network coverage, rising needs to support development and higher growth, and ongoing structural change, especially urbanisation.

The US Council of Economic Advisors' report of 2016 shows that the quantity and quality of infrastructure investment has declined across G7 countries over the past several decades. In the US, for example, the quantity of public capital investment as a share of GDP averaged 3.7% for the period 2011–15, its lowest trailing five-year average since 1950 (ibid.). The report also shows a decline in quality over the period 2006 to 2015.

Most advanced economies will require large investments to rehabilitate or replace existing infrastructure that has been run down due to neglect and insufficient investments over time, or that is at the end of its life. This offers an opportunity to improve sustainability and reduce emissions. The IMF argues there is a strong case for infrastructure investment in advanced economies, both to improve medium-term potential output and short-term domestic demand (IMF, 2015).

Building on the New Climate Economy's work of 2014, Bhattacharya et al. (2016) find that global infrastructure requirements to 2030 will be in the range of $75–86 trillion, or $5–5.7 trillion per year (on energy, transport, water and sanitation, and telecoms), with EMDEs (excluding China) expected to represent around 70% of these future infrastructure needs. The OECD estimates that global sustainable infrastructure investment needs for growth, development and climate are around $6.9 trillion per year over the period 2016–2030 (OECD, 2017). These estimates compare to pre-pandemic infrastructure spending of around $3.4–4.4 trillion globally (ibid.). Together, these estimates have informed the aggregate figures outlined in Table 3.1. Triangulation and updates applied are outlined in the Technical Note that accompanies this report (SYSTEMIQ, 2021).

All countries, but particularly EMDEs, have been unable to overcome a range of impediments that prevent them from transforming these large sustainable infrastructure needs and opportunities into realised demand. Countries are often unable to translate their needs and opportunities into a concrete pipeline of projects, and a significant proportion of new investment is not as sustainable as it should be. This is due to the inherent complexities of infrastructure investment (long-term nature, interconnectedness, social impacts, complex decision-making process and policy-induced risks and positive and negative externalities), and policy and institutional impediments. In addition, despite the large pools of available savings, mobilising long-term finance at reasonable cost to match the risks of the infrastructure project cycles and ensuring that finance is well-aligned with sustainability criteria remains a widespread challenge (Bhattacharya et al., 2019).

For G7 countries, investment in physical capital (especially large-scale infrastructure) and a redirection of investment away from solutions that deplete natural capital towards those that regenerate natural

capital will be the main drivers of sustainable growth in line with a net-zero, climate-resilient economy. Our bottom-up estimates (Table 3.1) indicate that global investment in key physical infrastructure needs to be increased above pre-COVID levels by $3–3.5 trillion p.a..[2]

A focus on quality investments across a range of vital physical, natural and intangible assets can drive both recovery and transformation to a sustainable, resilient and inclusive economy. Many of the investments necessary for sustainable recovery and growth can be quickly implemented, can mobilise significant private sector involvement, are labour-intensive in the short run, can promote greater equality of opportunity, and can drive productivity growth through their strong innovation potential in the medium to long run. These investments have large net economic and social benefits and strong potential to improve well-being across its many dimensions. The high economic multipliers of these investments will also be a key driver of economic recovery, job opportunities and enhanced future revenues. The IMF estimates the total output effect over two years of public investment in a period of high uncertainty to be a multiplier of 2.7, assuming good quality investments and debt and financing conditions allowing the private sector to be responsive (IMF, 2020b).

If countries act together, these investments can deliver quadruple wins:

- **Recovery** (a Keynesian demand recovery story, with countries mutually benefiting from increased demand)
- **Growth** (with strong expectations around the shared strategy driving sustained investments)
- **Innovation** (with learning-by-doing and cost reduction from scaling up, which will be much stronger if countries move in similar directions)
- **Tackling the immense threats from climate change, biodiversity loss and environmental degradation.**

3.1.2 Global investment in physical and natural capital

This section sets out the scale of global investments needed in key areas of physical and natural capital to **deliver a strong and sustainable recovery and economic growth.**

Investment estimates are based on recent research and evidence, subject to limitations in data availability. They are not generated from a new modelling exercise and in some areas, estimates may overlap, as indicated in the text. As such, these estimates should be considered as approximations providing indicative orders of magnitude. Comparisons of estimates featured in this report with those of significant reports, including the recent IEA's *Net Zero by 2050* report published in May 2021 (IEA, 2021), reflect a broad convergence and are included in the Technical Note (SYSTEMIQ, 2021).

Table 3.1 provides an overview of actual (pre-COVID-19) annual investment levels and **estimated gross annual investment opportunities** (as opposed to incremental investment versus a baseline) over the 2020s, by type of capital and sector.[3] These represent the most significant opportunities in terms of climate impact, size and/or attractiveness. The estimates include both investments (in a traditional economic sense) and in some cases government expenditure that enhances the value of a form of capital (for example, payments to landholders, producers and communities to protect natural capital). Furthermore, these figures focus on CAPEX investments to the extent possible, but in some areas OPEX figures are embedded in estimates (as indicated in the text).

Public and private funded investments are both included in Table 3.1, as are investments in both low-carbon and high-carbon solutions (for example, investment in fossil fuels is anticipated to continue, albeit at a declining level). It should be noted that within low-carbon solutions, the increase in investment rate does not necessarily mean higher costs: a significant driver of the net increase in investment is the fact that sustainable solutions carry more of their costs in upfront investment, in exchange for lower operating costs.

[2] These bottom-up estimates are not incremental (they are a different concept to the 2% estimate), but are magnitudes of investment opportunities in particular areas, expressed as totals and compared to pre-COVID levels.

[3] Pre-COVID annual investment levels are drawn from estimates published between 2016 and 2020. Both current investment levels and investment requirements are expressed in constant prices cited in these publications.

The broad assessment of current investment levels and investment opportunities in physical and natural capital (including in Adaptation and Resilience) shows that:

- **Actual pre-COVID annual global investment in the identified categories of physical and natural capital** is estimated at $5.5 trillion.
- **Gross annual investment opportunities in these categories of physical and natural capital** to support a sustainable recovery and transformation to a net-zero emissions and climate-resilient global economy are estimated at $9–9.5 trillion on average during the 2020s.[4]
- **The increase in investment on current levels across these opportunities in physical and natural capital** is estimated at +$3–4 trillion p.a. on average, during the 2020s.

The main investment drivers are summarised in Table 3.1 below for each type of capital. Investment estimates are provided at the global level including both G7 countries and EMDEs.

Table 3.1: Investment in physical and natural capital

Sector	Current investment p.a. ($ trillion)	Gross investment p.a., 2021–30 ($ trillion)	*Increase*
Physical capital (large-scale infrastructure)			
Energy (incl. energy efficiency in buildings)	1.9	2.8–3.3	0.9–1.4
Transport	1.3	2.7	1.4
Water and sanitation	0.6	0.9	0.3
Telecoms and digital	0.7	1	0.3
TOTAL (rounded to nearest 0.5)	4.5	7.5–8	3–3.5
Adaptation and resilience			
Adaptation and resilience in developing countries	0.02	>0.1–0.3	>0.1–0.3
TOTAL	0.02	>0.1–0.3	>0.1–0.3
Natural capital			
Agriculture, food and land use	0.9	1.2–1.4	0.3–0.5
TOTAL	0.9	1.2–1.4	0.3–0.5
TOTAL Investment opportunities (rounded to nearest 0.5)	5.5	9–9.5	3–4

NOTE: Current investment is pre-COVID-19. The last column calculates the increase in annual gross investment opportunities per year above current levels. The increases are not based on a counterfactual high-carbon baseline, the method often adopted in previous investment quantification studies. Detail on sources and methodology used to calculate each investment estimate can be found in the Technical Note by SYSTEMIQ that accompanies this paper.

[4] These figures are likely to be high as they include estimates of the costs of Adaptation & Resilience in developing countries, which are likely to overlap with physical and natural capital investment opportunities.

The increase in **physical capital investment of $3–3.5 trillion p.a.** is key both to **address historic underinvestment** (Bhattacharya et al., 2016) and to **restructure systems to steer towards a net-zero emissions and climate-resilient economy**.

Key investment areas include:

- **Energy:** Increase in annual investment to electrify the economy and transition to low-carbon solutions across the 2020s estimated at **$0.9–1.4 trillion** to reach **$2.8–3.3 trillion p.a.** (CAPEX only) (SYSTEMIQ, 2021). This includes a $1.5–1.7 trillion increase in annual investment in low-carbon solutions and a $0.4–0.6 trillion decline in investment in high-carbon solutions (i.e. fossil fuels). Investment areas include electricity generation, storage and networks; energy efficiency in buildings and industry; EV charging infrastructure investment (EV manufacturing is excluded, as is rail electrification); green hydrogen; and investment to decarbonise heavy transport (aviation and shipping) and industry. Annual investments into green hydrogen and low-carbon solutions in aviation, shipping and heavy industry are likely to increase considerably after 2030. Estimates provided in this report account for lower investment levels in the 2020s.
- **Transport:** Increase in annual investment to address historic underinvestment and scale-up light rail, enhance road infrastructure, airports and ports estimated at **$1.4 trillion** to reach **$2.7 trillion p.a.** (CAPEX only) (OECD, 2017). This increase includes investments to ensure infrastructure is climate resilient (although, due to the high-level approach adopted, the estimate is likely to be low). This estimate may underestimate the investment opportunity associated with rail electrification and mass transit.
- **Water and sanitation:** Increase in annual investment in urban and (to a lesser extent) rural water services, including to support climate resilience and adaptation but not including irrigation, of **$0.3 trillion** to reach **$0.9 trillion** p.a. (ibid.) (although as above, the estimate is likely to be low) (CAPEX only). Irrigation estimates are included in natural capital figures, outlined below.
- **Telecoms:** Increase in annual investment of **$0.3 trillion** to reach **$1 trillion p.a.** This figure assumes investment in telecoms remains flat, including the roll-out of and increased access to mobile, fixed-line and broadband infrastructure (CAPEX only) (OECD, 2017). Investment would increase by an estimated $0.3 trillion to scale up data centres globally (Synergy Research Group, 2020). This figure may include OPEX. This estimate does not include additional investment in CAPEX anticipated to accommodate 5G roll-out, which would be expected to be mostly financed by the private sector. These investment estimates are directional only and are not linked to delivery on climate or sustainable development goals.

An estimated **$0.1–0.3 trillion increase in investment is required in developing countries to support adaptation and resilience** to climate change. There are significant data challenges and there lacks a comprehensive, global estimate of investment requirements to support adaptation and resilience. In addition, there are **overlaps** with investment estimates in physical infrastructure (which include high-level estimates of investment required to ensure infrastructure is resilient) and in agriculture, food and land use (which can provide many of the solutions to support adaptation and resilience).

Beyond these estimation challenges, it is widely accepted that investment in adaptation and resilience needs to increase significantly from its current low share of climate finance (around 7%) (Macquarie, 2020). Specific investments in adaptation and resilience are described in section 3.2.5.

The increase in investment into **natural capital (i.e. agriculture, food and land use systems [AFOLU])** is estimated at **$0.3–0.5 trillion** reaching **$1.2–1.4 trillion** p.a. by 2030 (SYSTEMIQ, 2021).Investments in AFOLU do not clearly delineate between low and high carbon in the same way that they do in the energy sector. The $1 trillion current AFOLU investment includes vital investments in farm inputs, infrastructure and technology.[5] The $0.3–0.5 trillion investment highlighted in this report represents the investment required to implement interventions to protect and restore nature, to transition to regenerative

[5] Estimates of current investment levels in AFOLU are high-level due to a lack of consistent, comprehensive, and comparable data. See Technical Note for further detail (SYSTEMIQ, 2021).

agricultural practices and to increase the productivity and efficiency of existing agricultural systems. Existing investments in agriculture will remain a key part of the solution.

Specific investment areas in natural capital are described in sections 3.2.6 and 3.2.7 and include:

(i) **Protecting and restoring nature (marine and terrestrial)** – increase in investment of **$0.1–0.25 trillion** including CAPEX, land purchase and maintenance payments/costs, with $0.04–0.2 trillion in terrestrial ecosystems (Food and Land Use Coalition [FOLU], 2019a) and $0.03–0.04 trillion in marine ecosystems (Deutz et al., 2020).

(ii) **Implementing productive, sustainable and efficient agricultural systems –** increase in investment estimated at **$0.15 trillion p.a.** (FOLU, 2019a), covering increased investment in irrigation expansion and efficiency to enhance productivity of farmers including CAPEX, training and some long-term OPEX.

Additional investments in healthy diets and rural infrastructure –>$0.1 trillion (ibid.)**.** These include investments in rural roads and connectivity to support improved livelihoods, which are not covered in section 3.2 as they are not directly linked to low-carbon solutions in agriculture, food and land use.

3.1.3 Increasing expenditure in human and social capital

Expenditure to support human and social capital is crucial to manage and contain future impacts of COVID-19 and to relaunch the economy. **Education, health, retraining and the learning of new skills** are each necessary to create and drive a transformed economy while managing the dislocation arising from structural change. Estimates of annual expenditure requirements in health, education, social spending and justice in low- and lower-middle income countries range from $0.6 trillion to $1.4 trillion (Sustainable Development Solutions Network, 2019; Gaspar et al., 2019; Kharas and McArthur, 2019).

It is important to note that a **significant proportion of human and social capital is not categorised as traditional 'capital investment'** (such as social protection spending). In addition, high- and middle-income countries (which account for over 95% of current expenditure in human and social capital) generally finance growth in these areas out of current budgetary revenues. These should therefore not be considered against the frame of the traditional savings-investment balance.

By contrast, while low-income countries will not account for the majority of increased spend, it is in these countries that the financing gap is the largest. A sharp increase in Official Development Assistance (ODA) (which is currently estimated at $150 billion p.a. [OECD, 2020b]), alongside increased domestic resource mobilisation, will be needed to fill the financing gap in the poorest countries.

Spending has been deficient on health and education over a long period. As the additional spending is so large, this will need to be ramped up over time as the economy recovers and growth delivers greater fiscal space. Additional research is needed on this matter, given its importance.

Priorities to increase the value of human and social capital include:

- **Health:** reports typically identify increasing the health workforce, additional infrastructure and medical equipment as key spending needs.
- **Education:** priorities for increased expenditure include staff salaries, construction and furnishing of buildings, in-service training, large-scale student assessments, internet access and use of digital technology, to support basic education through secondary schooling.
- **Social protection:** increased expenditure will be required to end extreme poverty. Interventions include social protection transfers and broader government welfare services.
- **Justice:** priorities include a significant increase in expenditure in low-income and lower-middle income countries (some studies suggest around 2.5-times increase versus current levels [Kharas and McArthur, 2019]). Cost estimates assume the development of a system to resolve grievances, conflicts and crimes through formal and informal mechanisms.

Further complementary work should be undertaken to identify specific actions in education and health, including a focus on skills development and innovation to support the proposed path to sustainable recovery and growth.

Finally, several factors associated with a low-carbon pathway can have a material impact on investment requirements across human, physical, natural and social capital. Designing cities reflecting a **smarter urban development** approach and avoiding urban sprawl could reduce urban infrastructure investment requirements by **$0.2 trillion** (New Climate Economy, 2014). **Digitalisation** of energy, water, buildings and communications could deliver CAPEX savings of **$0.1 trillion** for city governments and $0.45 trillion in OPEX savings (Bonte, 2017). Shifting to a **circular economy** could reduce annual primary resource costs by **$0.2 trillion** in mobility, food and the built environment in Europe alone (Ellen MacArthur Foundation, 2015).[6] Investment in low-carbon and adaptation and resilience solutions themselves can drive down costs. For example, investing in natural capital can enhance adaptation and resilience, reducing investment needs in 'grey'" infrastructure (e.g. for watershed management and coastal erosion protection). These savings are not captured in the figures outlined above. They should be considered as important additional potential savings.

3.2 Investments for green recovery and transformational growth

A programme of investment in the following action areas can drive recovery, deliver financial and broader economic returns, promote strong and sustainable growth, protect nature and biodiversity and support an effective transformation to a net-zero emissions and climate-resilient economy:

- **Electricity generation from renewable energy sources (wind and solar), storage and network development** (including grids) underpinning an accelerated transition to a zero-carbon energy sector with declining costs to deliver affordable energy.
- **Energy efficiency of buildings and industry** through retrofits, enhanced standards for new construction aiming at zero-carbon buildings and the application of advanced industry production techniques, design and digital technology.
- **Transport,** including scaling up of charging infrastructure for electric vehicles supporting a transition to zero-emissions road transport, shifting to sustainable aviation (including new fuels) and electric aeroplanes, scaling up green shipping fuels and zero-emissions vessels.
- **Accelerated innovation** to transform 'hard to abate' sectors such as steel, cement, and air and sea transport, to include hydrogen and carbon capture, utilisation and storage (CCUS).
- **Adaptation and resilience,** including making infrastructure, both physical and natural, more resilient to a changing climate, strengthening early warning systems and enhancing disaster risk preparedness and response (including timely disaster finance).
- **Nature protection and restoration,** including forests, peatlands, mangroves, seagrasses and saltmarshes, through investment in land, establishment and maintenance of protected areas, and restoration of degraded landscapes, supported by the necessary incentives, institutional changes and collaboration with local communities.
- **Productive, sustainable and efficient agriculture** to support livelihoods, improve nutritional and health outcomes, and ease pressure on natural resources**,** including sustainably enhancing yields, enabling a shift to regenerative practices, diversifying alternative protein production, and reducing food loss and waste.

Cross-sectoral actions will play a major role, including:

- Developing **circular economy models** across economic sectors reducing waste, leading to more sustainable cities and communities, reducing pressure on natural resources and creating new production inputs.
- **Digitalisation,** to increase inclusion, manage complex systems, and increase productivity and new working methods.

[6] Ellen MacArthur Foundation (2015), '*Growth Within: a circular economy vision for a competitive Europe*.'

Investment in these areas directly supports COP26 priorities, including accelerating the energy transition and the move to zero-carbon road transport, adaptation and resilience, and the safeguarding of ecosystems and the protection of natural habitats.

In Table 3.2 a summary technical description is provided for each investment action area, together with a short rationale relative to the following dimensions:

- **Contribution to recovery and growth**: jobs, multipliers, other economic co-benefits
- **Contribution to net-zero emissions, climate-resilient trajectory and environmental sustainability**: emissions reduction potential, other environmental co-benefits
- **Social impacts**
- **Readiness** within the short to medium term providing a basis for tracking progress during the proposed three-year window of the Carbis Bay Action Plan

A more detailed description of the rationale, barriers and policy levers for each investment area is provided in Appendix 2.

Reflecting the global vision for the Carbis Bay G7 Summit, the assessment of investment action areas is made both globally and for G7 countries. This is particularly relevant as the resolution of the challenges outlined in section 1.1 requires a global approach to drive recovery, growth and trade, foster innovation and technical change, and tackle climate change and biodiversity loss.

Table 3.2: Investments for green recovery and transformational growth

Investment area	Investment rationale CO_2e reduction by 2030 (vs. BAU with no investment)	Public/ private	Investment estimate* ($ tn p.a.)	
			Global	G7
Energy transition				
Electricity generation, storage and networks • **Solar and wind generation and storage** • **Upgrade and extend transmission networks** **Solar and wind installation rate needs to double by 2025 to meet growing demand from electrified transport and heat**	• **Solar/wind lowest cost** new generation in **73% of countries** (by GDP) • Solar/wind/batteries **further 30–60% cost declines** over 2020s, undercutting price of **existing** coal/gas plants**.** 70% current coal plants economically stranded by 2025 • **Solar/wind deliver 3x more jobs/$ spending** vs. fossil • Potential for over **40% reduction in power emissions** underpinning decarbonisation of transport and industry	Mostly private	1.5–1.6	0.4–0.5 (25%)
Energy efficiency in buildings and industry • **Building insulation, low-carbon efficient heating and cooling** • **Shift to net-zero carbon buildings** • **Efficient industrial energy equipment and onsite renewable energy**	• **Up to 50%** building energy savings. Tackle **fuel poverty** • **Reversible heat pumps cost-competitive** with gas boiler and air conditioner • **10–20%** energy usage reduction in heavy industry • **9–30 jobs/$1m** invested in buildings energy efficiency • Potential **20%** reduction in building emissions via energy efficiency. Potential **15%** reduction in heavy industry	Private and public	0.6–0.8	0.2–0.3 (30%)

Investment area	Investment rationale CO_2e savings by 2030 (vs BAU with no investment)	Public/ private	Investment estimate ($ tn p.a.)	
			Global	G7
Transport • **Charging infrastructure (cars, trucks)** • **Green shipping fuel** • **Sustainable Aviation Fuels (SAFs), electric planes**	• **EV sticker price parity by 2024** vs. petrol/ diesel; EVs offer **3–4x cheaper fuel**; 50% less to maintain • **6m new direct jobs** in EV charging by 2030 • Short-haul electric/H_2 flights could be **cost-competitive with jet-fuelled planes by mid-2030s** • **66** zero-emission shipping pilots and projects launched • Potential **10–15%** reduction in light road and heavy road transport emissions and **10%** each shipping/aviation	Private and public	0.1	0.03 (35%)
Innovation • **Hydrogen production facilities, pipes, storage** • **Carbon capture, utilisation and storage (CCUS): transport and storage**	• **50,000 jobs** in CCUS in UK by 2030; growing H_2 industry • **H_2 costs to decline** from $3–6/kg to <$2/kg by 2030 • **$6–12bn p.a.** green hydrogen export market by 2030 • Around **0.3 Gt CO_2e p.a.** reduction via CCUS by 2030	Private and public	0.06–0.07	0.03 (45%)
Adaptation and resilience				
Adaptation and resilience • **Making physical and natural infrastructure resilient** • **Strengthening early warning systems** • **Enhancing disaster risk preparedness and response**	• **$7.1tn returns on $1.8tn invest:** 2–10x benefits vs. costs • Reduce losses: **$12tn p.a. flood damage** in 2°C pathway • **$236bn business opportunities** • Reduce **health costs**; **50m displaced** by desertification	Private and public	>0.1–0.3	Insufficient data
Nature, agriculture and food				
Nature protection and restoration, including forests, peatlands, mangroves, seagrasses, saltmarshes. **Investment in land, natural CAPEX, infrastructure, salaries, training**	• **45m jobs** in sustainable land management and ocean economy by 2030 • **$8tn Gross Value Added** with construction, agriculture, food and drink all highly dependent on nature • **Twice as expensive to delay** action to stabilise biodiversity intactness globally as to act immediately • Reduce **$1.7tn p.a. losses** via deforestation/degradation • Reduce **zoonotic disease risk:** land use change caused emergence of **>30% new diseases** reported since 1960 • Potential 90% emissions reduction and avoid ecosystem collapse	Mostly public	0.1–0.25	<0.01** (3%)
Productive, sustainable, efficient agriculture	• **Growing corporate demand** for regenerative agriculture	Private and public	0.15	0.03 (20%)

• **Enhancing productivity and shifting to regenerative practices** • **Reducing food loss and waste** • **Transitioning to healthy diets (alternative protein production and R&D)**	• **$100bn p.a. business opportunity** in boosting yields in Sub-Saharan Africa by 2030 • **$225bn p.a.** opportunity in reducing food loss and waste by 2030 reducing **$1.2tn food lost p.a.** • Enhance **food security and improve nutrition** • **Alternative protein** industry to grow to **$85bn** by 2030 • Soil degradation costs EU **€100bn p.a.** • **Reduce input costs** via precision tech and smart practices • Help to reduce **$3tn p.a. air pollution** healthcare costs • Potential **40%** emissions reduction			
TOTAL			**2.6–3.2**	**0.7–1 (25%)**

*: Investment estimates do not map directly into national account concepts.
**: The G7 countries estimate for nature protection and restoration covers only investment within G7 countries. Considering the global public good feature of natural capital in emerging markets and developing countries and taking account of the financial challenges confronted by these countries, the G7 should provide strong support to these countries in this area.

Table 3.2 summarises the results of a detailed review of **investment opportunities that would support a transition to net-zero emissions climate-resilient growth**. These numbers do not cover the whole 'investment universe', and some types of investment would be expected to decline while green investments grow. The numbers in this table are therefore not directly comparable to the increase in the macroeconomic investment ratio proposed in this report. In addition, these estimates are based on aggregate assessments on the basis of the latest information but are not based on a new modelling exercise. References used to derive these estimates are available in the background Technical Note (see SYSTEMIQ, 2021).

Driven by **appropriate policies**, and supported by **foundational public investments**, these investment areas can provide significant market opportunities for private-sector activity and financing. Electricity generation and energy efficiency, which account for a high share of the proposed investment, would involve the private sector heavily. Most areas would include close partnerships between the public and private sectors. For example, public investment in R&D on hydrogen energy and CCUS would provide a solid base for establishing market-driven growth.

3.2.1 Electricity generation, storage and networks

Key specific action

Target 80% zero-carbon electricity generation in G7 countries by 2030.

Technical investment components. The building of a low-carbon energy system over the next decade is at the core of the transformation that needs to occur if the world is to reach net-zero emissions by mid-century. Global investment requirements in the electricity system for that purpose are estimated at **$1.5–1.6 trillion p.a.,** including around **$0.4 trillion in G7 countries**. For the G7, total electricity demand is expected to grow from the mid-2020s as electrification of transport and heating scales up. Investments in the early 2020s will be in solar and wind energy as replacement to retiring generation, and in networks to prepare for the scaling of the electricity system in the mid-2020s.

Key investment elements include:

- **$0.75–0.8 trillion p.a. in electricity generation and storage**[7] to construct around 7–7.5 TW of solar and wind plants with the necessary storage to 2030 (scaling to 34–46 TW by 2050) (ibid.), compared with 7.5 TW total installed generation capacity (renewable and fossil) today (IEA, 2020c).
- **$0.75 trillion p.a. in scaling electricity networks.**[8] The majority of investment would be for: (i) upgrading distribution networks to support the electrification of transport and buildings; and (ii) extending transmission networks to areas of high renewable resource to make it easier for solar/wind developers to build projects and connect them to the grid. Transmission network investment needs to precede generation build-out due to the long lead-times for transmission network extension (5–8 years vs. 1–2 years to build solar/wind energy generation facilities).

Investment rationale. Low-carbon electricity underpins decarbonisation for 60–80% of the energy system. Renewable energy can now provide lower cost energy than fossil fuels to power economies. As costs have plummeted in the past 10 years and continue to fall, market tipping points are being crossed, e.g. solar and wind are already the lowest-cost new bulk generation in countries representing 70% of GDP, including all G7 countries except Japan (Bloomberg NEF, 2020). New solar/wind and storage are likely to become cheaper than *existing* coal/gas plants in a growing number of geographies by 2030 (this is already the case for higher cost coal plants). This results in a strong economic pull for solar/wind and storage to account for the majority of electricity generation by 2030, complemented in some locations by low-cost hydro or nuclear.

Renewable energy can generate a high number of quality jobs in the short term. Projects are currently ready to deploy or in development and can deliver three times more jobs per dollar invested than fossil fuels (Garrett-Peltier, 2017). Many of the jobs in wind/solar are concentrated in rural geographies, providing attractive returns with lower risk and much lower volatility than declining fossil sectors.

Investment barriers and policy levers. Investment barriers in mature markets can include:

- Uncertain forecast wholesale pricing.
- Misalignment of transmission network build-out approval and market need.
- Uncoordinated and/or slow permitting and planning processes.
- Continued financial support for fossil fuel energy (e.g. via subsidies), which distorts markets and directs investment away from renewable energy.
- In EMDEs, barriers can additionally include lack of reliable grid connection, an uncertain investment climate and a weak energy regulatory environment.

Policy levers that can be actioned by governments to drive the scale-up of private investment in electricity generation, storage and networks in mature markets include:

- Issue waves of long-term renewable energy contracts to avoid situations where the incentive to invest is blunted by uncertain future wholesale prices (see Chile case[9]).
- Extend transmission networks to areas of high solar and wind potential to unlock these areas for development and bring cheap and clean electricity to areas of demand.
- End financial support for fossil fuels, e.g. phase out fossil fuel subsidies within G7 by 2030, taking into account the management of distributional impacts; and phase out coal by 2030 within G7 countries, accompanied by support for the workforce in declining fossil fuel industries.
- In EMDEs, policy levers include: enhance the investment climate in developing countries to scale-up and mature their renewable energy markets and supply chains; create a supportive energy regulatory environment for private investment; and end financial support for fossil fuels overseas (e.g. via ODA).

[7] Energy Transitions Commission (ETC) analysis to inform 2020–30 picture. Aligned with 2020–50 estimates outlined in ETC (2021).

[8] See footnote 7.

[9] Chile has a world-leading approach to long-term energy auctions that is designed to meet system needs and also attract low-cost capital to deliver low-cost renewable generation build-out.

3.2.2 Energy efficiency

Key specific actions

- Target to **double buildings retrofit to 2% p.a. by 2024**.
- Apply **standards for 100% net-zero buildings by 2024**.
- Aim to achieve an **annual rate of energy intensity improvement averaging 4% to 2030** in line with the recent IEA analysis (IEA, 2021).

Technical investment components. There is an estimated **$0.4–0.5 trillion p.a.** global investment opportunity in improving the energy efficiency of buildings and shifting to net-zero buildings. This involves interventions to **enhance building energy efficiency**, including insulation and glazing. It also involves low-carbon and high-efficiency energy solutions in houses for space heating and cooling, water heating, cooking, lighting and appliances. A key intervention includes the installation of **heat pumps to replace gas boilers. Investment in G7 countries is estimated at $0.2 trillion. This will be dominated by building retrofits**, due to an older average building stock age (average building stock in 2012 was between 40 and 60 years old in UK, France, Germany, Italy and the UK, and 30 to 40 years old in Canada, Japan and the US) (Daniell et al., 2014) and lower new-build rate than in EMDEs.

A **step-up in retrofit rate** is needed as current average annual energy retrofit rates in buildings are less than 1% in most major markets, and a rate of around 3% p.a. is needed (IEA, 2020f). Support for building retrofits should **target the least efficient buildings and the most vulnerable (i.e. low-income) households**.

Additionally, there is an estimated **$0.2–0.3 trillion p.a.** global investment opportunity in enhancing energy efficiency in heavy industry ($0.05 trillion in the G7). This involves improving energy efficiency within existing processes through **advanced production techniques** (including improved machinery; reuse of waste heat and steam; adding **on-site renewable solutions** that deliver more efficient use of energy, such as solar or geothermal heat), the application of **digital technologies** (including monitoring systems to optimise processes and energy use) and **efficient design** (e.g. angular and wider piping to reduce pump/motor sizing) (IEA, 2020d; IRENA, 2018). This represents a significant uptick in investment relative to current levels, estimated at $40 billion per year over the 2015–18 period (IEA, 2019).

Investment rationale. Direct and indirect emissions from buildings account for around 20% of global CO_2 emissions not including construction, with space heating and cooling accounting for over 60% of direct CO_2 emissions in this sector (IEA, 2020f). Investments in energy efficiency and low-carbon heating and energy sources could reduce emissions by around 25% by 2030[10] (vs. no investment) and ultimately could tackle the majority of these emissions. Energy efficiency interventions can reduce emissions linked to heavy industry by an estimated 15% in 2030 (vs. no investment) (ibid.). Together, heavy industry sectors account for around 10% of global CO_2e emissions, meaning industrial energy efficiency could reduce global emissions by around 2% (Energy Transitions Commission, 2018).

Highly energy-efficient buildings in new build can be achieved at little additional cost (6–16% in residential), or even at lower costs (-10% in commercial), while energy efficiency retrofits can deliver energy savings of around 50%: 70–80% for old buildings in Europe and 30–50% in the US (Lucon et al., 2014). Efficiency gains can benefit lower-income households by helping to reduce fuel poverty.

An estimated nine to 30 jobs are created per $1 million investment in building retrofits, new builds and installation of energy-efficient and connected appliances (IEA, 2020f). These investments have high multipliers as they drive income for construction workers, who are likely to spend that income on consumption.

In heavy industry, energy efficiency interventions can reduce energy usage by 10–20% (Energy Transitions Commission, 2018). This represents a key opportunity to reduce industrial energy demand growth, particularly in EMDEs. The financial attractiveness of energy efficiency interventions varies by sector and individual projects, but can have very short payback periods in a number of cases.

[10] SYSTEMIQ analysis, see Technical Note for further detail (Turner et al., 2021).

Investment barriers and policy levers. Investment barriers to energy efficiency in buildings include:

- Lack of long-term signals from government.
- High upfront cost and a long payback period (e.g. the average cost of improving a property with all UK EPC recommended measures is £15,000).
- Future energy savings are not a sufficient incentive as they are heavily discounted by average consumers.
- Energy efficiency is not perceived to add value to properties, reducing consumer demand for interventions and preventing development of green mortgages and finance.

Investment barriers to enhance energy efficiency in heavy industry include:

- Lack of long-term signals from government
- Limited access to finance makes it difficult for suppliers to invest in improvements.
- The low margins and high risk profiles of some industrial suppliers (e.g. the textiles sector) mean that they lack significant savings, which limits their capacity to make upfront investments in energy efficiency measures.

Policy levers that can be actioned by G7 governments to drive the scale-up of investment in energy efficient buildings include:

- Set target to double retrofit rate to 2% p.a. by 2024
- Commit to all new-build as net-zero buildings (e.g. no gas usage) by 2024
- Help consumers to overcome upfront cost hurdle and provide incentives, e.g. subsidies for equipment or rebates on the cost of energy efficiency measures
- Provide long-term demand signals via regulations and market creation, e.g. by formulating and implementing building energy efficiency codes with high energy efficiency requirements.

Policy levers to scale-up investment in industrial energy efficiency include:

- Engage in and reaffirm commitments made as part of the Three Percent Club at the UN Climate Action Summit
- Provide financial support (e.g. federal grants, tax deductions, government-backed lending) for industrial plants to invest in energy efficiency interventions
- Incentivise and equip SMEs and industrial plant operators to prioritise energy efficiency by making financial support conditional on audited energy savings.

3.2.3 Transport

Key specific actions

- Target at least **100 public electric vehicle chargers per 100,000 population by 2023**.
- Target **procurement for all new urban buses to be electric by 2023**.
- Target **10% Sustainable Aviation Fuels blending by 2030**.
- Target **5% zero-emissions shipping fuels by 2030** and **25% zero-emission vessels for domestic shipping by 2030**.

This section on transport investment covers: (i) electric vehicles for light and heavy road transport; (ii) aviation; and (iii) shipping. It does not include investment estimates for rail electrification or mass transit.

Technical investment component: Electric vehicles for light and heavy road transport

The scale-up of electric vehicles (EVs) is estimated to require a global investment of **$70 billion p.a. in charging infrastructure**. G7 countries can strengthen their position as leading EV markets with an

estimated $0.02 trillion p.a. investment opportunity in the G7 alone. The UK government has committed £1.3 billion for charge points in its recent 10-point plan (HM Government, 2020a).

To support rapid EV adoption, **investment in charging infrastructure needs to be front-loaded in the early 2020s,** ahead of an anticipated **surge in EV uptake that is already occurring** in Europe, and is expected to happen in other countries. This surge is driven by rapidly declining battery costs, which are projected to result in EVs reaching sticker price parity with internal combustion vehicles by 2024 (UBS, 2020).

Supplying 100-plus chargers per 100,000 people by 2023 would be a first step towards ensuring that insufficient charging point coverage does not act as a barrier to the industry's scale-up. Widely available charging infrastructure is key to **allay range-anxiety and avoid negative driver experiences** (e.g. long wait times to charge) that **could slow EV adoption**.

This estimate does not include investment in the manufacture of electric vehicles (or the batteries) to be covered by auto manufacturers as part of their business models. Nor does this include the necessary distribution grid investments to support scale-up in EVs charging.

Technical investment component: Aviation

The global investment opportunity in green aviation is estimated at **$25 billion p.a.** over the next decade with an estimated 40% in the G7. Around $10 billion p.a. on average is in CAPEX costs associated with scaling Sustainable Aviation Fuel production (Energy Transitions Commission analysis, based on World Economic Forum, 2020a), and at least $15 billion in R&D (e.g. e-aviation, hydrogen).[11] The vast majority (90%) of SAF-related investment is expected to occur after 2025. These investments will support three categories of actions linked to short-, medium- and long-haul flights:

- **Electric aeroplanes** (including hydrogen-electric) can serve regional and short-haul flights which account for 28% of aviation emissions.
- **Sustainable Aviation Fuels (SAFs)** are most likely to decarbonise medium- to long-haul flights, which account for 72% of emissions.[12]
- Emerging technologies in **hydrogen propulsion** (rather than in the form of a fuel cell) could prove promising, though they remain an early-stage technology with high levels of uncertainty.

Technical investment component: Shipping

Global shipping provides an estimated **$20–40 billion p.a.** global investment opportunity from 2020 to 2030 on the path to net-zero emissions by 2050, with $80 billion cumulative investment required by 2025 and $320–390 billion required by 2030 (UMAS, 2020[13]). The majority of this annual investment figure is in green hydrogen production. It is therefore a subset of the investment estimates for green hydrogen provided in Section 3.2.4, rather than incremental.

G7 governments can help to **create the conditions for zero-emission ships to scale**, accelerating progress towards commercial production by the mid-2020s. This requires a **shift from heavy fuel oil (HFO) to alternative fuels or engines**:

- **Long-haul** routes (roughly 70% of total shipping emissions) could be powered by green ammonia and biofuels
- **Short-haul** routes could be served by battery- or hydrogen-based **electrified ships**, and the use of **hydrogen as an alternative fuel**.

Green ammonia production would account for 90% of the estimated $320–390 billion investment to 2030, and **engine and fuel cell R&D, production and retrofits for 10%** (ibid.). The cheapest green ammonia can be **produced in regions with the best solar and wind** resources, and thus cheapest green

[11] Investment estimates are lacking but the sector will likely need to meet or exceed the $15 billion in efficiency-related R&D 2010-19 (Air Transport Action Group, 2020).

[12] Categories of SAF include (i) Hydrogenated Esters & Fatty Acids (HEFAs), made of waste and residue lipids which are a proven and scalable technology; (ii) Alcohol-to-jet fuel and Gasification/Fischer-Tropsch fuels produced from agricultural and forestry residues, municipal solid waste and purposely grown cellulosic energy crops, which have potential over the mid-term but face techno-economical uncertainty; (iii) Power-to-liquid, which uses CO_2 as an input (e.g. via direct air capture) but which remains at proof of concept stage.

[13] *Shipping: Potential for zero-emission fuel adoption by 2030: A short-term roadmap to reduce emissions in line with Paris targets.* Not available online; contact SYSTEMIQ to view this document.

hydrogen production. Such countries include Australia, Chile, Morocco, Namibia, South Africa and countries in the Middle East.

G7 countries can drive the demand for cheap green ammonia and may invest in such production facilities in the above countries, e.g. via export-import banks. **Vessel and engine production investments** could involve domestic investments for G7 countries.

Investment rationale. Today, light road transport accounts for around 5Gt CO_2e (10% of the total), trucking accounts for 3Gt CO_2e (5% of the total), aviation represents between 2% and 4% of the global total (with the upper limit an estimate linked to radiative emissions, e.g. contrails, for which estimates are evolving), and shipping accounts for 1.1Gt CO_2e per year (3% of global CO_2e emissions) (International Maritime Organization, 2021). Investments in the scale-up of electric vehicles, supported by charging infrastructure roll-out, green aviation and shipping, could help to reduce light road transport emissions globally by up to 15%, trucking emissions by 8% by 2030 (versus BAU, with no investment),[14] aviation emissions by around 10% by 2030 (vs. 2020 baseline), and emissions associated with shipping by 5–10% by 2030 (vs. BAU with no investment).[15]

EVs offer the potential to reduce transport costs for consumers and businesses. They are three to four times cheaper to fuel per kilometre and cost around 50% less to maintain. Building out charging infrastructure could create around 6 million new *direct* jobs by 2030,[16] and cleaner air resulting from EV scale-up can help to reduce $3 trillion in annual health care costs linked to air pollution globally (Farrow et al., 2020).

Increased investment in green aviation and shipping could support technology development of future industries. Two hundred electric aeroplane developments are ongoing worldwide, with potential for SAF capacity to double in the next five years (Thomson, 2020), while 66 zero-emissions shipping pilot and demonstration projects have been launched in recent years, with the potential to scale in the next five to 10 years. Increased investment can also compress the 'green' premium for SAF and green ammonia, particularly as the cost of hydrogen declines. At $2/kg hydrogen, synthetic jet fuel carries a +$0.90/litre premium (vs. $0.65/kg kerosene) and green shipping fuel carries a +140% premium vs. heavy fuel oils (compared to a +300% premium today). Once hydrogen prices reach $1/kg H_2 (an achievable scenario), synthetic jet fuel could carry only a +$0.40/l premium, or as low as +$0.20/l if low-cost sources of circular CO_2 are available,[17] and green shipping fuels a +70% premium.

Investment barriers and policy levers. While private companies and investors are deploying charging infrastructure for EVs, public support is needed to scale-up coverage at pace and to ensure sparsely populated areas (less attractive for private-led projects) are not left behind (KPMG, 2019). For example, in the UK, EV charging density ranges from around 70 charging points per 100,000 (in London) to under 20 points (in the North of England) (HM Government, 2020b).

SAFs are likely to remain more expensive than fossil-based jet fuel over the medium term. Blending mandates to create premium markets are needed to enable SAFs to compete with kerosene jet fuel. Certification schemes are an investment barrier for electric and hydrogen-fuelled aviation. Even with technological maturity, new planes can only enter the market with certification, which can be a time-consuming process.

Similarly, the main investment barrier in shipping is that green shipping fuel is likely to remain more costly than conventional fuel, meaning policy incentives are needed to create markets for premium green shipping fuels.

Policy levers that could be actioned by governments to drive the scale-up of investment in EV deployment include rolling-out charging infrastructure and strengthening distribution networks ahead of EV demand, by, for example, providing utilities with regulatory approval to build 'charger ready' sites, at which private

[14] See Technical Note for further detail (SYSTEMIQ, 2021).

[15] SYSTEMIQ analysis. Assumes 5% green shipping fuel in international shipping and 25% zero-emissions vessels for domestic shipping by 2030. See Technical Note for further detail (ibid.).

[16] Jobs are in EV charging infrastructure, construction, installation, maintenance, grid connections, civil and road work (Goldman Sachs, 2020).

[17] Circular CO_2 refers to CO_2 that originated in the atmosphere and is released back into the atmosphere (i.e. when synthetic jet fuel is combusted). Potential sources of super low-cost circular CO_2 could include capturing CO_2 exhaust from a biomass combined heat and power plant (with it being critical to ensure the source of biomass is sustainable).

players can then compete to build charge-points. Governments should target at least 100 public chargers per 100,000 people by 2023 with broad coverage to ensure benefits from the transition are shared widely across populations. Governments can also stimulate market development and provide demand signals for EV scale-up by:

- Providing financial support to consumers and manufacturers of EVs
- Leveraging public procurement by committing that 100% of new urban buses are electric by 2023
- Introducing ICE phase-out dates and Low-Emission Zones.

Policy levers to drive the scale-up of green aviation and shipping include:

- Commit to green fuel blending mandates to create market premiums and that provide incentives for SAFs and green shipping fuels (targets of 10% SAF blending and 5% zero-emissions shipping fuels by 2030 are achievable)
- Design and implement regulatory standards for green shipping fuel to create a premium market
- Implement fuel taxes on kerosene jet fuel to create a level playing field for SAFs to compete
- Launch public-private partnerships and/or blended finance instruments to reduce capital expenditure and cost of capital for green ammonia production and fuel infrastructure
- Scale-up public investment in R&D to drive down the cost of core technologies in electric aviation, SAFs (beyond HEFA) and green shipping fuels
- Update and streamline certification schemes for new technologies in aviation.

3.2.4 Innovation: Green hydrogen (H_2) and carbon capture, utilisation and storage (CCUS)

Key specific actions

- Target **25GW of green hydrogen production** and use (e.g. in green ammonia for shipping; for green steel production) by 2026, aiming to achieve 200GW by 2030.
- Increase carbon capture via all forms of engineered carbon capture, removal, use and storage, including target of **0.15Gt CO_2 p.a. within the G7** via CCUS by 2030.
- **Increase public R&D** for commercially oriented **climate solutions** and provide market support, including via Advanced Market Commitments.

Technical investment component: Hydrogen

The global development of hydrogen production, transport and storage is estimated to require investment of **around $0.02 trillion p.a.** over the current decade, with nearly 40% in G7 countries (Energy Transitions Commission, 2020).

This reflects increasing confidence that **hydrogen will be central to low-carbon solutions** in shipping, aviation and steel, and can potentially provide high-temperature industrial heat and reliable/seasonal power balances in 100% clean power systems in the longer term. Annual investment opportunities are expected to increase significantly after 2030 as technology scales.

Key investment areas include hydrogen production facilities, and backbone H_2 pipes and storage, e.g. in salt or rock caverns, or more expensively in steel tanks.

Supply of hydrogen and fuels/products produced with green hydrogen for G7 countries will come **both domestically** (>50%) and from **remote locations** (<50%) **where lowest cost hydrogen can be produced** (i.e. countries with best solar/wind resources). **Global trade** of hydrogen will be restricted to trade of fuels and products produced with green hydrogen, e.g. **green ammonia, synthetic jet fuel, green steel.** Hydrogen as a gas itself will not be globally traded since it is too expensive to compress/liquify and then decompress/gasify at the end-location.

Technical investment components: **Carbon capture, utilisation and storage (CCUS)**

The development of CCUS capacity from 2020 to 2050 is estimated to require a global investment of **$160–190 billion p.a.** with an estimated $40–50 billion p.a. over the next decade (Energy Transitions Commission, 2020). Of the $160–190 billion annual investment, an estimated **$20–35 billion p.a.** is required to scale CO_2 transportation and storage (ibid.). CCUS represents an opportunity to reduce current greenhouse gas emission rates. The use of CCUS should focus on 'hard-to-abate' sectors in the long run while its application to fossil-fuel based electricity production should be limited to the transition from natural gas to renewable energy. Additional investment opportunities are emerging in Negative Emissions Technologies, which recapture previously emitted greenhouse gas emissions. However, these are not the focus of this report due to their relative technological immaturity (see Box 1 in Appendix 2).

The majority of investment in CCUS will occur after 2030, following a ramp up in the late 2020s. The investment opportunity in CCUS across the 2020s, estimated at around **$40–50 billion p.a.**, will help to deliver the increase in capacity needed to deliver on net-zero emissions by 2050, from 0.04Gt p.a. today to ~0.3Gt p.a. by 2030 and to 4–5Gt p.a. by 2050.[18] An ambitious target for the G7 would be 0.15Gt annual CCUS capacity by 2030, representing half of the global total.

While it should not replace broader decarbonisation efforts, CCUS can play a critical role in decarbonising the economy. Until fully green solutions are scaled across all industries, CCUS will be needed to decarbonise steel, cement and chemicals.

Governments need to play a role in providing backbone infrastructure to scale CCUS at the rate required. CO_2 pipes for transportation and storage sites need to be available for industry players to capture and funnel CO_2 into a central system.

Investment rationale. Hydrogen can play a central role in decarbonising steel, chemicals (refining, plastics), shipping and aviation. Together, these sectors account for 12% of current emissions (6Gt CO_2e in 2018) (Energy Transitions Commission, 2018). CCUS will also contribute to decarbonising steel and chemicals (refining, plastics), along with cement. Together, these sectors account for nearly 20% of current CO_2 emissions (ibid.). Additional greenhouse gas reductions could be achieved through the use of CCUS to serve in the production of blue hydrogen. It will also be important for negative emissions solutions.

The premium associated with green hydrogen is set to decline as the costs of electrolysers and renewable energy fall. As a result, the cost of green hydrogen is projected to decline from $3–6/kg H_2 today to less than $2/kg H_2 or below before 2030. This will decrease the cost premium for goods produced with green hydrogen, creating more investment and further propelling cost declines.

Increased investment in hydrogen and CCUS can accelerate the scale-up of future industries. Governments worldwide have already committed $70 billion in public funding for hydrogen and G7 countries are already taking steps to scale-up CCUS. To build on existing momentum, more investment is needed now to move H_2 down the learning curve and drive down costs, to hit around 15Mt of H_2 by 2026, and around 40Mt by 2030. Countries that scale hydrogen production can benefit from an export market that is projected to scale to $6–12 billion p.a. by 2030.[19] By facilitating the production of green power and industrial products, CCUS can enhance the long-term competitiveness of national industries in a global net-zero emissions economy.

The construction and operation of CCUS infrastructure can generate jobs, particularly linked to industrial clusters. Projects can be launched in the near-term, generating employment as part of the recovery (Unsworth et al., 2020). A growing H_2 industry and upstream solar/wind energy used to feed electrolysers can also result in longer-term job creation. For example, Australia's Asian Renewable Energy Hub is projected to create approximately 20,000 jobs during its 10-year construction period (asianrehub.com).

Investment barriers and policy levers. Investment barriers to innovation in expanding the role of hydrogen as an energy carrier and in CCUS include:

[18] Ongoing SYSTEMIQ analysis; figures subject to be updated; informed by Global Carbon Capture and Storage Institute (2020); IPCC 2 Degree Scenario; IEA Sustainable Development Scenario.

[19] SYSTEMIQ analysis. H_2 export market in 2030 estimated at ~2-4% of 2050 projection; Strategy& (2020).

Hydrogen

- The lack of long-term policy framework enabling support and certainty of H_2 off-take, e.g. public procurement requirements for use of green steel in public infrastructure projects (e.g. bridge construction), or in wind turbine manufacturing.
- Unclear infrastructure planning for H_2 transportation (e.g. pipelines) and storage (e.g. salt or rock caverns; steel tanks).

CCUS

- Insufficient value on carbon dioxide to generate revenues for private investors to secure attractive return on investment in CCUS.
- Insufficient support for CCUS R&D and pilots to bring down cost per tonne of CO_2 captured and stored.

Policy levers to scale investment in increasing hydrogen production and use and in CCUS include:

- Leverage regulatory and policy tools to create a long-term policy framework and signal demand for green hydrogen, e.g. by providing long-term outlook for investors by improving certainty on decarbonisation strategies (e.g. implementing laws) and preference for zero-carbon technologies via clear governmental targets and policies.
- Provide planning and support for H_2 production, transportation and storage infrastructure, e.g. scale-up subsidies for H_2 production plants.
- Value carbon dioxide by committing to a carbon price, taking account of the findings of the High-Level Commission on Carbon Prices, providing a clear, predictable price signal for CO_2 capture and storage (Carbon Pricing Leadership Coalition, 2017).
- Provide support for R&D and pilots into CCUS technology, including Direct Air Capture solutions, improving CO2 storage efficiency and security by advancing new and early-stage monitoring tools and models.

3.2.5 Adaptation and resilience

Key specific actions

- Support **comprehensive risk assessments** to identify likely costs and opportunities in adaptation and resilience, with governments providing funding for publicly available sector- and geography-specific assessments.
- Integrate **climate risk into spatial planning, economic policy, subsidies, technical codes and standards**.
- Leverage **public procurement** by including resilience requirements in all publicly funded infrastructure contracts (across all forms of construction, including bridges, roads, residential and commercial buildings, hospitals, schools).
- Increase **the scale and catalytic use of international climate finance** for global adaptation and resilience.
- Scale the share of **ODA** for solutions that deliver adaptation, integrating climate risk into ODA allocation, and increasing funding for R&D for adaptation and resilience.
- Ensure that the role of **nature-based solutions** is factored into each of the above actions, including risk assessments, spatial planning and early opportunities supported through public procurement.

Technical investment components. While it is difficult to provide with precision a comprehensive global estimate of investment requirements for adaptation and resilience, a sharp increase is necessary from current levels to address the catastrophic impacts of climate change. Most of the financing gap is in

developing countries at an estimated **$140–300 billion p.a**. by 2030,[20] with emerging economies also facing challenges to meet the level of investment required (UNEP, 2021). Advanced economies are better equipped to invest, although the scale of damage that could be faced remains to be assessed with more precision and the level of finance required has not been set out.

Investments in adaptation and resilience will vary by location. However, priority action areas across geographies include: (i) **food**, including increasing agricultural productivity and resilience; (ii) **natural environment**, leveraging nature-based solutions to mitigate and adapt to climate change; (iii) **water systems** to build levees, irrigation systems and water management; (iv) **cities**, particularly in urbanising economies; (v) **infrastructure**, including flood protection and ensuring that planned projects embed resilience (often at no additional cost); and (vi) **disaster risk management** to prevent hazards from becoming disasters.

Investment rationale. Based on the work of the Global Commission on Adaptation, investments in adaptation and resilience can deliver high returns: $1.8 trillion investment in five key areas can deliver $7.1 trillion returns over the next decade (these five areas do not represent the full breadth of investment opportunities). Such measures can reduce costs, e.g. by reducing disruptions to economic activity caused by extreme weather events – Hurricane Florence in 2018, for example, caused $24 billion in losses in the US in industries including aerospace and pharmaceuticals (Global Commission on Adaptation, 2019)– and open up business opportunities, such as flood dykes and drought-resilient seeds, estimated at $236 billion (Bartlett and Coleman, 2019).

Adaptation and resilience interventions are critical to securing a more stable world. Without appropriate adaptation action, climate change could push more than 100 million people below the poverty line by 2030 (Global Commission on Adaptation, 2019). Around 2 billion people live in dry lands vulnerable to desertification, a process that could displace 50 million people by 2030.

Supporting populations to manage climate impacts can also avoid health costs. For example, after the 2003 heat wave killed 15,000 people in France, the government implemented preventive measures and warning messages. As a result, despite exceeding temperatures in 2003, the death toll from the 2019 heat wave was 10 times smaller (Ford, 2019).

Investment barriers and policy levers. Investment barriers include:

- Lack of understanding and/or under-appreciation of future costs linked to climate scenarios (how close or far from being Paris-aligned) and lack of integration of anticipated impacts of global temperature shifts, which makes it difficult for investors to calculate returns on investment.
- Lack of financial capacity to take on high upfront costs in developing countries, exacerbated by high financing costs.
- Lack of incentives to properly evaluate risks and integrate into planning and decision-making for the finance community, businesses, and governments due to: (i) limited availability of reliable and accurate data and weak technical capacity; and (ii) regulatory requirements for insurers to provide insurance for certain highly exposed assets at regulated prices, therefore removing risk signal for these investments.

The Global Commission on Adaptation identifies three revolutions to bring climate adaptation and resilience action to scale:

- *A revolution in **understanding**,* e.g. supporting risk assessments and developing a universally agreed set of metrics for adaptation to track effectiveness of interventions.
- *A revolution in **finance**,* e.g. increasing the scale and catalytic use of international climate finance for adaptation, issued in the form of grants rather than loans.
- *A revolution in **planning***, e.g. creating incentives to integrate climate risk into spatial planning, economic policy, subsidies, technical codes and standards.

[20] $140–300 billion represents costs of acute climate hazards in developing countries only.

There is a significant opportunity to ensure that nature-based solutions are factored into each, particularly risk assessments, spatial planning and supporting early opportunities via public procurement.

3.2.6 Nature protection and restoration

Key specific actions

- Call for **global target protection of 30% of land and ocean** (in line with commitments made as part of the High Ambition Coalition for Nature and People) and integrate national targets into biodiversity strategies and long-term low-emission development strategies under the UNFCCC.
- Scale-up public and private finance for **land restoration** within and beyond the G7 to deliver on the Bonn Challenge to bring 350 million hectares of degraded and deforested landscapes into restoration by 2030 and the AFR100 aim to bring 100 million hectares of land in Africa into restoration by 2030, including support for the Great Green Wall.
- Drive **appropriate valuation of nature and ecosystem services** in line with the Dasgupta Review; creating, regulating and supporting effective carbon markets; and support the integration of climate and nature-related risks into investment, including work with the Taskforce on Nature-related Financial Disclosures (TFND).
- Increase **scale and catalytic use of finance** to reach $1 billion from G7 countries via REDD+ aligned funds in 2021 and $5 billion by 2025, prioritising jurisdictional approaches where feasible.
- Call for commitment to **deforestation-free supply-chains** through engagement with the Forest, Agriculture, Commodities Trade 'FACT' Dialogues at COP26.
- Improve the coverage of existing **biodiversity databases** and to open and coordinated data-sharing by all relevant institutions, nationally and internationally.

Technical investment components. Investment requirements to protect and restore terrestrial and marine nature are estimated at **US$ 0.1–0.25 trillion p.a.**. The majority of investment needed is in emerging and developing countries in the tropical belt, which account for a significant share of the world's land-based mitigation potential and global biodiversity. For the G7, the majority of finance for protecting and restoring nature would be directed internationally. As part of this approach, it is important to take account of the post-2020 Global Biodiversity Framework, which is currently under negotiation and addresses the long-term biodiversity goals and actions to get to a world living in harmony with nature by 2050.

Key investment elements include **$44–200 billion p.a.**[21] to protect and restore forests and peatlands and **$30–40 billion p.a.** (Deutz et al., 2020) to restore mangroves, seagrasses and saltmarshes. This represents a significant step-up from the annual average funding for forest protection.

Types of investment include: (i) land acquisition or leases; (ii) infrastructure and equipment, including vehicles, communication equipment, digital technology; (iii) investment in natural capital such as trees, seeds and foundation stocks of wildlife; (iv) staff salaries and training, including park rangers and ecotourism staff; and (v) capacity-building and training for local communities. These investments need to be made in the context of maturing markets for nature-based solutions to ensure that these do not become stranded assets (i.e. if investments are made on the assumption of returns delivered via markets, these markets need to be supported to develop).

Public and philanthropic investments do not typically go directly to land acquisition or maintenance. Instead, they can be **used to finance projects** that in turn protect and restore nature via **funds, direct**

[21] Low estimate taken from FOLU (2019); high estimate taken from UNEP, WEF and ELD (2021).

investment, or loans. These projects include **sustainable business models** (for example, sustainable forestry) and **community projects** that leverage payments for ecosystem services to invest in nature.

Investment rationale. Halting deforestation and restoring 450 million ha of natural land and forests would reduce annual net greenhouse gases by over 5Gt by 2030. Further, forests are home to most of Earth's terrestrial biodiversity. They account for 80% of all known amphibian species, 75% of all birds and 70% of all mammals (IUCN, 2008). Without action, the mounting risk of ecosystem collapse threatens to transition the Earth's three remaining major tropical rainforests (the Amazon, Congo and South East Asia) from carbon sinks to carbon sources. Protecting and restoring coastal and marine ecosystems could reduce annual net greenhouse gases by 0.9Gt by 2030 and by 1.4Gt by 2050 (High Level Panel for a Sustainable Ocean Economy, 2019).

Stable natural ecosystems also underpin productivity across sectors. The three largest sectors (agriculture, food and beverages, and construction) that are highly dependent on nature generate an estimated $8 trillion gross value added (World Economic Forum, 2020b). There are an estimated $200 billion annual business opportunities in forest ecosystem services, including sustainable forestry management approaches, terrestrial carbon markets and payments for ecosystem services (FOLU, 2019a). Deforestation, water scarcity and land degradation impose costs of almost $1.7 trillion from losses in output and biodiversity (ibid.).

Protecting and restoring nature can avoid health costs through improved air quality and reduced exposure to disease; for example, land-use change is a globally significant driver of pandemics and has caused the emergence of more than 30% of new diseases reported since 1960 (IPBES, 2020). Sustainable land managementt can generate direct jobs and job opportunities in adjacent sectors – e.g. the redirection of 5% of stimulus into nature-based solutions could create 7% more jobs globally than the BAU scenario (Vivid Economics, 2020).

Investment barriers and policy levers. Investment barriers include:

- Lack of mechanisms to accurately account for the value of natural capital; e.g. the Dasgupta Review highlights the asset management problem that has resulted from the lack of consideration of natural capital in measures of economic growth and wealth – i.e. GDP.
- Weak access to finance for projects, individuals and communities working to protect and restore nature, as these groups often have insecure land tenure, are in remote locations and have no credit history.
- Data gaps and inconsistent progress indicators make it difficult to effectively target policies.
- Weak international rules and enforcement to create disincentives for unsustainable practices, e.g. trade in illegal forest products and environmental crime.

Policy levers to drive the scale-up of investment in protecting and restoring nature include:

- Drive appropriate valuation of nature and ecosystem services, e.g. by committing to measure economic success using inclusive measures of wealth, reflecting both human produced and natural assets, in line with the Dasgupta Review, and applying these to policymaking; create and regulate effective carbon markets.
- Incentivise and support the integration of climate and nature risk into investor decisions, including via engagement in the Task Force for Nature-related Disclosures.
- Improve access to finance for the protection and restoration of nature by increasing the scale and catalytic use of public climate finance for protection and restoration of terrestrial and marine ecosystems via direct REDD+ aligned transactions, prioritising jurisdictional approaches where feasible.
- Improve the coverage of existing biodiversity databases and enhance open and coordinated data-sharing by all relevant institutions, nationally and internationally.
- Leverage market and legislative tools to strengthen international rules and enforcement and create disincentives for investment in unsustainable practices, e.g. by committing to deforestation-free supply-chains through engagement with the Forest, Agriculture, Commodities

Trade 'FACT' Dialogues at COP26 and to a new global agreement on wildlife crime, in line with the recommendations of the Global Initiative to End Wildlife Crime.

3.2.7 Productive, sustainable and efficient agriculture

Key specific actions

- **Integrate agriculture into climate strategies**, including Long-term Low Emissions Development Strategies and Nationally Determined Contributions (NDCs).
- Target to scale-up **climate- and nature-positive farming practices to 50%** of domestic farms by 2030, including regenerative practices.
- Repurpose one-third of government outlays (within total agricultural subsidies) to **support farmers in adopting sustainable practices** in managing land and in increasing the affordability of diverse protein sources, rising to two-thirds by 2030.
- Double public **R&D** into nature-based solutions and climate- and nature-positive farming inputs and practices by 2025.
- Reassert commitments to **halve food loss and waste at retail and consumer levels**, and support countries to reduce supply-chain losses by 2030.
- Target **transition to more plant-based diets** with reduction of domestic meat consumption by 2030 with country-specific targets reflecting national customs and food supply-chains.

Technical investment component: **Climate- and nature-positive agriculture**

The global investment opportunity in sustainably enhancing agricultural yields and transitioning to regenerative agriculture practices is estimated at **$90 billion p.a.**. This represents the incremental investment needed to enhance yields in key areas and to transition to regenerative, productive practices. Continued investment in agriculture and nature-based solutions will be necessary in addition to the incremental investment requirement, as part of a sustainable pathway.

Main investments include:

- **$80 billion to enhance productivity** via extension services, capital equipment improvement on farms, scaling precision agriculture, digital and biological technology, and expanding and increasing efficiency of irrigation. The majority of this investment is in EMDEs, where a failure to increase yields as the population grows will put increasing pressure on natural resources, including driving deforestation.
- **$5–6 billion to transition to regenerative agricultural practices that enhance soil quality**, including reduced use of agrochemicals, maintaining permanent soil cover, intercropping (cultivating two or more crops simultaneously), crop rotation, agroforestry (planting trees among crops) and hedgerows. Investments include training experts, R&D and production of improved agri-inputs and technology. Advanced economies account for an estimated $2–2.4 billion p.a. of the global total (FOLU, 2019a).
- **$10 billion to promote local loops and linkages**, including urban farming (e.g. in greenhouses and vertical farms) and improve composting systems (ibid.).

Technical investment component: **Reducing food loss and waste**

There is an estimated **$30 billion p.a.** investment opportunity in reducing food loss and waste globally. An estimated **$1.4 billion p.a.** will be required to reduce waste in G7 countries specifically (SYSTEMIQ, 2021; FOLU, 2019a). As with sustainably enhancing yields, these figures represent the incremental investment needed to reduce food loss and waste beyond current levels. This will not replace continued investment in agriculture and land use (estimated at around $1 trillion today), including an estimated $180 billion global cold chain storage market (Mordor Intelligence, 2018).

Key investment elements include:

- **$26 billion p.a. to reduce post-harvest losses and supply-chain waste in developing economies** by improving infrastructure, including cold-chain storage on-farm, collection, transport and warehouses; enhancing supply-chain communication mechanisms to enable farmers to better time harvests; and investing in product reformulation and processing facilities to extend product shelf-life.
- **$2.8 billion p.a. to reduce consumer waste levels and supply-chain waste in advanced economies** by scaling-up marketing, awareness-raising and behaviour change (50% of food lost or wasted in advanced economies is at the consumer stage [Lipinski et al., 2013]), improving supply-chain processes and R&D into preservation technologies.

Technical investment component: Shifting to more plant-based, healthier diets

The transition to a nutritious and sustainable 'human and planetary health' diet would have major economic and environmental benefits. This involves a reduction in over-consumption and meat consumption, and diversification of protein sources. The investment requirement is estimated at **$20–30 billion p.a.**. While regulatory and policy levers play a major role in this transition, investment requirements include:

- **$20–30 billion p.a. to diversify protein supply**, including R&D and production capacity to scale-up plant-/fermented/cultured/ocean-based proteins. The majority of these investments can and are being made by the private sector.
- **In addition to these CAPEX investments, over $10 billion p.a. spend in marketing and public health campaigns** would help to incentivise consumers to adopt more healthy diets. To be effective, funding should seek to approach or match marketing and advertising spend for junk food today, which is $11 billion p.a. in the USA and £140 million p.a. in the UK (30 times more than the Government's annual flagship health eating campaign) (Chu, 2017).

Investment rationale. Land use change accounts for around 10% of global CO_2e emissions and deforestation linked to agriculture accounts for around 40% of tropical forest loss (New Climate Economy, 2018). Without a change in practices, agriculture's footprint is set to grow (ibid.). Boosting yields is critical to reduce the strain on natural resources and reducing food loss and waste would deliver greenhouse gas reductions by easing pressure to convert natural ecosystems for agriculture (FOLU, 2019a), but shifting food consumption patterns is the most impactful step G7 countries could take to reduce demands on nature via the food system. Cattle farming is one of the biggest drivers of deforestation globally. Pasture grazed by cattle occupies 45 million ha of land deforested between 2001 and 2015, an area four times larger than that replaced by oil palm in the same period (Goldman, 2020). A transition to plant-based healthy diets could reduce food- and agriculture-related emissions by 50% globally (Clark et al., 2020). Recognising that cattle-grazing represents a critical livelihood for millions and a source of collateral for poor farmers in developing economies, this transition will need to be carefully managed (e.g. support for cattle ranchers to shift to sustainable grazing practices and new opportunities will be key). Sustainable, productive practices can also build resilience to climate shocks by reducing soil erosion, supporting watershed management and promoting diverse crops that reduce the risk of crops being simultaneously destroyed by pests.

Productive, regenerative agriculture can enhance livelihoods, boost productivity and growth, improve food security in food-stressed regions and reduce $1.2 trillion hidden costs linked to extractive farming practices today (FOLU, 2019a). Reducing food loss and waste can also improve the quantity and reliability of food supply, as well as delivering an economic return of $455 billion p.a. (ibid.).

A transition to regenerative agricultural practices is already underway. By accelerating this transition, governments can unleash agricultural yield and innovation benefits, including a $100 billion business opportunity in increasing agricultural yields in Sub-Saharan Africa alone, with high-quality inputs, technology and infrastructure (FOLU, 2019b). Further, reducing food loss and waste in supply-chains could deliver $255 billion p.a. in business opportunities by 2030, including in cold-chain storage provision, preservation technologies and using food waste to create new products (ibid.).

The US alternative proteins industry grew by ~30% in the two years to 2020, to ~$5 billion (Good Food Institute, 2020). By 2035, the market is projected to grow to $290 billion (Morach et al., 2021). The scale-up of diverse protein production could reinforce a shift towards more local food production, helping to reduce vulnerability to volatile supply-chain risks. Health costs can also be avoided. Research by FAIRR (2020) has found that over 70% of animal agriculture firms are at a high risk of fostering future pandemics. At the same time, certain industries (such as meat and dairy) are likely to experience declines. Farmers and other agricultural workers in these value-chains will require support to navigate this transition.

Investment barriers and policy levers. Barriers to investment in climate- and nature-positive agriculture and reducing food loss and waste include:

Nature-positive agriculture

- Lack of secure land tenure combined with the remote location of farming communities, weak infrastructure and limited access to markets and knowledge platforms limit farmer access to finance and inputs to enhance productivity in EMDEs.
- Lack of incentives or support for farmers to adopt sustainable practices, e.g. government agricultural support often favours more input-intensive forms of agriculture and does little to drive better nutrition or environmental outcomes.

Reducing food loss and waste

- Perverse incentives resulting from unintended consequences of policies on food safety, quality, labelling, packaging and tax incentives that limit the potential for food to be redistributed and remove incentives for retailers to manage waste; lack of consumer motivation to reduce food waste – due to low cost and ready availability of food – limits the commercial potential of business models that help consumers to reduce waste.
- The predominance of small-scale producers and traders, and of informal trading links, in developing economies can prevent establishment of uninterrupted cold storage and distribution facilities, as this requires coordination between multiple stakeholders.

A number of barriers are slowing the transition towards healthier diets, including:

- Outdated dietary guidelines that do not factor in planetary or human health setting the wrong standards for regulations, institutional meals (including school meals) and advocacy.
- Agricultural subsidies that are currently geared more towards intensive agricultural systems, with recent research finding that subsidies are highly concentrated on a few commodities, including highly-emitting animal protein products such as pork, beef and veal (Bellmann, 2019).

Policy levers that can be actioned by governments to drive the scale-up of investment in productive, sustainable and efficient agriculture include:

- Create incentives and support for farmers to adopt sustainable practices, e.g. commit to integrate agriculture into climate strategies, including Long-term Low Emissions Development Strategies and Nationally Determined Contributions (NDCs), and redirect national agricultural subsidies to incentivise and support farmers to transition.
- Work with MDBs, DFIs and the private sector to design facilities that enhance farmer access to finance and inputs, including credit, insurance, remittances and local banking capacity; reassert goals to halve food loss and waste at retail and consumer levels, and support countries to reduce supply-chain losses by 2030.
- Domestically in the G7, increase consumer motivation to reduce food loss and waste by providing public funding for consumer-oriented behaviour change campaigns.
- In EMDEs, increase the scale and catalytic use of development risk capital and ODA to support EMDEs to improve infrastructure and supply-chain communications, targeting $20 billion p.a. by 2025, and where possible link interventions to vaccine cold-chain roll-out.
- Update national dietary guidelines to align with planetary and human health and shift marketing and advertising legislation, working with civil society groups to translate these into awareness and healthy eating campaigns.

- Commit to redirect agricultural subsidies to increase the availability and affordability of healthier and more sustainable food choices for consumers, e.g. redirecting a portion of the $300 billion annual market price support towards more diverse, nutritious crops and food products.
- Leverage public procurement to create demand for diverse proteins by increasing social acceptability and reducing costs.
- Support the meat and dairy industry workforce to navigate the transition towards plant-based diets.

3.2.8 Cross-sectoral: Circular economy and digital

Key specific actions

- Promote **circular economy** through **global** assessment of maximum budget for extractable materials, definition of targets for effective decoupling of new resource consumption from human wellbeing; and support joint innovation financing and technology transfer in circular approaches.

Developing a circular economy and digital infrastructure to support digitalisation can contribute to reducing emissions and deliver cost savings across the investment areas outlined in the previous section. For example, material efficiency and greater circularity could reduce CO_2 emissions by 40% in heavy industry (steel, cement and plastics) by 2050 (Energy Transitions Commission, 2020).

Circular economy

Technical investment opportunities. Circular solutions can be applied to sectors across the economy, from mobility to food to fashion to the built environment.

Key investment opportunities vary by sector and include:

- **Mobility:** integrating public transport systems with shared vehicles; designing and producing (zero-emission) cars with reusable components (i.e. batteries); remanufacturing car components at scale.
- **Food:** scaling nutrient and energy recovery from waste, including increased composting and the use of by-products to generate new food products.
- **Built environment:** designing and producing multi-usage, modular, energy-positive buildings from durable, non-toxic materials; boosting reuse of building materials; integrating circular economy principles into urban design and development.
- **Cross-cutting:** reverse logistics systems to manage the circulation of products; digital technology to track products and connect consumers and service providers; R&D to develop innovative new materials and technologies; and business models pioneering new solutions (e.g. EV car manufacturers providing batteries as a rental service; fashion subscription and rental models; and electronics rental services).

Investment rationale. An economy-wide transition to circularity could halve emissions by 2030 in geographies such as the EU (Ellen MacArthur Foundation website). Material efficiency measures and greater circularity could reduce emissions by 40% in heavy industrial sectors (plastics, steel, aluminium and cement) by 2050 (Energy Transitions Commission, 2020). Together, these sectors account for over 10% of emissions today (6Gt in 2018).

Transitioning to a circular economy could generate net material cost savings of $380 billion p.a. in Europe (during transition), and up to $630 billion if a fundamental economic shift across all sectors were achieved (i.e. once technologies and infrastructure to support circulation of materials is scaled up and other enabling conditions such as customer acceptance, legal frameworks and cross-chain collaboration are in place) (Ellen MacArthur Foundation, 2013). There is a potential $0.2 trillion p.a. resource saving from transition to circular systems in mobility, food and the built environment in the EU alone (ibid., 2015). A reduced import dependency for raw materials can help to avoid shortages and relieve companies from volatile prices of products and raw materials, such as cobalt and lithium.

Scaling up the circular economy could create 6 million additional jobs globally by 2030. Processing recyclables can sustain around 20 times more jobs than landfill and plastic manufacturers (Goldstein and Electris, 2011). This assumes a shift in costs away from primary production towards labour (i.e. reduced CAPEX costs), in parallel with an increase in primary resource costs that account for externalities resulting from extractive practices and over-consumption of primary resources. Accounting for these externalities is critical to enable circular models to compete.

Investment barriers and policy levers. Investment barriers to the rapid development of the circular economy include:

- Lack of clear government signals and support
- Lack of enabling infrastructure to support the circulation of materials through the economy, e.g. weak collection systems limit infrastructure available to support circular systems, particularly in EMDEs
- Perverse incentives penalise circular models
- High labour costs in developed markets penalise models that require labour inputs, amplified by high labour taxation rates
- Business risks associated with retaining product liabilities over lifetime for product-as-a-service business models.

Policy levers to scale-up investment in this area include:

- Work towards a formal multilateral resources forum to assess the need for a maximum budget of extractable materials globally
- Determine targets in line with effective decoupling of virgin resource consumption from human wellbeing
- Strengthen enabling infrastructure domestically and internationally, e.g. by working with the private sector to develop and invest in waste management systems supporting 'reverse logistics' systems – collection, disassembly and redistribution systems that enable the circulation of materials
- Realign fiscal and regulatory incentives to support investment in circular models, e.g. by shifting taxes from human resources (labour) to physical and natural resources (i.e. primary products), and introducing regulation and standards (such as Producer Ownership schemes and mandatory 'material passports' in key economic ecosystems) to support the emergence of markets for circular business models
- Scale-up investment in R&D to develop circular technologies and material (e.g. recyclable, compostable or reusable packaging; textiles made of regenerative materials; and robotics to disassemble products).

Digital

The digital transformation will play a central role in transitioning to a low-carbon economy. For example, it supports a **transformation in the energy system** to 'electrify everything' and scale up renewable generation. The demand-side response of millions of assets becomes more critical as transportation and heating get electrified, e.g. smart charging behaviour for millions of electric cars, and time-shifting when electric heat pumps run and using hot water storage tanks as a buffer. Digital solutions (e.g. Internet of Things, AI forecasting and optimisation algorithms) are critical in enabling these assets to interact with the broader electricity system in a smart manner. And as solar and wind become a larger share of generation, accurately forecasting output and gathering live readings from the generation sources is important. Digital solutions (e.g. AI forecasting) are critical to this.

Digital technologies can support the **transformation of food and land use systems** by enhancing traceability, increasing productivity on farms and strengthening value-chain linkages. For example, new technologies make it possible to monitor land use, track changes in forest boundaries and biodiversity levels, and identify and address deliberate deforestation. Digital precision agriculture tools can

significantly reduce input requirements and enhance yields on farms, while access to online data offers consumers more power to choose products based on health, ethical and sustainability standards.

Advances in digital technology are **expanding the opportunities for circular models**, driving down costs and enhancing convenience relative to linear models. For example, digital tools enable closed loop solutions by tracking the location and characteristics of key materials, and digital technology underpins a sharing economy by enabling individuals and communities to connect, exchange and pool resources (as evidenced by the proliferation of digital apps, including Uber, Airbnb and fashion resale site Depop).

Beyond the above specific examples, the digitalisation of both the public and private sectors offers enormous potential as well as regulatory challenges. The work of the G7 in the context of the Summit in Biarritz in 2019, including the determination to promote an open, free and secure digital transformation, provides a relevant basis for effective digital development supporting strong, sustainable and inclusive growth.

3.2 Enabling investment-led sustainable, resilient, and inclusive recovery and growth

Key specific actions

- **Shift the policy focus from economic rescue to economic recovery** as the pandemic is brought under control.
- **Focus on an investment-driven recovery programme** centered on job-rich, green, high-impact public and private investment.
- Drive **public investment stimulus** with a coordinated, large-scale boost to public investment by 1–2% of GDP, initially debt-financed, and scaling back as private investment accelerates.
- Set out and commit to **medium-term fiscal consolidation** strategies.
- **Budget reporting** with transparency on investment versus other public expenditure, and on climate-related risks in the budget.
- **Reform tax regimes** to support fiscal revenue while shifting incentives towards green investments.

The COVID-19 pandemic is causing historically severe shocks, both human and economic. The global fiscal response, largely for rescue and short-term support, has been equally unprecedented with $16 trillion to date for health measures and to support incomes, employment and financial lifelines for businesses (IMF, 2021b).[22] Among G7 countries, the loosening of fiscal stances ranged between 6.6% and 20% of GDP in 2020. Nevertheless, G7 GDP contracted more sharply than at any time since the Great Depression. For most countries, this follows decades of declining investment ratios and slowing productivity growth. It also comes at a time of accelerating innovation in digital technologies, growing inequalities and the existential threat of climate change.

Crisis rescue and relief measures will remain essential for as long as the pandemic is not enduringly under control. There are concerns that fiscal programmes might expire prematurely. And as the crisis gives way to recovery in the coming months, relief should be replaced by policies stimulating a vigorous recovery and growth. Placing public and private investment at the core of this shift would offer a golden opportunity to drive aggregate demand, output and jobs while lifting economies onto a zero-carbon, climate-resilient, higher-productivity and inclusive growth path. This has to be done **without jeopardising fiscal sustainability in the medium term**, and strengthening and rationalising public finances in the adjustment period is essential.

As the world moves out of rescue and towards recovery, **the challenge for policy is threefold:**

- To **stimulate recovery and growth through investment while preserving fiscal sustainability.**

[22] Current as of 17 March 2021.

- To change the level and composition of investment, consistent with resilience and environmental sustainability.
- To ensure that the transition is fair and inclusive, contributing to a decline in inequality and promoting access to opportunity across gender, race and geography.

The G7 can respond strongly to this set of challenges by:

- Orienting and calibrating the near-term fiscal stimulus to promote job creation quickly, particularly via investment, including by the public sector, and recognising regional differences and needs within countries.
- Supporting an economy-wide and lasting step-up in green investments, based on a multi-level strategic infrastructure investment plan.
- Setting a medium-term framework for fiscal sustainability.
- Complementing the macroeconomic stance with policies that shift relative prices away from the dirty and towards the clean, thereby incentivising the supply of and demand for green solutions; managing the distributional impact within the population and across locations; and easing labour mobility.

Lifting investment

Investment in the advanced economies has been on a downward trend for decades, declining by 4.5% of GDP between the 1970s and the 2010s including a 1.5% drop since the global financial crisis[23] and a further sharp decrease in 2020. Public investment accounts for a disproportionate share of the decline, reflecting attempts to rebalance fiscal accounts and control public debt as fiscal consolidation tends to come at the expense of capital outlays. Public investment represented 3% of GDP in the OECD area in 2019, having dropped by 1.3% annually in real terms from 2008 to 2016. Private investment has also remained weak, with evidence suggesting that historically high uncertainty about the future state of the economy and expected profits has played a major role in holding back investment after the global financial crisis (and financing conditions less so).[24] A stronger recovery of investment would seem to depend on a reduction in economic uncertainty and expectations of stronger future growth (Bank for International Settlements, 2015).

The macroeconomic framework, including the fiscal stance, should be geared towards enabling a significant step-up of investments – including physical, natural and other capital investments. The aim would be to reverse the loss of recent years, setting the ambition for a lasting increase of around 2% of the share of investment in GDP (see section 3.1).

While eventually the private sector would be the main source of investment, public investment must play a key role, especially in the early phase – private investors are cautious given the uncertainties, and corporate balance sheets are highly leveraged. The G7 has the opportunity to call for a coordinated, large-scale, medium-term boost to public investment aimed at creating the high-return assets described in the previous section. Public investment should replace rescue-related consumption spending and be financed by public borrowing in order to avoid premature withdrawal of macroeconomic stimulus.

Frontloading a public investment push, on the order of 1–2% of GDP, initially financed by public borrowing and declining in the outer years of the 2020s, would:

- Generate infrastructure and other capital in support of long-term growth, sustainability, resilience and inclusion
- In the short-term, provide a fiscal impulse for the recovery, supporting demand in job-rich sectors while building growth expectations for private investors

[23] World Development Indicators, World Bank. The data refer to high-income countries. The average of the investment ratios of the G7 countries, weighted by 2019 PPP GDP, declined by 4.7% cumulatively between the 1970s and the 2010s, and by 1.6% in the decade since the global financial crisis.

[24] While investment ratios overall have also declined over the longer term, private investment in machinery and equipment has increased in real terms over the past 30 years, explained in part by a sharp decrease in the relative price of capital goods (IMF, 2019).

- **Create the foundation for complementary private investment and raise expected returns to that investment.** For instance, publicly funded green grids or charging infrastructure would unblock markets and raise returns to private investment in renewable power generation and electric vehicles, respectively.

Not all public investment opportunities are shovel-ready and therefore able to contribute to recovery in the short term. In fact, sustainable infrastructure projects will tend to have long lead times. Investments would have to be carefully reviewed and sequenced for their ability to be implemented rapidly, for instance by accelerating existing plans in the pipeline.

Demand in the G7 has been very responsive to the COVID-19 fiscal support packages but has focused on consumption spending given the nature of the stimulus, supply constraints during the lockdowns and significant economic uncertainty. Signalling a clear **commitment to growth through investment** and to policies that foster the transition to a zero-carbon and climate-resilient economy would **catalyse a broader private-sector response and encourage the private investment that will be at the core of sustained growth**.

The fiscal multiplier – the overall impact on GDP – of an increase in public investment tends to be higher than for other government expenditures or tax reductions. When there is a large negative output gap as is currently the case, and monetary policy is accommodating, the fiscal multiplier can be especially high. The IMF concludes that the multiplier in those circumstances could be above 2 over two years, larger than in normal times, if investments are well-governed and -managed (IMF, 2020b). With public investment targeted at high-impact, job-rich sectors, as proposed in section 3.2, it is plausible that the multiplier could exceed this level.[25]

Whereas these short-term results are driven by the demand impulse from public investment, supply-side benefits for growth extend into the medium and longer term. In particular, **public infrastructure has been shown to have a significant impact on output per worker in the private sector**, thus raising returns to private investment; this result is quite robust across countries and time.[26] Furthermore, increasing activity and investment now improves productivity by avoiding post-pandemic 'scarring' that could render countries permanently poorer. All told, modelling by the IMF suggests that **a green public investment impulse, combined with expenditure switching and other policies, would help set economies on a sustainable and strong long-term growth trajectory,** with public investment providing early support for recovery and, over time, lowering the transition costs of adjusting capital stocks to net-zero carbon by 2050 (IMF, 2020). Recent joint analysis by the IEA and the IMF estimates that the proposed increase in clean energy, energy infrastructure and energy efficiency would result in a "global GDP 4% higher in 2030 than it would be based on current trends" (IEA, 2021).

There is an important caveat, as the pandemic's damage to corporate balance sheets could hinder a vigorous private investment response. Leverage and solvency issues that have grown but remained hidden during the pandemic will become more evident once regulatory exemptions and government guarantee programmes are phased out.[27] There is a strong argument for gradualism and caution when withdrawing these measures. At the same time, countries should consider strengthening their insolvency regimes, for instance, by enabling speedy procedures and out-of-court settlements. Impaired balance sheets can otherwise weigh heavily on the recovery and blunt the effectiveness of fiscal policy.

Giving a fiscal impulse for recovery while managing debt over time[28]

Managing the public finances is central to a sustainable economic strategy. A public investment programme coming on the heels of fiscal rescue packages and large deficits raises concerns over the build-up and sustainability of debt; global public debt grew from 84% of GDP in 2019 to 97% in 2020. Reflecting these concerns as well as the diminishing strength of the pandemic and the turnaround in

[25] Idem; the Fiscal Monitor suggests that an additional $1 in public borrowing, to invest in "job-rich, highly productive, and greener activities", would generate an extra $2.7 of additional output.

[26] Calderon et al. (2015) provide an overview and find an elasticity of 0.08 for worker productivity in response to an increase in the aggregate stock of infrastructure. The European Fiscal Board argued in 2019, for a boost to public investment based on ample empirical evidence of significant long-term positive economic effects.

[27] Six months into the crisis, S&P had downgraded or cut the outlook for 35-40% of companies it rates worldwide.

[28] This section draws on the background paper by Stern and Zenghelis (2021).

economic conditions, fiscal balances in the G7 and other advanced economies are expected to begin narrowing in 2021, though by far less than projected at the beginning of the year.[29] The shift is likely to be largely the work of automatic fiscal stabilisers; discretionary spending measures remain significant, though there are differences across countries.

The continued fiscal stimulus reflects the recognition that **a contractionary fiscal policy would be premature at this stage of the crisis, when recovery is only just incipient**. The lesson from the global financial crisis of 2008–09 is that, despite short-term deficits, fiscal policy that focuses initially on the demand and growth conditions for economic recovery is more likely to bring debt ratios under control over the medium term than a focus on sharp immediate reductions in the deficit itself. Economic analysis of the experience of G7 countries in the wake of the crash found that fiscal stimuli during periods of economic weakness can improve fiscal sustainability (see Auerbach and Gorodnichenko, 2017). Even in countries with high public debt, the penalty for activist discretionary fiscal policy was found to be small. In the adjustment period, it will be important, however, to recognise and account for any build-up of liabilities.

Fiscal action so far has been overwhelmingly aimed at rescue. In 2020, advanced economies (per IMF definition) monitored by the Global Recovery Observatory announced measures worth 22.5% of combined GDP, while the corresponding figure for emerging market and developing economies was 10.6% (O'Callaghan and Murdock, 2021).[30]. Of the total, 13% represented recovery spending, and of that share, only 18% ($341 billion) was identifiably earmarked for green or environmentally positive spending – less than 2.5% of discretionary public spending in response to COVID-19. There is the risk here of a huge opportunity being missed.

The initial policy focus on economic rescue, i.e. the need to support people's lives and livelihoods and keep businesses solvent during the global pandemic, was of course necessary and understandable. With the roll-out of effective COVID-19 vaccines, however, **the policy focus should now shift decisively towards economic recovery.** Though both call on public resources and debt, they are distinct in their impact on fiscal sustainability. Whereas rescue is intended to prevent collapse, particularly in the context of pandemic policy measures, recovery seeks to drive investment and growth. Crucially, it is the most promising way of **achieving fiscal stability over time**, through growth that is strong and sustained, and not at risk of faltering. **If public borrowing is used to invest in improving the productivity of public assets, or enabling private assets to become more productive, it can enhance the medium- to longer-term sustainability of debt.** It is encouraging that programmes going forward, e.g. Next Generation EU and the American Jobs Plan, are beginning to emphasise both recovery and green, quality investments.

Public debt remains very affordable in the advanced economies because interest rates are so low. Interest on general government debt, as a share of GDP, is clustering around 2% for advanced economies, lower than it has been for decades, despite growing debt. If economies grow faster than the rate of interest on their debt stock, debt ratios will fall and/or they will retain a certain amount of fiscal space to accommodate primary deficits. Rather than focus on the size of debt, policymakers have been advised to assess fiscal capacity in terms of real interest payments.[31]

Interest rates and therefore debt dynamics will of course be sensitive to market conditions and expectations. Even though there has been an uptick recently in yields on some government bonds, **markets generally continue to take the view that interest rates will remain 'low for long'** – low rates are priced into forward bond yields and the market for inflation swaps suggests that there is confidence that inflation will remain subdued.[32] While measured inflation has increased, following record-low prices for key commodities a year ago, that base effect as well as some expected volatility in the coming period should be short-lived, given subdued labour markets and continued economic slack, according to the IMF's World Economic Outlook of April 2021. Guidance from the major central banks is reinforcing these

[29] The April 2021 IMF Fiscal Monitor projects a reduction in the advanced economy general government deficit by 1.3% of GDP, as opposed to a 5% swing projected in January.

[30] O'Callaghan and Murdock (2021) monitor the 51 largest economies. Per capita spending was 17 times higher in advanced than in emerging market and developing economies.

[31] Furman and Summers (2020) recommend for the US to ensure real interest payments remain comfortably below 2% of GDP.

[32] Despite heightened sensitivity and discussion, 10-year inflation expectations in the US as measured by the Cleveland Fed on May 12, 2021, were at 1.57%. https://www.clevelandfed.org/our-research/indicators-and-data/inflation-expectations.aspx

expectations.[33] The fact that advanced country governments have been able to deliver some of the largest and most rapid new borrowing programmes in history while financial conditions have remained so benign suggests that there is more space for fiscal ambition than had generally been thought.

Nevertheless, the current favourable borrowing environment will not last forever. Successful recovery and growth will eventually drive up real bond yields. With economies operating closer to capacity, public borrowing may crowd out private investment. The correct fiscal stance would then be to tighten policy. The time for discretionary fiscal tightening and consolidation is when the motor of the private economy is comfortably running, generating jobs, wages, growth and public revenues.[34] For countries with limited fiscal space – especially those with narrow domestic funding markets – fiscal deficits would need to be reduced faster or their borrowing needs met with international support. This is not expected to be the case for the G7 or all of the G20.

Developing medium-term fiscal sustainability[35]

The response to the pandemic required extraordinary fiscal measures that were not foreseeable before the virus emerged. But going forward it is **critical to balance short-term demand support for the recovery with medium-term sustainability**. Credible fiscal adjustment and consolidation strategies need to be developed that anchor investor expectations, to offer both predictability and flexibility. Early announcement of such packages could create near-term space for manoeuvre. As economies grow back towards their potential, fiscal stabilisers will kick in and remaining crisis-related non-investment fiscal spending can be reduced. In addition, the frameworks might contain appropriate tax and other fiscal reforms that are consistent with a path to net-zero carbon, sustainable and inclusive economies.

One anchor for expectations might be the scheduled return to fiscal rules, some of which (such as in the European Union) have been suspended during the crisis. However, the growth in debt stocks means that rules may have to be modified.[36] The point here is not to determine the appropriate rule for every country at every time, but to ensure that any medium-term measures designed to reimpose fiscal discipline are consistent with the sort of investment programme necessary to secure growth in underlying productive capacity that is inclusive and sustainable.[37]

In this connection, there should be an important **revision of government expenditure accounting that results in a clear distinction between investment and consumption spending**. Where government investment is a source of private-sector-led growth and sustainability, with positive multipliers as discussed earlier, it goes against economic logic to treat it like consumption (Buiter et al., 2020). Fiscal sustainability and consistency with climate goals would be further enhanced if budget processes mandated analysis and provided for transparency and reporting of climate related risks, as proposed by the Paris Collaborative on Green Budgeting (OECD, 2020a). This, however, requires coordinated work at different levels of government on balance sheets that are compatible with the Government Finance Statistics Manual 2014 (GFSM 2014).

The medium-term fiscal strategy would also offer an opportunity to consider tax reforms and supplementary policies that are effective tools for pursuing climate objectives, reinforcing the investment measures. A key national priority would be the **appropriate pricing of carbon through tax and trading schemes** (see next section). Effective carbon taxation at the national level provides an opportunity for congested or polluted cities to impose higher 'piggy-backs' or surcharges. Such own-source revenues can be critical for sub-national government in establishing sustained access to private finance, and tax-benefit linkages at the local level reduce the likelihood of political opposition, including on property taxes. Furthermore, at the national level, strengthening the VAT to replace distortive taxes would help in

[33] Government bond market yields picked up somewhat in the US in Q1 2021 and yield curves have steepened slightly but are still moderate, and conditions on the European and other bond markets continue to be soft.

[34] Excess desired global savings, which are a factor explaining low-for-long real interest rates, may also diminish as a result of demographic change (Goodhart and Pradhan, 2020). But change will be gradual and leave a long window of opportunity for the kind of fiscal action described in this report.

[35] For greater detail see background papers to this report by Stern and Zenghelis (2021) and Ahmad (2021).

[36] Blanchard et al. (2021) propose "fiscal standards" to replace rules and ensure accountable governance, given the near impossibility of designing unambiguous rules.

[37] Note that flexibility is needed in the face of constraints on monetary policy, such as when interest rates hit the zero lower bound, requiring additional fiscal and monetary policy coordination.

preventing 'base shifting'. Internationally, an approach that could provide a material revenue boost and ensure greater cross-country tax equity would be agreement on a global minimum corporate tax, following the G20's commitment to reach an agreement by year's end. And with the crisis accelerating the shift toward technologically enhanced tools, there will be a need to rethink certain other aspects of taxation, including finding new sources of revenue from online businesses (O'Neill, 2021).

3.4 Aligning policy with structural change

Key specific actions

- **Commit to putting the right price on carbon and rapidly eliminating fossil-fuel subsidies**. This could include consideration of an international carbon price floor among large emitters such as the G20, and border adjustments for energy-intensive trade-exposed sectors.
- **Lead in the global energy transition by setting targets for zero-carbon power and road transport**; investing strongly in clean energy and energy efficiency at home and in developing countries; phasing out **unabated coal power generation domestically by 2030**; **ending overseas support for fossil fuel investments, starting with coal power generation**; and defining a clear phase-out strategy for fossil fuels other than coal, in line with the goals of the Paris Agreement. Foster and share research and development in energy and beyond.
- **Commit to a 'just transition';** ensure that the benefits and opportunities are shared widely; protect those that are most vulnerable to economic losses.
- Step up **green R&D** and bring innovations to market rapidly through direct public support, risk capital and open markets.

Systemic change occurs at scale through the effective combination of macroeconomic and structural policies, setting a clear sense of direction and giving confidence to investors. Through structural policies, i.e. policies impacting the composition of economic activity directly or through relative prices, action by the G7 can **accelerate progress towards net-zero emissions while boosting recovery and social cohesion**.

Stepped-up public investment for a green recovery can catalyse private investment and contribute to a higher share of investment in GDP. The previous section discussed the **macroeconomic enabling conditions**. However, the larger challenge is to **change the composition of the whole capital stock** over time by making all new investment decisions consistent with a zero-carbon trajectory and encouraging retrofits where possible. Physical capital, e.g. in the energy sector or buildings, can depreciate over many decades, making it urgent to ensure that investment decisions become aligned very quickly. Such rapid and comprehensive change can only be achieved through shifts in price signals and economic incentives, complementing the public investment programme, and including public support to accelerate R&D by addressing failures in the markets for knowledge. Finally, a crucial component of any programme of sustainable growth is to provide assistance to those most affected by the transition, helping ensure fairness and inclusion as well as the necessary political support for change.

Beyond policies targeting individual prices or markets there is the importance of affecting broad-based change in key systems, including cities and areas such as land use, transport and logistics, and of course energy. These systems together account for a large majority of greenhouse gas emissions. Change would require vision, a strategic approach involving multiple public policy tools, as well as comprehensive and coordinated action by the public and private sectors.

The need for carbon pricing, subsidy reform and regulatory action

Putting a price on carbon, through a tax or emissions trading system (ETS), is the single most powerful and economically efficient mechanism to promote the use of clean energy and the adoption of low-carbon industrial processes and energy savings practices – directly and through innovation – when supported by complementary policies to encourage substitution and taking into account distributive effects. A tax is simpler to administer and provides for more stable prices. An ETS is more complex and volatile but can be politically more palatable since it is easy to grasp ownership of the 'product' that is a unit of emission. The increase in the price of high-carbon relative to low-carbon products and activities

shifts demand towards lower carbon intensity, and with it investment, innovation and employment. But whichever the approach, we need to be clear: contrary to some popular rhetoric, putting a price on carbon strengthens the market economy, since it establishes property rights and assigns a value to carbon supply and demand. Not pricing carbon undermines the market economy.

Carbon pricing has been endorsed by industry bodies as it would provide transparency, a predictable framework for decision-making and 'future-proof' investment decisions.[38] In 2019, about 1,600 companies disclosed that they currently use internal carbon pricing or that they anticipate doing so within two years (World Bank, 2020c). But using carbon pricing as the key measure that it should be to achieve climate targets would require both more carbon pricing policies to emerge and existing carbon prices to increase. In mid-2020 there were 61 carbon pricing initiatives in place or scheduled for implementation at regional, national and sub-national levels, consisting of 31 ETSs and 30 carbon taxes, covering 12Gt CO_2e or about 22% of global greenhouse gas emissions (ibid.). However, effective carbon prices even under these schemes remain generally far below necessary levels.

The G7 has the opportunity to accelerate movement towards a meaningful carbon price, with the Stern/Stiglitz schedule as a common reference (Carbon Pricing Leadership Coalition, 2017). Modelling suggests that a step-by-step increase in carbon prices, even by a modest 7% annually, starting at $6–20/t$CO_2$e if part of a broader policy package, could be effective at placing economies on a path to net-zero by 2050 (IMF, 2020).

Carbon pricing should be synchronised across countries. A coordinated approach would increase effectiveness by preventing 'tax dodging', i.e. shifting carbon-intensive activities into low-tax jurisdictions; it would help ensure a level playing field in trade; and international cooperation through carbon markets under Article 6 of the Paris Agreement can enable access to a wider pool of opportunities to reduce emissions. Given the urgency to act, a practical approach proposed by the Managing Director of the IMF[39] would be for large emitters such as the G7 and G20 to agree an international carbon price floor, which could be implemented domestically through mechanisms that match each country's policy preferences. However, to the extent that countries do not move in lock-step it may be necessary, for both economic reasons and political acceptance, to consider border adjustment schemes that 'level out' the impact of carbon pricing for energy-intensive goods that are exposed to trade. Since border adjustments can backfire on cooperation, their use will need to be limited, well-targeted on the most relevant products – high polluting hard-to-abate sectors in particular – and linked to support schemes and a framework for recalibration.

Similarly, it is urgent that subsidies for fossil fuels are phased out as they function as a negative carbon price and represent a glaring inconsistency on the path to net-zero-carbon economies (indeed, many countries simultaneously tax and subsidise carbon). Volumes of subsidies represent a multiple of the revenues from carbon taxes and emissions trading ($180 billion in fiscal support in the OECD area, or more than $5 trillion globally when factoring in the value of externalities) (Coady et al., 2019).[40] Eliminating these subsidies would generate considerable fiscal gains. This is relevant in the context of current revenue mobilisation needs (ibid.).

Since 2009, when G20 leaders committed to "rationalise and phase out over the medium-term inefficient fossil fuel subsidies that encourage wasteful consumption" (G20, 2009), subsidies had been on a downward trend, a trend, however, that appears to have recently reversed. According to the OECD (2021), "there is little evidence that governments are using COVID-19 recovery efforts and current [oil] market conditions as a spur for fossil-fuel subsidy reform. Many countries are funnelling the bulk of stimulus funding to support fossil-fuel and related industries, often with no climate change or pollution-reduction requirements attached." Continuation of such policies, which could, of course, significantly undermine a sustainable recovery, would be a matter of serious concern.

The G7 could recommit to the earlier timetable to phase out fossil fuel subsidies by 2025 and encourage partners in the G20 as well to follow through on their past commitments. The impact for society would be

[38] See Carbon Pricing Leadership Coalition website, www.carbonpricingleadership.org/.

[39] Managing Director Kristalina Georgieva at the inaugural Leaders Summit on Climate, 21 April 2021.

[40] Projections refer to 2017.

vastly net-positive, but at the same time it would be important to support those that lose out during the transition (see below).

Price and subsidy action on their own may not be effective fast enough in view of dwindling carbon budgets and as the huge scale of climate risks becomes ever clearer. Put differently, supply and demand inertia (elasticities) in some sectors may be such that rapid change would require unacceptably steep hikes in carbon prices. For the most polluting sources of energy, in particular coal and gasoline, a more effective and necessary approach would be regulatory action and a schedule for phasing them out. The historical evidence is that regulatory limits have been highly effective not only at curtailing environmental pollutants (from SO_2 to CO_2 and heavy metals) but also at setting a powerful signal for private sector behaviour and spurring innovation. It is absolutely clear today that global coal plant life expectancy and existing investment trajectories are not compatible with the goals of the Paris Agreement.[41] Commitments to phase coal down and out, and to end the international financing of coal plants, have been made in various fora, including the inaugural Leaders Summit on Climate this April. But these commitments need to be concrete, especially for the largest emitters, and have suitably ambitious dates attached. The same is true for the internal combustion engine, for which the UK and Japan have established sunsets; other countries should follow. The G7 can and should establish leadership in this area.

The fourth key component of the structural policy package, supplementing carbon pricing, the phase-out of subsidies and regulatory action on coal and other major pollutants, is action through the financial sector. Appropriately factoring climate risk and impacts into decision-making in the financial markets – on loans as well as portfolios – aligns financial choices with the signals contained in carbon prices. There has been significant progress in recent years with factoring climate-related risks (both physical risks and asset stranding) into financial models, supported by guidance from the Financial Stability Board/Task Force on Climate-related Financial Disclosures. Systematic accounting for such risks should become mandatory, cover other parts of the financial sector, not just banks, and incorporate threats to natural assets including biodiversity in addition to climate-related risks. The launch of the Glasgow Financial Alliance for Net Zero (GFANZ) in April 2021 promises to catalyse a welcome, comprehensive approach. In central banking as well, net-zero risks and objectives could be incorporated into collateral frameworks, refinancing and asset purchase programmes. The G7 can lead by setting the direction of travel in this area. These points are taken up in section 3.5 but it is worth noting the internal logic and complementarities of the wider package of policies directed at readjusting economic incentives to the climate challenge.

Ensuring inclusive growth and a just transition

It is important that the post-pandemic recovery and the transition to a net-zero emissions and climate-resilient economy are, and are perceived to be, **'just'**, both for ethical reasons and to maintain support within society. **This means ensuring that the benefits and opportunities are shared widely, while protecting those who are most vulnerable to economic losses**. It is particularly important to mitigate the potential negative distributional effects arising from an accelerated green transition. Committing credibly and in advance to managing dislocation, especially when concentrated in particular locations, will be a crucial part of this process and will involve investment in places and people. The transition and reallocation costs to assist displaced workers will require budgetary support, which should be part of the recovery packages and spending beyond. It will also be important to tackle inequalities between countries, and particularly to ensure that poor and fragile states are not left behind.

As set out in the *Solidarity and Just Transition Silesia Declaration* (at COP24): "a just transition of the workforce and the creation of decent work and quality jobs are crucial to ensure an effective and inclusive transition".

The evidence from existing carbon pricing schemes shows considerable job shifting (Yamazaki, 2017) but overall, carbon pricing is "consistent with no effect of the tax on the growth rates of GDP or

[41] UN Secretary-General António Guterres in his message to the Powering Past Coal Alliance Summit on 2 March 2021. Mr Guterres noted that governments are not on track to meet the Paris Agreement goals, and urged to "end the deadly addiction to coal" by cancelling all global coal projects in the pipeline. Phasing out coal would be "the single most important step to get in line with the 1.5-degree goal of the Paris Agreement".

employment" (Stock and Metcalf, 2020). At the same time, the public investment programme at the core of the recovery package will create new jobs in zero-carbon sectors that are often relatively less capital- and more labour-intensive to offset job losses in high-carbon sectors. Therefore, modelling of the climate transition considering the various elements of the package shows net-positive employment effects (IMF, 2020). Net job creation is the first and most important element of a just transition.

However, looking more closely at the transition at sector level, some workers may get trapped in declining carbon-intensive industries and skills and the geography of the new, low-carbon jobs will often differ from the old. And in the shorter term, a green investment push means – by design – that 'browner' industries will not benefit proportionately from the recovery and may not revive fully once the pandemic is over.

These concerns need to be addressed through programmes for a just transition that will be country-specific, taking account of local circumstances and based on social dialogue (see ILO Climate Actions for Jobs Initiative, 2019). Measures might include facilitating the reallocation of labour and capital through, for example, targeted hiring subsidies, wage-loss insurance programmes, and systematic training and job search assistance (IMF, 2021a). The transition of industries towards decarbonisation and the accompanying changes in employment will require worker retraining and the learning of new skills. Sending clear signals and taking appropriate actions will not only support industrial transitions but also lead to greater social acceptance of the necessary socioeconomic transformations.

A just transition may also require action at the local level, such as restructuring existing housing stock. Programmes should consider directing public investment towards economically lagging locations, where justified by expected economic rates of return. However, national investment in connectivity (e.g. high speed trains), as part of 'levelling-up', may not result in creating employment in lagging regions unless there are commensurate enhancements in local services and infrastructure (Ahmad, 2021).

Carbon prices and subsidy withdrawal will also impact consumers differentially. Much of the burden of adjustment tends to fall on urban middle-class households on fixed incomes, or those who no longer function in the labour market, such as the elderly or disabled who rely on government benefits. Possible adjustments in benefit payments will need to be addressed on a country-by-country basis and might include adjustments in pensions, unemployment insurance and child benefits, depending on the social security arrangements in place in different countries. International finance institutions often recommend conditional cash transfers (CCTs) in emerging market countries to accompany carbon price adjustments. However, CCTs are typically designed to protect the poorest households and care should be taken to ensure that target populations are indeed those that are most heavily affected.[42]

Distributional goals in the post-COVID future are likely to stretch well beyond redressing the impact of the climate transition. For instance, there will be a need to rethink the distribution of risks in society, taking account of growing old-age dependency ratios and rapid growth in demand for care; to ensure gender fairness and cohesion at work; and rebalance the progressivity of fiscal revenue and expenditure.

There are existing initiatives and experiences in each of these areas, some under implementation in G7 countries. The G7 would be sending a meaningful signal if it were to make and communicate its commitment to measures supporting a just transition and inclusive growth as part of its broader programme for a sustainable recovery.

Support research and development to improve trade-offs and accelerate change

Both stronger policy and further technological innovation are needed to reach deep decarbonisation goals, with one complementing the other. Pricing carbon spurs innovation in low-carbon solutions throughout the economy;[43] and innovation makes it easier and more affordable to phase out carbon-intensive processes and products in response to price signals.

Innovation will be central to change and can be directly supported through well-oriented and creative R&D and innovation institutions such as Mission Innovation and the International Solar Alliance.

[42] To the extent that political opposition to carbon pricing reflects relative impact, this has often come from the urban lower middle class, not necessarily the urban or rural poor.

[43] The power of prices was evident in the replacement of coal in the US energy mix by gas and renewable energy as a result of their relative cost decline over the past decade, even in the absence of carbon prices.

Standards and regulations can play a powerful role in the complementing of innovation policy, so too the **design of cities** and the development of **circular economies** and similar frameworks that are crucial to innovation at both individual and system levels. The key systems are cities, energy, transport and land.

Investors see growing market potential in low-carbon technologies (International Finance Corporation, 2021). Nevertheless, the pace of innovation is insufficient to reach climate goals. For instance, in the United States, absent further innovation, electricity generation from low-carbon sources is not projected to grow fast enough to make a significant dent in overall emissions; prospects are similar at the global level, using the IEA's Reference Technology Scenario (Cunliff, 2018). Net-zero emissions goals rely on several large-scale, *pre-commercial* technologies such as long-term grid storage, CCUS, low-carbon steel processes, green hydrogen, and new ship and aircraft concepts (see sections 3.2.3 and 3.2.4).

Carbon pricing policies will be important to accelerate change, but while they help to incorporate the social costs of emissions into energy prices, they do not tackle market failures in the market for innovation itself which prevent more rapid discovery, adoption and commercial scaling. Knowledge spillovers make it difficult for firms to realise the true social value of their inventions, and capital market imperfections in the face of long time horizons and large upfront costs impede the transition from the laboratory to commercialisation (Popp, 2019a, 2019b).

Public innovation policy is needed to support fundamental research, which is too distant from commercial applications, as well as to bridge technologies across the commercial 'Valley of Death' (Carbon Pricing Leadership Coalition, 2017). **Governments have a pivotal role that goes far beyond simply funding research and development.** They set overall national objectives and priorities, and are vital in determining market expectations, ensuring the flow of knowledge, investing in essential infrastructure, and enabling major demonstration projects to go ahead (IEA, 2020e).

Modelling by the U.S. Department of Energy from 2017 demonstrates the relative impact of clean energy technology innovation and additional policies. Increases in both clean energy public research, development and demonstration (RD&D) support and in carbon prices can drive significant cuts in CO_2 emissions from energy, but the impact of the combination of both far exceeds that of each approach on its own. Any hope of achieving decarbonisation targets for 2050 would require a stretch scenario for public innovation support, including full implementation of governments' Mission Innovation commitments to double public clean energy R&D investments, together with carbon pricing. Accelerating R&D can soften the trade-offs around carbon pricing and help build political consensus for climate policies.[44]

However, despite the evidence and the commitments, the share of public energy R&D spending of OECD members relative to GDP has remained flat over the last decade, and other public research objectives, such as defence, receive around five times more R&D funding than energy (IEA, 2020e).[45] And while companies active in renewable energy showed an impressive 74% growth in R&D spending between 2010 and 2019, their share remains below one-tenth of total corporate R&D (ibid.). Meanwhile sectors that do not yet have commercially viable solutions for deep decarbonisation, such as cement and iron and steel, typically spend relatively little on R&D. Fewer patents have been filed for low-carbon energy technologies each year since 2011. The COVID-19 pandemic may further dampen the outlook for public and private R&D spending, in the way that past crises have.[46] The reality is that the broad-based adoption and implementation of technologies – both across and within countries and sectors – are lagging far behind were they need to be.

To build back better, technology needs to be literally wired into the physical, natural, human and social capital stock that will be created in the coming years. The G7 has the opportunity to launch a concerted

[44] According to the IMF's World Economic Outlook of October 2020, assuming a plausible response of technological change to the price of carbon – and combining it with a subsidy (of 70%) for green R&D – would allow a similar emission target to be achieved with a carbon price path at about half the prices required in a scenario with no such support. In the presence of endogenous technical change and R&D subsidies, the transitional costs of mitigation policies are therefore significantly lower, and global GDP rises towards the baseline earlier (around the mid-2040s) than in the absence of innovation.

[45] Climate change has been identified as a national security threat and defence spending could be invested in R&D to combat and/or adapt to climate change.

[46] According to the IEA (2020), corporate R&D is highly likely to be cut or to grow much more slowly in most energy-related sectors as a result of lower revenues in 2020 and beyond. This impact was already evident in company reports for the first quarter of 2020, with companies representing a large share of global revenue in the automotive, aviation and chemicals spending less on R&D than in previous years.

initiative to support the conversion at scale of technological innovations into business, government and household applications. Support for clean energy R&D is likely to show high and rapid returns, particularly where it is focused on bringing new technologies to market. According to the IEA (2020e), around 40% of the cumulative CO_2 emissions reductions needed to shift to a sustainable path will come from available technologies not yet commercially deployed on a mass-market scale. Both financial and demand-side support can accelerate adoption. For earlier stage technologies (around 34% of emissions reductions), there will be a need to ensure technologies currently only in the laboratory or at the stage of small prototypes are quickly made available for commercial investment. Direct financial support is more important for technologies that are further from the market and where knowledge spillovers are particularly significant, including through government funding of research projects and support such as tax credits for private sector R&D.

Finally, innovation requires markets, including for climate technologies. The G7 might take the lead in reaffirming the global, rules-based trading system with the WTO at its core. Trade operates best when it is open but also perceived to be fair, especially around the rules governing social and environmental factors, as well as digital trade. As noted in a background paper for the Development Committee (World Bank, Spring Meetings 2021), developed countries can support a global, sustained and inclusive recovery through trade reforms that reduce the current bias towards carbon-intensive upstream goods, support green trade liberalisation and review trade-related measures, such as intellectual property rights, that may restrict the diffusion of clean technologies to developing countries. In this context, the G7 could work together on creating lead markets for climate-neutral products, on refinancing the public support required for the transformation of industry, and on establishing guidelines for measuring the carbon footprints of materials.

3.5 Financing for green recovery and transformational growth

Public finance has a crucial role in supporting demand, enabling investment and helping to shift incentives economy-wide. The design of public finance is also important because of the signals it sends about the stability of the macroeconomic framework. The perception of a lack of medium-term fiscal sustainability deters private investment and would reduce the output and jobs multipliers associated with fiscal action. Public expenditure frameworks, for instance in planning and procuring infrastructure, should reduce existing gaps with respect to efficiency benchmarks. And tax policy should help ensure a revenue buoyancy that is sufficient – and seen to be sufficient – over the medium term to support fiscal consolidation. In that context, closer international tax cooperation could help to bolster public finances by providing clarity on the global tax regime, including through the consideration of a minimum floor for corporate taxation. A convincing proposal that has been made would be to set the minimum tax rate on corporate profits at 21%.

Finance ministries will be central in these efforts and they will need to ensure that climate is mainstreamed into their operations. It is important in this context to **ensure that the policy and investment components of recovery plans support the Paris Agreement goals.** The Coalition of Finance Ministers for Climate Action, currently involving over 60 countries, is helping finance ministries accelerate the mainstreaming of climate into macroeconomic policy, fiscal planning, budgeting, public investment management and procurement practices; developing climate-oriented fiscal tools; and promoting the mobilisation of private sources of climate finance. And there are potentially powerful cost-reduction effects from sharing sustainability standards around procurement. Furthermore, reflecting the growing role of cities in developing and implementing sustainable, resilient and inclusive action at the local level, close attention to strengthening sub-national finance capacity is required.

Transforming the financial system is a major component of action to help both scale up and shift the composition of investment, and also enhance its quality. This is reflected in the work of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) and in the COP26 Private Finance Strategy, both of which aim to ensure that every financial decision takes account of climate change.

3.5.1 G7 finance action areas

Key specific actions

- **Strengthen international tax cooperation** to help bolster public finances and provide clarity on the global tax regime, including through the consideration of a minimum tax rate on corporate profits of 21%.
- **Accelerate the shift in the financial system by working together and with the private sector to:**
  - **Improve the availability of information on climate-related financial risks** that is consistent, comparable and reliable, including support for **mandatory disclosure.**
  - **Strengthen risk management** by developing the activities of the NGFS and encouraging central banks to further strengthen the analytical tools in the financial sector to assess climate-related risk, requiring all financial institutions (insurance, banks, funds) to include climate- and nature-related risk assessment as part of the banking supervision function.
  - **Support efforts to identify opportunities for green investments.** This will involve strengthening and unifying green and environmental, social and governance (ESG) standards and protocols for measurement and transparency of the sustainability of all investment products.
  - **Step-up sovereign green/sustainable bond issuance** to finance the recovery and develop the green finance market.
  - **Encourage financial institutions to align their portfolios with the Paris Agreement goals.**

In G7 countries, **the private sector is already allocating finance towards specific market segments,** where the combination of declining capital costs and favourable investment conditions is becoming established due to sound policy and clear regulatory signals. This is the case, for example, for renewable energy finance. There is also an increasing recognition that high-carbon investments are not only damaging from an environmental and health perspective but involve growing commercial and financial risks in the context of a strong shift towards an environmentally sustainable recovery. This positive trend must be accompanied by the curtailment of financing for coal investments.

The role of public finance will remain crucial, however, particularly in areas where policy and regulatory risk is perceived to remain high, for example due to the lack of established markets, the long-term nature of investments, significant public good characteristics, or high early-stage or first-mover costs. In this case, public policy and innovative finance will be key to accelerating the mobilisation of private-sector finance through appropriate de-risking or incentive mechanisms and creating certainty through clear policy signals. Infrastructure and development banks, national and international, could have a significant role in this context. The public sector has a major role in shifting perceived risks and opportunities associated with key assets.

Specific policy levers for each investment action area are highlighted in section 3.2 and Appendix 2. For example, while the private sector will build electric vehicles, the public sector must play a key role in setting a clear policy path (for example by regulating the phase-out of internal combustion engines for cars) and by supporting the rapid expansion of charging infrastructure. The European Green Deal provides a good illustration of the type of policy, investment priorities and finance mechanisms that can drive such a transition, including the important role of public finance institutions like the European Investment Bank. This is also reflected in both the UK government's Ten Point Plan for a Green Industrial Revolution set out in November 2020 and its plan to create a national Infrastructure Bank (building on the success of the Green Investment Bank, which helped establish a thriving British offshore wind industry).

Furthermore, reflecting the growing role of cities in developing and implementing sustainable, resilient and inclusive action at the local level, further attention should be given to **strengthening sub-national finance capacity**.

As mentioned above, **transforming the financial system is a core component of action to support green investment** and is reflected in the work of the NGFS and in the COP26 Private Finance Strategy. Important work is also being carried out in complementary initiatives to green the financial system, including the International Platform for Sustainable Finance, the TCFD, the UNFCCC's 'Race to Zero' campaign, building up private carbon markets, and the recently launched Glasgow Financial Alliance for Net Zero (GFANZ) which involves over 160 firms, together responsible for assets in excess of $70 trillion. Taken together, these initiatives seek to green both the allocation of private capital and public finance policy.

The "fundamental reshaping of finance for a whole economy transition" (as the COP26 Private Sector Strategy calls for) involves a transformation of the financial system consistent with the path set by government structural and sectoral policies (see sections 3.2 and 3.4, and Appendix 2). These recommendations would influence the asset allocation and risk assessment process for the largest pools of finance, including pension funds, insurers and banks. While proposals have a broad applicability beyond the G7, a decisive move by the G7 on these measures would have a **significant impact in enhancing the productive use of global savings and expand sharply the flow of finance for green and resilient investment**.

Reporting, risk management and returns

The *COP26 Private Finance Strategy* published in November 2020 aims to ensure that every professional financial decision takes climate change into account through the application of the '3Rs' – reporting, risk management and returns:

- **Reporting** to support capital allocation decisions based on:
  - reliable, comparable, and consistent information about the exposure of portfolios and balance sheets to high-carbon assets and to physical climate impacts; and
  - objective and standardised information about the characteristics of 'green' and 'sustainable' financial products.

  A broad range of initiatives have been taken to support the provision of such information. This includes the framework defined by the Task Force on Climate-related Financial Disclosures (TCFD) and the EU Taxonomy for Sustainable Finance, which provides a classification tool setting environmental sustainability performance requirements for economic activities across a wide range of industries. Going forward it is important to both define the scope of mandatory requirements and to move towards more unified sustainable finance standards (see section below on standards). Support to the establishment of the Task Force on Nature-related Financial Disclosure (TFND) should be considered to assist the financial sector to better assess and manage the risk posed by biodiversity loss and ecosystem degradation on financial stability.
- **Risk management** to ensure that financial institutions and other market participants systematically measure and manage climate-related financial risks. This includes the risk-weighting of bank assets based on their climate-related characteristics, climate-risk stress testing for banks and insurance companies, and monitoring of transition and stranded asset risks in asset portfolios and across the financial system as a whole. Reflecting the evolution of the policy context, increasing emphasis should be given to net-zero emissions scenarios.
- **Returns** to identify and focus on the opportunities arising from the transition to a net-zero, climate-resilient economy **and to report their own alignment with this transition**. Actions in this area include pledges and strategies for portfolio decarbonisation, the expansion of green finance products, and increased investment in climate mitigation and adaptation. Such actions by major financial players can send meaningful signals to the market, contributing to the accelerated development of green finance. It will be critical that the G7 supports a strong focus on accountability and transparency so that major commitments to decarbonise and invest sustainably are actually delivered over the next decade. This could include a **new regulatory focus on concrete climate transition plans** for large companies and financial institutions within clear time horizon and **annual accountability** mechanisms.

This approach can have a significant impact on the scale of capital deployed towards a net-zero, climate-resilient economy, particularly in developed economies.

Sustainable finance standards

The combination of increased clarity of climate policy directions and growing investor appetite for sustainable investment has led to a significant increase in the range of both sustainable finance products and standards. For example, the range of sustainable bond products has expanded to include green, blue, SDG, social, transition, resilience and sustainability-linked bonds. Standards range from broad principles such as the PRI's Principles of Responsible Banking to the recently published British Standard Institute PAS 7340:2020 (*Framework for embedding the principles of sustainable finance in financial services organisations – Guide*) to tailored approaches by individual asset managers to ESG integration by investment strategy and asset class.

The definition of **unified sustainable finance standards** building on the range of initiatives and activities in this area would support a significant growth and confidence in sustainable finance and reduce the scope for 'greenwashing', which can have a corrosive impact on market confidence and development. Work is underway to streamline the evaluation of green bonds and other sustainable investing products and to improve the coherence of standards across private firms, industry bodies and international organisations. Existing fora such as the Basel Committee, NGFS and International Financial Reporting Standards (IFRS) should be used for this purpose. Initiatives underway include the IFRS consultation on sustainability reporting, green bond standards, and work to enhance the comparability of ESG disclosures. The EU is developing a sustainable finance package supporting the Green Deal, setting transparency, reporting and labelling standards to channel private finance into sustainable investments. The formulation of clear and consistent standards and definitions would promote transparency and efficiency, while enhancing public and market confidence in 'green' or 'sustainable' financial products.

Central banks

Reflecting recognition of the impact of climate change on financial, price and macroeconomic stability, central banks have become increasingly active in considering climate-related factors in relation to their mandates. This is particularly visible in the work of the NGFS, which includes 90 members, as well as the work of the Bank for International Settlements, the European Central Bank and a number of individual central banks such as the Bank of England, the Banque de France and the De Nederlandsche Bank. The recent establishment of the Supervision Climate Committee by the US Federal Reserve System is a further important step.

Building on this important work, central banks should be encouraged to consider the following practical actions:

- Reaffirm that their financial stability mandate implies assessing climate change-related physical and transition risks in their jurisdictions
- Work towards aligning central bank portfolios and asset purchase programmes with net-zero-carbon objectives, including in the design of COVID-19 recovery packages
- Promote liaison and coordination between central banks, supervisors, and policymakers on net-zero
- Strengthen and unify standards and taxonomy on green investment products
- Further strengthen the analytical tools in the financial sector to assess climate-related risk, including macro models, risk metrics, stress tests and scenarios, and portfolio design compatible with 1.5°C
- Include climate risk assessments as part of the supervision of all financial institutions (insurance, banks, funds).

Green bonds

In parallel to the development of more unified standards, the growth of the sustainable finance market should be actively pursued. In this context the growth of the green bonds market has been particularly encouraging, with cumulative issuance reaching $1 trillion by the end of 2020.

Scaling of the issuance of high-integrity green and sustainable sovereign bonds to finance the recovery should be encouraged. The EU has already confirmed plans to issue €225 billion in green bonds to support its recovery plan and the implementation of the European Green Deal. Green bond issuance reached a record level of $269.5 billion in 2020, reflecting in part the rising policy focus on a sustainable recovery and 'building back better'. Green bond issuance from the US, Germany and France was above $30 billion each, with the US issuing $51.1 billion in 2020. Energy accounted for around one-third of green bond issuance in 2020, with buildings and transport accounting for around one-quarter each. Green bond issuances in the transport sector, including urban transport, included half of the top 10 certified issuers, with the largest being the $12.2 billion green bond programme for the Société du Grand Paris to fund the expansion of the Paris commuter and metro rail network.

3.5.2 G7 global support and cooperation

Key specific actions

- Act strongly to **alleviate the debt constraints of low-income and vulnerable countries.** This could include **extending the Debt Service Suspension Initiative**, requiring comparable treatment of the private sector and tackling over-indebtedness by **strengthening the G20 Common Framework for Debt Treatments,** reprofiling and reducing the cost of official debt, and considering the potential of debt-for-nature and debt-for-climate swaps.
- Make a **collective commitment to double climate finance, improve quality, and raise the proportion of grants, to deliver on and go beyond the $100 billion per year target** that is critical to the success of COP26 and adequate support for climate action by developing countries.
- **Follow the agreement of a new allocation of special drawing rights of $650 billion, support reallocation mechanisms** that can widen financing options for recovery programmes in low-income and vulnerable countries, support effective vaccination and health campaigns, and promote green transitions.
- **Enable the multilateral development banks (MDBs) to scale up support for a green recovery, the drive to net-zero emissions and climate adaptation/resilience, and the fight against biodiversity loss** through: an **accelerated International Development Association (IDA) replenishment** in 2021; **more effective use of MDB balance sheets**; enhanced **private-sector finance mobilisation**; accelerated **alignment with the Paris Agreement**; and proactive **MDB capital increases** within a requirement to work better together.
- Call upon the **IMF and the World Bank to: fully integrate climate into surveillance/development assessments,** including the implications for the drive to net-zero emissions and for climate resilience, and the monitoring of financial systems' exposures to climate and environmental risks when conducting Financial Sector Assessment Programme (FSAP) and Article IV consultation; and to **assist countries to formulate sustainable, resilient and inclusive development strategies**.

The G7 and G20 economies have the fiscal space, given the low-interest environment, to implement an investment-led stimulus and growth programme. Many emerging market and developing economies do not have sufficient domestic funding options or international market access. For the first time in a decade, global development has regressed. At the same time, bilateral aid commitments (ODA and other flows) may have dropped by more than one-third in 2020, while commitments by the international finance institutions (IFIs) rose by a similar amount (Dodd et al., 2021).

The G7 will need to assist emerging market and developing countries in tackling their greater debt and finance constraints that have resulted from the pandemic, and embark on programmes of green recovery and transformation. At a time when the world was hoping to make quick progress towards the SDGs and

net-zero emissions, the needs of emerging market and developing countries have increased by more than $2.5 trillion as a result of the pandemic, according to the Managing Director of the IMF. Low- and middle-income countries have been hit disproportionately, leading to unprecedented capital flight, triggering major disruptions to exchange rates and supply chains, stagnating cross-border portfolio investment, significantly reducing remittances and increasing the perception of risk for investors in developing economies.

Accordingly, there is a considerable risk that:

- Many, especially the poorer countries, will be unable to access vaccines, provide health care, pay their debts and restart their economies.
- The increase in poverty rates caused by the pandemic will be lasting and deeply scarring.
- There will be little or no capacity to embark on a climate path consistent with the Paris Agreement for a long time to come.

Economies at all levels are heavily integrated, and a healthy recovery and long-term, sustainable growth should be broad-based. Climate goals can only be achieved collectively. And the pandemic has demonstrated the need to enhance global resilience. Leadership by the G7 will be crucial to enable all countries to join these common endeavours. In this context, **the UNFCCC $100 billion annual climate finance target is a crucial element in building commitment to a global approach, which still requires focus and sustained action to be achieved.**

Concessional finance

Within the current economic and climate policy context, **concessional finance** (including grants, concessional loans and other catalytic instruments like guarantees, insurance, first loss/junior equity and technical assistance) **is key to support EMDEs on their path to a sustainable economic recovery** by:

- Buttressing the integrity, solidity and predictability of finance flows for adaptation and mitigation action in EMDEs
- Developing climate activities in least-developed countries and for poor and vulnerable communities
- Supporting projects with significant social and environmental benefits where commercial returns cannot realistically be expected
- Building a high-quality pipeline and tackling pre-construction risk
- Being a major determinant of climate adaptation projects
- Underpinning the development of blended finance instruments, which are key to de-risking investments in developing countries
- Based on above, helping to mobilise and scale up other sources of finance, particularly in the private sector.

The fact that over half of the 70 low-income countries are presently assessed at a high risk of debt distress or in debt distress emphasises the case for mobilising more grants and concessional finance.

Concessional finance is also important to the fulfilment of the annual $100 billion of climate finance by 2020 target which is a core component of international climate finance, underpinning international agreement and cooperation on climate action. This annual level is expected to be maintained to 2024 and a new target set in 2025. Increased mobilisation of climate finance will be challenging, reflecting declining aid envelopes and a complex international climate finance architecture.

Finally, **concessional finance is a strong instrument to support policy formation, project preparation and risk, and to drive investment and the scaling-up of investment in innovative sectors, in EMDEs, and in vulnerable communities**. Long-Term Strategies, NDCs and sector decarbonisation pathways are rising priorities, and an **initiative to support EMDEs to prepare Long-Term Strategies aligned with the goals of the Paris Agreement** would be a significant contribution to guide the world towards a climate-resilient and net-zero emissions future.

Bilateral funding is the source of almost all concessional climate finance. The support of G7 countries to meeting the $100 billion target (of real importance to success at COP26) and further expanding the provision of climate finance will be crucial, especially in the challenging period ahead. At the UN Climate Action Summit, the UK announced that it would double its climate finance commitment to £11.7 billion in the coming five years. Germany also announced that it will double the delivery of climate finance by 2020 from its 2014 level. While some countries have stepped up their climate finance commitments, all developed countries should set more ambitious targets for a net increase in concessional funding overall and for climate action in the lead-up to COP26. G7 support to strong climate action in developing countries at this juncture will enable them to raise their ambition on climate action, which is critical to meeting the collective net-zero emissions target by 2050 to the benefit of the whole world.

The current level of grants for climate action in EMDEs is insufficient relative to the fundamental nature of the issues at hand and of the resulting scale of requirements. **Consideration should be given to increase this level significantly, with the aim to double or treble by 2025**. Furthermore, the latest OECD report shows that while the grant component of public climate finance increased by 20% from 2015 to 2018, the loan component increased by 50%, from $30.7 billion to $46.3 billion. The proposed increase in grants reflects the **critical role of grants to scale-up the overall climate finance system with particular attention to least-developed countries, to supporting adaptation action and to the mobilisation of private capital**. Concessional finance is particularly important for low-income countries and those in fragile and conflict situations and that have a high incidence of poverty, which are often where the impacts of climate change are already most severe. Bilateral climate finance plays a crucial role in building capacity and governance, and support for adaptation, biodiversity protection and natural capital preservation. And in fragile and conflict situations, support for scaling up distributed renewable energy can address fundamental development needs as well as climate goals.

G7 countries and other developed countries are also the primary source of funding for **multilateral concessional funds** that play a critical role in the climate finance architecture. Multilateral vehicles – such as the Green Climate Fund (GCF), the Global Environment Facility, the Adaptation Fund and the Climate Investment Funds, as well as non-dedicated ones such as the IDA, AfDF or AsDF (the concessional windows of MDBs) and the Global Infrastructure Facility – are particularly effective means of enhancing the impact of concessional finance. However, these funds remain too small, particularly in view of the scale of the climate challenge ahead, with the GCF first replenishment mobilising $10 billion, GEF-7 $3.3 billion equivalent and the Adaptation Fund with total contributions of $1 billion.

Ambitious replenishments for these funds will be critical over the coming five years given their importance for boosting mitigation and adaptation finance and enabling the MDBs and Development Finance Institutions (DFI) system more broadly to increase their activity in this area and to mobilise private investment. Capital replenishments should be accompanied by ambitious plans to mobilise private capital, to standardise and streamline practices, and to accelerate deployment to the most vulnerable countries.

Concessional finance and nature

Climate change adaptation and the preservation of nature are two areas that will require particular focus in terms of concessional finance. Strong action to halt and reverse biodiversity loss and emissions from agriculture is needed to secure the productivity, resilience and security of the global economy, and for its inherent value. Nature-based solutions could provide an estimated 30% of the emissions reductions needed to limit global warming to 2°C, while playing a critical role in adaptation to climate impacts. Both of these areas need urgent action in EMDEs and have overall high concessionality requirements due to nascent business models (e.g. regenerative agriculture, soil carbon), smaller scale projects, and difficulty generating project-specific revenue flows. Significant financing is required in the short term to derive benefits over the medium to long term. The G7 should increase the scale and catalytic use of public climate finance for the protection and restoration of ecosystems.

Reflecting the above points, the seminal report from the Global Commission on Adaptation (2019) highlights the crucial role of public finance and identifies four key measures to finance adaptation:

- Shift how investment decisions are made by taking systematically physical climate risk into account

- Scale up and deploy public finance more effectively, "to both increase the 'adaptation quality' of existing investments and to increase the amount of funding flowing to adaptation investments"
- Scale up contingent finance and insurance, including disaster risk finance strategies and deepening markets for sovereign and private insurance and other risk finance instruments
- Harness private capital for resilience, including requiring the disclosure of climate risks by publicly listed entities and the development of more effective blended finance vehicles for long-term adaptation solutions.

In light of these recommendations, consideration should be given to significantly increase public funding for adaptation, both in G7 countries and in EMDEs, and to enhance the range of contingent finance and insurance. MDBs and DFIs can also increase their focus on scaling-up adaptation finance, as mentioned later in this section.

The ***Dasgupta Review on the Economics of Biodiversity*** highlights that: **"Nature's worth to society – the true value of the various goods and services it provides – is not reflected in market prices because much of it is open to all at no monetary charge**. These pricing distortions have led us to invest relatively more in other assets, such as produced capital, and underinvest in our natural assets" (Dasgupta, 2021; bold added). To address these market and institutional failures, strong policy levers coupled with significant concessional resources will be required to make an appropriate valuation of nature and to shift capital allocation into nature-positive, regenerative and low-carbon methods of production and consumption.

The Dasgupta Review considers in this regard that "**while the relative share of biodiversity funding within the overall budget for Official Development Assistance has increased in recent years, existing flows are insufficient to meet conservation needs in developing countries.** Increasing those financial flows could take the form of debt forgiveness, direct grants or technical assistance. The creation of binding targets on public investments in natural capital to ensure that globally agreed objectives are met would go an important step further" (ibid.; bold added).

Currently, less than 3% of public climate finance goes to making food and land use systems resilient, while MDB exposure to agriculture accounts for less than 10% of total climate finance portfolios (both mitigation and adaptation). Increasing finance for nature and sustainable supply chains is critical. Development banks will need to build their own capacity to invest in more nascent nature-based business models, ensuring development capital is fit for purpose for natural solutions.

Finally, scaling up what is already working rather than continuing sub-scale innovation will help to accelerate investment. Blended finance vehicles targeting smallholder finance and conservation, financing linked to sustainable farming practices and ESG improvements, digital platforms for data collection and dissemination, and sustainable capital market instruments should all be scaled for investors that are looking to shift capital out of '4-degree' portfolios and into a nature-positive economy but currently lack investable opportunities.

Debt relief and debt swaps

More than half of low-income countries (38 out of 70) are assessed to be at high risk of, or in, debt distress, and many emerging markets/middle-income economies are similarly vulnerable. For many countries, tailored debt restructuring will be considered under the G20 Common Framework. Some 60% of eligible low-income countries have availed themselves of debt suspension under the Debt Service Suspension Initiative (DSSI), rolling forward some $5 billion in debt service for three to five years. But suspension of debt service provides only temporary relief and can lead to bunching of debt servicing needs in the future.

Considering the debt distress and excessive debt overhang of a number of low- and middle-income countries in the wake of the pandemic, further consideration should be given to enabling poor, vulnerable and fragile countries to facilitate timely and orderly debt treatment by fully **implementing the G20 'Common Framework for Debt Treatments beyond the DSSI'**, with broad creditor participation, including the private sector.

As the pandemic continues to impact negatively on both solvency and liquidity indicators in EMDEs, a range of approaches will need to be considered. While some countries will need debt reduction, others

will need new money and much larger capital inflows and yet others need cancellation of old expensive debts and their replacement by cheaper and longer-term financing.

For countries with high debt that are not distressed, consideration could be given to examine the demand for and feasibility of **debt-for-climate-or-nature swaps** designed to mobilise resources for investments in resilient infrastructure and environmental conservation measures taking account of the operational, financial and economic issues related to this approach. The World Bank and IMF (as well as major foundations like OSF, CIFF and Rockefeller) are leading work on the potential benefits and issues of these instruments.

International Monetary Fund

The IMF has been stepping up its climate-related work in terms of analysis, policy options and country engagement, ranging, for example, from country-specific guidance on policy options such as carbon pricing to fossil fuel subsidy reform and financial regulation to internalise risks from exposure to 'brown' assets such as fossil fuels. The IMF has also been working with the World Bank to provide "overarching assessments of preparedness, macroeconomic impact, mitigation, adaptation and financing strategies for small, vulnerable, and capacity-constrained countries".

Building on this work, the IMF should examine how **climate and environmental factors could be integrated into its surveillance, lending and capacity-building activities**. This could include the integration of monitoring of financial systems exposures to climate and environmental risks in Financial Sector Assessment Program (FSAP) and Article IV consultations, and specific policy work building on the macroeconomic and financial expertise of the IMF.

Confronting increasing current account deficits estimated at $210 billion for 2021 and high debt service obligations of $4 trillion, including $430 billion of interest and financing requirements to support the recovery involving both essential public services (for example vaccinations) and sustainable infrastructure investment, developing countries have urgent and significant short-term liquidity requirements. This pressure is further exacerbated by a negative private direct investment outlook and portfolio flows for 2021.

In this context, following the agreement by G7 Finance Ministers in March 2021, and subsequent agreements by G20 Finance Ministers and the International Monetary and Financial Committee, to support a new and sizeable **allocation of Special Drawing Rights (SDRs) based on a needs assessment by the IMF**, consideration can be given to reallocation mechanisms that widen financing options for recovery programmes in low-income and vulnerable countries through either the IMF or the World Bank, supporting effective vaccination and health campaigns and promoting green transitions. This will enable the strengthening of emerging market and developing country foreign exchange reserves, responding to the sharp deterioration in external positions during the pandemic, widening financing options for recovery programmes, including green recoveries, and providing crucial liquidity for the global trading system. It would also promote stability by avoiding the social and political impact of sharp austerity measures, by averting debt defaults, and by supporting both effective vaccination campaigns and investment in sustainable infrastructure.

Innovative uses of SDR allocations should be considered, based on reallocations, for example for replenishing the IMF's Poverty Reduction and Growth Trust Fund and utilisation as collateral for bond issues addressing longer-term financing needs. The possibility for individual countries to decide to allocate these funds for climate finance would provide a **significant boost to recovery and transformational growth**, supporting investment areas identified in section 3.2.

Multilateral development banks

The MDBs are an effective and unique international instrument to support their countries of operation to address the challenges of the recovery from the pandemic and to position them on a sustainable growth path. This reflects not only their investment and risk-bearing capacity, but also their policy analysis and capacity-building activity. **This integrated set of policy, financial and technical assistance instruments provides a strong basis to contribute to country action across economic sectors.** MDBs also play an important role in the mobilisation of private finance flows to EMDEs, both in terms of strengthening the investment climate at country level and in terms of structuring catalytic transactions. Finally, MDBs have

an efficient capital structure from a shareholder perspective, reflecting a relatively low share of paid-in capital relative to callable capital.

MDB climate finance in EMDEs increased by 65% in four years, from $25.1 billion in 2015 to $41.5 billion in 2019, with the following compositional features:

- Adaptation financing accounted for one-third of MDBs' climate finance in EMDEs in 2019
- 22% was in the private sector
- 69% of financing was provided in loans and 15% through policy-based and results-based loans with credit lines, guarantees, equity and other instruments accounting for the remaining share
- Regionally, 36% was in South Asia, East Asia and Pacific, 18% in Africa (26% of adaptation finance), 17% in Latin America and Caribbean (20% of adaptation finance), 14% in non-EU and Central Asia, and 9% in the Middle East and North Africa
- 46% of adaptation finance was in energy, transport, built environment infrastructure, water and wastewater
- Two-thirds of mitigation finance was in renewable energy, transport and energy efficiency, with renewable energy alone accounting for 28%.

At the UN Climate Action Summit in 2019, the MDBs announced a further expansion of their climate finance activity, setting the following targets to 2025:

- Increase their global climate finance level to $65 billion
- Recognising the increasing impact of climate change, double annual combined climate adaptation finance to $18 billion
- Seek to mobilise an additional $40 billion from private sector investors.

During 2020, the impact of the rapid crisis response by most MDBs resulted in a decrease in the level of climate finance and even more of the climate finance ratio relative to total finance. This particularly reflects the sharp 'rescue' focus of crisis response finance, including financing to strengthen health care systems, provide social safety nets, support the private sector to save jobs and livelihoods, and withstand the expected long-term socioeconomic impact of the crisis.

Taking account of the sharp increase in MDB crisis-response finance (estimated at over $230 billion over a 12–18 month period), of the massive recovery challenges confronting EMDEs in the wake of the pandemic and of the major role that MDBs can play to support their countries of operation to get on a sustainable growth path**, consideration should be given to rapidly scale up MDB and other IFI lending capacity through greater balance sheet efficiency, capital increases, an accelerated IDA replenishment (**the largest sources of concessional climate finance for poor and vulnerable countries**) and by enhancing the focus on private sector finance mobilisation.** This would provide a powerful impulse to accelerate the transition to a net-zero emissions and climate-resilient economy, and to protect biodiversity. While biodiversity plays a different role in every country, low-income countries tend to depend more on nature than others. And, fundamentally, 'do no harm to biodiversity' approaches are essential to really 'build back better', so MDBs will need to integrate and mainstream biodiversity into their operations.

Boosting lending through MDBs/IFIs leverages up shareholder contributions multiple times and provides funding through a well-tested governance framework. **The goal might be to double the lending capacity of the MDBs to approximately $400 billion annually** while scaling catalytic instruments to accelerate co-investment from the private sector. This should take account of the context of each MDB in terms of potential increase in activity and headroom. Such increases would have to support both recovery and the transformation to net-zero, climate-resilient economies.

Beyond the use of their own capital, MDBs must place higher priority on achieving significant increases in **private sector mobilisation**. Prioritising mobilisation will often require a significant shift in internal incentive structures, use of financial products and modes of project origination and operation; it will therefore require a strong mandate from G7 countries (as MDB shareholders). Increased mobilisation will contribute both to increase the overall flow of finance for recovery and transformational growth and to set the context for systemic impact towards a net-zero, climate-resilient economy. It is also the only way in which financial flows can reach the orders of magnitude required to achieve this transformation at

scale and in time. Private sector involvement also expands technical and management implementation capacity, contributing to results.

As shown in the *2019 Joint Report on Multilateral Development Banks' Climate Finance*, MDBs mobilised on average less than a dollar from the private sector for every dollar of MDB climate finance (African Development Bank et al., 2020). While MDBs have developed their private sector development focus and have expanded their range of blended finance instruments to increase private finance mobilisation, many of these instruments have not scaled-up to the extent and at the speed required to spur market transformation and result in significant increases in financial flow.

The MDBs announced at the One Planet Summit in 2017 their vision to **align financial flows with the Paris Agreement**. Since then, work on developing a common framework has been structured in six building blocks:

- Alignment with mitigation goals
- Adaptation and climate-resilient operations
- Accelerated contribution to the transition through climate finance
- Strategy, engagement and policy development
- Reporting on Paris Agreement alignment
- Alignment of internal activities.

Key design principles of the approach include:

- Ensure consistency with long-term goals of the Paris Agreement in the context of economy-wide transitions
- Ensure country and context specificity, manage uncertainty and support just transition
- Facilitate classification consistency and ensure consistency with emerging climate risk frameworks to facilitate wider dissemination and adoption.

The Paris alignment methodology for direct finance was road-tested during 2020 with the development of case studies ahead of full application in 2021. Beyond implementation of the methodology, discussions are ongoing with shareholders on the timing of commitment of each MDB to full alignment with the Paris Agreement. While the European Investment Bank has already made the commitment to "align all its activities with the principles and goals of the Paris Agreement by the end of 2020", this topic is under review at other MDBs in the run-up to COP26. Full alignment would contribute to optimising the contribution of MDBs in supporting their countries of operation to achieve the goals of the Paris Agreement.

The financing needs of EMDEs are expected to increase significantly in the short and medium term in order to tackle the specific impacts of the pandemic as well as to address pre-existing challenges critical to meeting the Sustainable Development Goals.

The World Bank, for example, is operating through its JET agenda (Jobs and Economic Transformation), which is reflected in the International Bank for Reconstruction and Development (IBRD) and International Finance Corporation (IFC) capital increases, and the IDA 19 Replenishment. JET priorities have been recalibrated to respond to the crisis and are fully integrated with special themes such as climate change.

Cities in EMDEs will be playing a key role in this regard and MDBs should be enhancing their focus and instruments to develop city finance capacity and expand project financing supporting a sustainable, resilient and inclusive recovery. An important element in the application of a Paris alignment methodology is the development of country Long Term Strategies (LTS) and Nationally Determined Contributions (NDCs) in line with the goals of the Paris Agreement. In this context, the establishment of a specific LTS development fund to support EMDEs in formulating their LTS would support the definition of a clear country-specific framework and trajectory towards a zero-carbon and climate-resilient economy.

CONCLUSION: The leadership of the G7 at a special moment in history

The transition to a zero-emissions and climate-resilient world provides the greatest economic, business and commercial opportunities of our time. Now is the moment for the G7 to embark on further joint actions for a **safer, stronger, healthier and more dynamic world** by ensuring a growing commitment to sustainability in COVID-19 rescue and recovery packages. The next decade could mark a transformation to a much better path of growth and development: sustainable, resilient and inclusive.

However, if we as a world are to realise this better outcome, there must be determined action across all the fronts described in this report; just choosing a few 'items from the menu' would simply fail to deliver on the scale and urgency required. Particular focus must fall on linking the immediate macroeconomic imperatives with the medium-term structural requirements to manage the transition effectively. This will require coordinated policies and institutional reform.

G7 countries have strong resources, skills, influence in international organisations, innovation, policy and analytical capacity. Their actions together, at scale, serve as powerful examples. On the basis of G7 example and leadership, the world's countries together can build a new form of growth and development that is far more attractive than what has gone before. But this requires investment across a whole range of activities and across the world. Recovery, growth, innovation, climate and environmental benefits will all be much stronger with the world acting together. **There has never been a more crucial moment for leadership from the G7**.

APPENDIX 1

Economic, social and environmental challenges

Economic output. While the effects of the pandemic on economies and labour markets are still unfolding, COVID-19 risks triggering an economic crisis, accelerating climate change and nature loss, while exacerbating inequality and poverty.

- Global output is estimated to have contracted 4.3% in 2020 as a result of COVID-19, making it the **fourth most severe global recession of the past 150 years**, exceeded only by the First World War, the Great Depression, and the Second World War (World Bank, 2021).
- While global output is currently projected to expand by 4% in 2021, the level of global GDP in 2021 is still forecast to be 5.3% below pre-pandemic projections.
- Furthermore, global potential growth is projected to slow down by another 0.3 percentage points a year compared with pre-pandemic trends over the period 2020–29, undermining prospects for poverty reduction (World Bank, 2021).
- Growth in emerging markets and developing economies (EMDEs) is estimated to have shrunk by 5.0% in 2020 (excluding China) due to COVID-19 (2.6% including China), the worst rate in 60 years. EMDEs' growth is estimated at 5% in 2021 (or 3.4% excluding China). Despite this outlook, aggregate output from the EMDEs output in 2022 is projected to be 6% below its pre-pandemic projection. The pandemic is estimated to have erased at least 10 years of per capita income gains in more than a quarter of EMDEs in 2020.

Employment. Employment losses in 2020 are estimated at 114 million jobs relative to the pre-crisis employment level in 2019. The unemployment rate increased by 1.1% compared to 0.6% during the global financial crisis of 2009 (International Labour Organisation [ILO], 2021).

- In 2020, 8.8% of global working hours were lost relative to the fourth quarter of 2019. This is equivalent to 255 million full-time jobs and approximately four times greater than during the global financial crisis in 2009 (ibid.). In 2021, the trend is expected to continue, with a **projected loss of 90 million full-time equivalent jobs** (International Monetary Fund [IMF], 2020a).
- The unemployment rate in G7 countries is projected to rise from 4.3% in 2019 to 7.2% in 2020 and 6.7% in 2021 (ibid.).
- Employment losses understate the full impact of the COVID-19 crisis on the labour market. In contrast to previous crises, most of the global employment loss in 2020 reflected rising inactivity rather than unemployment, leading to an additional 81 million people shifting to inactivity alongside 33 million unemployed (ILO, 2021).

Investment. During the 2009 global recession, investment decreased by 10.5% in advanced economies followed by an increase of 1.5% in 2010. Over the subsequent decade investment in advanced economies grew by between 1.6% and 3.6%. In 2020 **investment in advanced countries declined by 6.4%** (6.1% in G7 countries).

Investment in EMDEs excluding China decreased by 6.2% in 2009 (+4.9% with China). Investment then grew by 9.6% in 2010 in EMDEs not including China. This was followed by a decade-long declining trend down to 0.5 % in 2019. Investment in EMDEs contracted in 2020 by an estimated 4.5 %. Excluding China, **investments in EMDEs reduced by a much deeper 10.6%**.

In EMDEs, the contraction in 2020 was sharpest in Latin America and the Caribbean and South Asia, where GDP also declined the most. The decline in investment was smallest in East Asia, where activity was supported by large fiscal stimulus programmes in China and Vietnam (World Bank, 2021).

Investment, which decelerated in the past decade, is expected to weaken further. According to the World Bank, based on the experience of past epidemics, investment is likely to remain weak for several years following the COVID-19 pandemic unless decisive action is taken to reverse this trend.

Public debt. The COVID-19 associated recession and policy response have resulted in a **surge in debt levels** and exacerbated existing debt-related risks and vulnerabilities.

- Prior to the COVID-19 pandemic, starting from 2010, a fourth wave of global debt accumulation was underway, resulting in the largest and fastest increase in global debt in five decades. At the global level, total debt had risen to a record high 230% of GDP in 2019. In EMDEs, total debt had reached 176% of GDP, led by private debt which rose to 123% of GDP (World Bank, 2021).
- In 2020, **global government debt is expected to reach 99% of GDP for the first time on record**, compared to 83% in 2019 (ibid.).
- In G7 countries, government net debt is estimated to have increased by over 20 percentage points of GDP in all countries except Germany between 2019 and 2020 (IMF, 2020a).
- Government debt in EMDEs is expected to increase by 9% of GDP in 2020. This is the largest increase since the late 1980s following debt crises in EMDEs. South Asia has seen the steepest increases, with India's government debt projected to rise by 17 percentage points of GDP (World Bank, 2021).

Health. Globally as at end-May 2021 there had been over 170 million COVID-19 cases in the world (**31% in G7 countries**), resulting in over 3.5 million deaths (**31% in G7 countries**).

- In 2019 air pollution was the fourth leading risk factor for premature deaths globally, which totalled over 6.67 million, accounting for nearly 12% of all deaths (Health Effects Institute, 2020).
- Air pollution is considered to have increased the health risks associated with COVID-19, as long-term exposure to air pollution is responsible for many of the health conditions associated with increased vulnerability to COVID-19 (Conticini et al., 2020; Yao et al., 2020; Hendryx and Lou, 2020).
- A substantial improvement in air quality was observed worldwide after the lockdowns imposed by many countries, with substantial reductions in nitrogen dioxide (NO_2) and fine-particle air pollution ($PM_{2.5}$) (Baldasano, 2020; Giani et al., 2020).

Human capital. A report into the effect of the pandemic on human capital identifies a range of impacts in terms of health and education. Early simulations project an increase of 45% in child mortality due to health service shortfalls and reductions in access to food in 118 low-income and middle-income countries (Roberton et al., 2020). The pandemic has **disrupted education for 90% of the world's children** (World Bank, 2020b) and may roll back years of improvements in human capital. Expected years of school are projected to decrease with out-of-school population among global youth estimated to increase by 2% as a result of economic recession.

Poverty. The COVID-19 pandemic is set to **reverse the downward trend in poverty for the first time in 20 years**, with the number of people living in extreme poverty projected to increase by around 120 million in 2020, with around 60% of these in South Asia (World Bank, 2021). Over the past three decades, the only crisis that generated an increase in global poverty was the 1997 financial crisis, which resulted in a rise of extreme poverty by 18 million in 1997 and a further 47 million in 1998. In the two decades since 1999, the number of people living in extreme poverty worldwide had fallen by more than 1 billion people.

Inequality. Inequality is projected to worsen as the pandemic is expected to have a **disproportionately negative effect on vulnerable socioeconomic groups and countries**. Global inequality is expected to increase both within and between countries (Furceri et al., 2020).

- Within countries, the **sharply differentiated impact of the pandemic across economic sectors** is contributing to the increase in inequality. At-risk sectors (such as hospitality and food services, arts and culture, retail, and construction) have been hard hit by the pandemic, suffering massive job losses. In hospitality and food services, the hardest hit sector, employment decreased by more than 20%. In contrast, higher-skilled services sectors (such as information and communication, and

finance and insurance) saw an increase in employment by 5.0% and 3.4%, respectively in the second quarter of 2020 (ILO, 2021).

- The pandemic has hit lower-paid workers particularly hard, including the informally employed, women, immigrants, and low-skilled workers who tend to be less able to work from home and are more vulnerable to job or income losses due to lockdowns (Adams-Prassl et al., 2020; Brussevich et al., 2020).
- Across countries, **lower- to middle-income countries experienced the greatest losses in working hours,** reaching 11.3% in 2020 and above the global average of 8.8% (ILO, 2021). Lower-income countries also tend to have large informal sectors, which are particularly vulnerable to pandemic-related disruptions (World Bank, 2020a). The **lack of fiscal space and capacity to implement income support measures**, including job retention schemes, in developing countries has had negative employment implications.
- For 2021, the pace of the recovery is expected to vary considerably, with greater weakness in countries with larger pandemic outbreaks or greater exposure to global spillovers through tourism and industrial commodity exports. While economic activity is projected to grow in the East Asia and Pacific region in 2021, it is projected to be weakest in the Middle East and North Africa and Sub-Saharan Africa regions. **More than a quarter of EMDEs are estimated to lose a decade or more of per capita income gains in 2020** (World Bank, 2021).

Greenhouse gas (GHG) emissions. Although 2020 GHG emissions are estimated to have declined, **GHG concentrations in the atmosphere continue to rise** (World Meteorological Organization [WMO], 2020a). Furthermore, unless followed by economic rescue and recovery measures that support a low-carbon transition, the 2020 dip in global GHG emissions is estimated to result in no more than a 0.01°C reduction of global warming by 2050 (United Nations Environment Programme [UNEP], 2020).

- Global GHG emissions continued to grow for the third consecutive year in 2019, indicating that the slowdown in emissions growth during 2015 and 2016 was short-lived.
- Due to COVID-19, it is estimated that CO_2 emissions decreased by between 7% and 8.5% in 2020 compared with 2019 emissions levels, with the sharpest decrease occurring in the transport sector (International Energy Agency [IEA], 2020c; Enerdata, 2020). This reduction is unprecedented and significantly larger than the reduction of 0.9% in CO_2 emissions during the 2007–08 global financial crisis.
- Over the last decade, the top four emitters (China, USA, EU27+UK and India) have contributed 55% of total GHG emissions (UNEP, 2020).
- The top seven emitters (including Russia, Japan and international transport) have contributed 65% of GHG emissions and the G20 countries 78%.

Climate change impact. In 2020, the global mean surface temperature was 1.2 ± 0.1°C warmer than the pre-industrial baseline (1850–1900). The **last decade from 2011 to 2020 is the warmest on record** (WMO, 2020b).

- Climate change is already causing an increase in the frequency and intensity of extreme events. In 2020 the Arctic sea ice cover shrank to its second lowest extent since the beginning of modern record-keeping (NASA, 2020). The number of climate-related weather events costing more than $1 billion each is about to reach a record level in the US (NOAA National Centers for Environmental Information, 2021).
- Natural disasters cost about $18 billion a year in low- and middle-income countries through damage to power generation and transport infrastructure alone. They also trigger wider disruptions for households and firms costing at least $390 billion a year (Hallegatte et al., 2019).

Biodiversity. In the past four decades, there has been a decline of 60% on average in the populations of mammals, birds, fish, reptiles, and amphibians, mostly in the tropics (Dasgupta, 2020). One million animal and plant species (approximately 25% of the total) are threatened with extinction (IPBES, 2019). The Global Risks Report ranked biodiversity loss and ecosystem collapse among the top five global risks

(World Economic Forum, 2020d). For the first time, all top five global risks, in terms of likelihood and severity of impact, were environmental.

- Deforestation, conversion of primary forest for intensive agriculture and extractive industries, and illegal wildlife trade are causing both biodiversity loss and contributing to the emergence and spread of infectious diseases like COVID-19 (Dasgupta, 2020). **Land-use change has been identified as the leading driver of recently-emerging infectious diseases** (Patz et al., 2000; Jones et al., 2008; Loh et al., 2015).
- Climate change is already contributing to rapid ecosystem changes, with significant consequences for biodiversity and may become the dominant driver of biodiversity loss in the coming decades (Newbold, 2018; IPBES, 2019). The likelihood of losing critical ecosystem service functions increases considerably beyond the 1.5°C threshold (Intergovernmental Panel on Climate Change [IPCC], 2018).
- Stressing or destroying vital ecosystems will have enormous economic as well as environmental and social costs. Protecting and enhancing biodiversity will help to address climate change. Conversely actions to mitigate and adapt to climate change can deliver benefits for biodiversity.

Land use and water. Since 1990, it is estimated that **420 million hectares of forest have been lost through conversion to other land uses**, although the rate of deforestation has decreased over the past three decades (Food and Agriculture Organization [FAO] and UNEP, 2020). The decrease of water availability is already underway. The **annual amount of available freshwater resources per person has declined by more than 20% in the past two decades**, due to population and economic growth, as well as dietary changes implying more demand for water-intensive foods (e.g. meat and dairy products) (FAO, 2020).

- Global population is projected to grow from 7 billion in 2010 to 9.7 billion in 2050 (UN Department of Economic and Social Affairs, 2019). As a consequence of population growth and income growth in developing countries, **overall food demand is expected to increase by more than 50%, and demand for animal-based foods by nearly 70%** (Searchinger et al., 2019). In order to meet this increased demand, an area of close to 600 million hectares (twice the surface of India) would need to be converted to agricultural land.
- This would have major climate consequences as land use change, in particular deforestation, is a significant contributor to climate change (IPCC, 2019). Agriculture, forestry and other land uses (AFOLU) accounted for 24% of global greenhouse gas emissions in 2010 (IPCC, 2014).
- The food challenge will also have a significant impact on water availability, as **agriculture accounts for the largest use of water at over 70% of global withdrawals** (FAO, 2020).
- Agricultural expansion is the main driver of deforestation and forest degradation and the associated loss of forest biodiversity. Large-scale commercial agriculture (primarily cattle ranching and cultivation of soya bean and oil palm) accounted for 40% of tropical deforestation between 2000 and 2010, and local subsistence agriculture for another 33% (FAO and UNEP, 2020).

Around 1.2 billion jobs in sectors such as farming, fisheries, forestry, and tourism are dependent on the effective management and sustainability of healthy ecosystems (ILO, 2018). To a greater or less degree, **half of the world's GDP is dependent on nature.**

APPENDIX 2

Investments for green recovery and transformational growth: rationale, barriers and policy levers

This Appendix provides a more detailed description of the rationale, barriers and policy levers for each investment area summarised in section 3.2 of the report.

A2.1 Electricity generation, storage and networks

Investment rationale. Economic and environmental benefits arising from investment in electricity generation, storage and networks include:

- **Near-term jobs: renewable energy delivers three times more jobs per dollar invested than fossil fuels** (Garrett-Peltier, 2018). Renewable resources are widespread, the cost of equipment is low and decreasing further, and the majority of cost in renewables is in labour for installation and maintenance.
    - **Projects are ready to deploy or in development today**, providing the potential to generate jobs and scale-up in the near term. Wind turbine service technician and solar installer are set to be the first and third fastest growing jobs in the US (US Bureau of Labor Statistics, 2021).
    - In general, these are also **skilled blue-collar jobs** that are similarly or better paid than jobs in coal. However, there will be some (although much less) displacement of jobs in oil and gas, which tend to be higher paid.
    - Many of the jobs in wind, solar and network construction are also concentrated in **rural areas** (e.g. UK offshore wind creating jobs through the Midlands), and tend to be more **stable** than those in fossil fuels. While there are inherent structural elements that lead to boom-bust cycles in oil and gas (and to a degree in coal), solar, wind and network construction are expected to only see growth in net additions and therefore jobs.
    - A 2ºC investment pathway would generate **7 million new *direct* jobs in renewables generation** by 2030 (Goldman Sachs, 2020), up from 12 million in 2019 (IRENA, 2020). A **similar scale of new *direct* jobs** would also be created in **electricity network build out,** in particular for distribution grids, which are labour-intensive.
    - It will be important to provide targeted retraining to support workers to transition to new sectors, and to create the conditions to support strong labour rights.
- **Climate: Low-carbon electricity underpins decarbonisation for 60–80% of the energy system** in a strategic shift to: (i) "electrify everything"; (ii) move to electricity serving 50–60% of energy requirements; and (iii) increase use of green hydrogen (produced from low-carbon electricity) to meet another 10–20% of energy needs. These investments could help to move towards reducing the 25% global CO_2e emissions for which electricity accounts (13.6 Gt in 2018) and ultimately tackling the majority of the 18 Gt annual CO_2e emissions across the transportation, buildings and industrial sectors.
- **Productivity and efficiency:** Renewable energy can now provide **lower cost energy than fossil fuels to power economies.** As costs have plummeted in the past 10 years and continue to fall, market tipping points are being crossed:
    - **Solar and wind are already the lowest-cost new bulk generation** in countries representing 70% of GDP, including all G7 countries except Japan (Bloomberg NEF, 2020).

- *New* solar/wind lower cost than *existing* coal/gas: over 70% of coal plants worldwide will be more expensive to *run* (marginal operating cost) by 2025 vs. building *new* wind or solar. Currently, this is the case for around 80% of the coal fleet in the US and the EU.
- Solar/wind + *storage* – lowest cost dispatchable generation: this is already the case in some locations. In Germany solar and storage provides lower cost electricity than gas peaking plants as of 2020, and is set to get another 40% cheaper by 2030 (McCarthy et al., 2020).
- *New* solar/wind + storage – lower cost than *existing* coal/gas: this is already the case for higher cost coal plants. As solar/wind/batteries prices decline another 30–60% before 2030 (IRENA, 2019), this final tipping point will be crossed ubiquitously.

- The net result of the above is a strong economic pull for solar/wind and storage to account for the majority of electricity generation by 2030 complemented in some locations by low-cost hydro or nuclear.
- Establish upscaled and growing renewables industries: renewable energy sectors provide attractive returns with lower risk and much lower volatility than declining fossil sectors. Economies built on renewables industries will be more resilient.
  - Renewable energy stocks delivered 10–20% higher annual returns than fossil fuels in advanced economies from 2010–20, and with less volatility (IEA and Imperial College Business School, 2020). This reflects investor confidence in the continued growth of the renewable energy market to mid-century.
  - In developing countries, international investments and government support can help to move renewable energy markets to increased maturity and competitiveness. In addition, the build-out of transmission lines can de-risk the market by providing projects in areas of high renewable resource with a de-risked physical route to market.
- Social impact:
  - Improving electricity access: as a more distributed generation source, solar is well suited to mini-grid solutions that serve electrification in developing countries.
  - Improving air quality: air pollution differentially harms lower-income households. Therefore improvements to air quality that stem from decarbonised power systems will benefit these groups disproportionately.

Investment barriers and policy levers

Investment barriers in mature markets can include:

- Highly uncertain forecast wholesale pricing for investors considering projects in countries that lack a long-term energy market.
- Transmission network build-out is not often approved by regulators *before* the market need arises. However, once the market need arises it is too late to wait for the long lead times of transmission build out (5–8 years).[47]
- Uncoordinated and/or slow permitting and planning processes.
- Continued financial support for fossil fuel energy (e.g. via subsidies) distorts market and directs investment away from renewable energy.

In emerging markets and developing economies (EMDEs), investment barriers can additionally include:

- Lack of supportive investment climate – e.g. FX risk, sovereign debt issues, rule of law issues.

[47] Examples of such transmission network build-out include, for example, US – connecting windy Midwest regions to sell power into networks on East coast; UK – transmission line through North Sea for offshore wind build-out.

- Lack of supportive **energy regulatory environment** – e.g. generation not competitive/unbundled; no renewable targets or auctions pipeline; PPAs not 'bankable'.[48]
- Lack of **reliable grid connection** – e.g. no requirement for utility to connect new projects and transmission not extended to zones with high renewable resource.
- Continued financial support for **fossil fuel energy** from advanced economies distorts market and directs investment away from renewable energy.

Policy levers that can be actioned by governments to drive the scale-up of private investment in electricity generation, storage and networks include:

In mature markets:

- **Issue waves of long-term energy contracts for renewables** to avoid situations where the incentive to invest is blunted by **uncertain future wholesale prices** (see Chile case[49]).
- **Extend transmission networks** to areas of high solar and wind potential to unlock these areas for development and to bring their cheap and clean electricity to areas of demand. **Double renewables build rate by 2025** to meet demand as fossil fuels come offline and transport electrification takes off, deriving benefit from cheaper and cleaner sources of electricity.
- **Streamline planning and permitting** processes.
- **End financial support for fossil fuels:**
  - **Phase out fossil fuel subsidies** within G7 by 2030, taking into account management of distributional impacts.
  - Set target of **low-carbon generation serving 80% of electricity generation in G7 countries by 2030**.
- **Phase out coal by 2030** within G7 countries to reduce reliance on uncompetitive and increasingly unreliable generation, and reduce stranded asset risk. **Support the workforce in declining fossil fuel industries** through retraining to new industries (such as wind turbine technical), relocation support and other economic revitalisation measures.

In EMDEs:

- Support the **investment climate** in developing countries to scale up and **mature their renewable energy markets** and supply chains by **increasing the scale and catalytic use of public finance** – including leveraging **de-risking mechanisms such** as blended finance.
- **Create supportive energy regulatory environment** by tying support to energy sector regulatory changes that de-risk the sector for private investors (including implementing policy levers listed above for mature markets).
- **End financial support for fossil fuels overseas** (e.g. via ODA).

A2.2 Energy efficiency

A2.2.1 Energy-efficient buildings

Investment rationale. Economic and environmental benefits arising from enhancing buildings' energy efficiency and shifting to net-zero buildings include:

- **Near-term jobs:** An estimated **9 to 30 jobs are created per $1 million investment in building retrofits,** new builds and installation of energy efficient and connected appliances (IEA, 2020f). Building

[48] 'Bankable' PPA = long-term (15-20+ years), preferential dispatch onto grid (i.e. curtailment risk removed), balancing costs not incurred, PPA ideally guaranteed by sovereign though this can exacerbate debt issues.

[49] Chile has a world-leading approach to long-term energy auctions that is designed to meet system needs and also attract low-cost capital to deliver low-cost renewable generation build-out.

retrofit projects often have short lead-times, with existing efficiency programmes able to scale rapidly (ibid.).

- **Climate benefit:** Building heating and energy accounts for **5% of global CO_2e emissions (3.3 Gt in 2018).** Investments in energy efficiency and low-carbon heating and energy sources could reduce emissions by around 25% by 2030 (SYSTEMIQ, 2021) (vs. no investment) and ultimately could tackle the majority of these emissions. **Space heating** and cooling account for over **60% of direct CO_2 emissions** in the sector (Energy Transitions Commission [ETC], 2018).
- **Multiplier:** Energy efficiency investments drive income for construction workers, who are likely to spend that income on consumption.
- **Productivity and efficiency:**
  - Energy efficiency retrofits can deliver **energy savings of around 50%**: 70–80% for old buildings in Europe and 30–50% in the US (Lucon et al., 2014).
  - Individuals and businesses benefiting from more energy efficient buildings are **more financially resilient** with lower mortgage default rates (Guin and Korhonen, 2020).
  - Highly energy-efficient buildings in **new build** can be achieved at **little additional cost** (6–16% in residential), or even at lower costs (-10% in commercial) (Lucon et al., 2014).
- **Social impact:** Efficiency gains can benefit lower-income households by helping to reduce **fuel poverty.**

Investment barriers and policy levers

Investment barriers include:

- **High upfront cost and long payback period**: the average cost of improving a property with all UK EPC recommended measures is £15,000.
- **Energy savings are not a sufficient incentive**: future savings are heavily discounted by individuals due to limited concern on energy bills for average consumers.
- **Lack of long-term signals from government:** regulatory or other government signals on future energy efficiency requirements would enhance confidence to invest.
- **Energy efficiency is not perceived to add value to properties,** reducing consumer demand for interventions and preventing development of **green mortgages and finance**.

Policy levers which can be actioned by G7 governments to drive the scale-up of investment in this action area include:

- Set target to **double retrofit rate to 2% p.a. by 2024**.
- Commit to all **new build as net-zero buildings** (e.g. no gas usage) **by 2024**.
- **Help consumers to overcome upfront cost hurdle and provide incentives** for building efficiency improvements, smart energy management solutions and on-site low-carbon energy solutions including subsidies for equipment or rebates on the cost of energy efficiency measures.
- Provide **long-term demand signals** via regulations and market creation:
  - Formulate and implement building **energy efficiency codes** with high energy efficiency requirements.
  - **Provide guarantees** to encourage energy service companies (ESCOs) to invest in buildings retrofits.
  - Leverage **public procurement to create markets** for efficiency improvements, setting efficiency retrofits targets across all inefficient social housing, schools, offices and healthcare facilities by 2030.

- **Incentivise banks to offer lower mortgage rates to energy-efficient homes** and allow inclusion of energy efficiency renovations under mortgage by committing to include efficiency of houses as a parameter in stress tests of mortgage portfolios. This is financially justified since owners of energy-efficient houses are less likely to default.

A2.2.2 Industrial energy efficiency

Investment rationale. Economic and environmental benefits arising from enhancing industrial energy efficiency include:

- **Energy efficiency interventions can reduce energy usage in heavy industry by 10–20%** (Energy Transitions Commission, 2018). This represents a key opportunity to reduce industrial energy demand growth, particularly in EMDEs. The financial attractiveness of energy efficiency interventions varies by sector and individual projects.
- **Cost savings:** as of 2016, the 28 companies implementing the United States' Superior Energy Performance programme experienced annual energy cost savings of $87,000–1 million using no- or low-cost operational measures (Fawkes et al., 2016).
- **Climate benefit:** by reducing energy usage, energy efficiency interventions can reduce emissions linked to heavy industry by an estimated 15% in 2030 (vs. no investment) (SYSTEMIQ, 2021).[50] Together these sectors account for over 10% of global CO_2e emissions, meaning industrial energy efficiency could reduce global emissions by 4% (ETC, 2018).

Investment barriers to enhance energy efficiency in heavy industry include:

- **Limited access to finance** makes it difficult for suppliers to invest in improvements. Industrial suppliers in some sectors (for example, the textiles sector) lack significant savings due to low margins and have high risk profiles. This limits their capacity to make upfront investments in energy efficiency measures. Some energy efficiency interventions can have a **long payback period** and are **not prioritised by investors** (IEA, 2020b).

Policy levers to scale-up investment in this area include:

- Build on engagements made at the 2019 UN Climate Action Summit to pursue an **annual rate of energy intensity improvements averaging 4% to 2030.**
- **Provide financial support for industrial plants** to invest in energy efficiency interventions, including issuing federal grants, financial incentives such as tax deductions and government-backed lending.
- **Incentivise and equip SMEs and industrial plant operators** to prioritise **energy efficiency** by making financial support conditional on audited energy savings.

A2.3 Transport

A2.3.1 Electric vehicles for light and heavy road transport

Investment rationale. Economic and environmental benefits arising from expanding the public EV charging network include:

- **Near-term jobs:** Building out charging infrastructure could **create around 6 million new *direct* jobs by 2030** (Goldman Sachs, 2020).[51]
- **Climate benefit:** The scale-up of electric vehicles, supported by charging infrastructure roll-out, could help to **reduce light road transport emissions globally by up to 15% and trucking emissions by 8% by 2030** (versus BAU, with no investment) (SYSTEMIQ, 2021).[52] Today, light road transport accounts for around 5 Gt CO_2e (10% of total). Trucking accounts for 3 Gt CO_2e (5% of total).
- **Productivity and efficiency:**

[50] See accompanying Technical Note (SYSTEMIQ, 2021) for further detail.
[51] Jobs are in EV charging infrastructure, construction, installation, maintenance, grid connections, civil and road work.
[52] See accompanying Technical Note (SYSTEMIQ, 2021) for further detail.

- EVs offer the potential to **reduce transport costs** for consumers and businesses. They are **three to four times cheaper to fuel per kilometre** and cost around **50% less to maintain**.
- As more EVs are connected to the grid, they can help to provide additional flexibility in the power system, improving grid/network performance and lowering the total cost of renewable energy by providing additional low-cost flexibility.

- **Establish resilient EV industry:**
  - **Consumer demand for EVs is increasing rapidly.** The number of models is projected to grow from 200 today to 500 by 2022. Sales will further increase once upfront cost parity is reached by 2024. At that point, EVs will outcompete ICE vehicles on all key consumer purchase criteria.
  - A large domestic EV market will support domestic auto manufacturers to pivot to EVs faster and ensure they have a future in the automotive sector.
- **Avoided health costs:** Cleaner air as a result of EV scale-up can help to reduce **$3 trillion in annual health care costs** linked to air pollution globally (Farrow et al., 2020). A minimal increase in pollution has been found to lead to an 11% increase in a country's mortality rate related to COVID-19 (Jackson and Hodges, 2020).

Investment barriers and policy levers

Investment barriers include:

- **Uncertainty of returns**: The EV market is starting to scale but without certainty around the pace of scale-up, private companies lack certainty of returns on investment.
- While private companies and investors are deploying charging infrastructure, **public support is needed to scale-up coverage at pace and to ensure sparsely populated areas** (less attractive for private-led projects) **are not left behind** (KPMG, 2019).

Policy levers that could be actioned by governments to drive the scale-up of investment in EV deployment include:

- **Roll-out charging infrastructure and strengthen distribution networks** ahead of EV demand
  - Provide utilities with regulatory approval to build 'charger ready' sites, at which private players can then compete to build charge-points. There is a **2–5 year lead time on distribution upgrades**, therefore **building now is paramount.** To ensure sufficient coverage given rising demand, governments should target for **at least 100 public chargers per 100,000 people by 2023** with broad coverage to support benefit from the transition shared across the population.
- **Address concerns about uncertainty of returns by stimulating market development and providing demand signals for EV scale-up**
  - Stimulate market development by providing **financial support to consumers** and manufacturers of EVs (e.g. purchase subsidies, tax exemptions for giga-factories).
  - Signal demand for EV scale-up by leveraging **public procurement** by committing that 100% of new urban buses are electric by 2023.
  - Introduce **ICE phase-out dates** and **low-emissions zones** to improve air quality and send clear signal to auto manufacturers on need to transition to remain competitive.

A2.3.2 Aviation

Investment rationale. Economic and environmental benefits arising from investment in green aviation include:

- **Support technology development of future industries:**
  - **200** electric aeroplane developments ongoing worldwide with Sustainable Aviation Fuel (SAF) capacity potential to **double** in next five years (Thomson, 2020).
  - **Short-haul flights could be cost-competitive with jet-fuelled planes** by mid-2030s.

- **Climate benefit:** Together, these investments could help to reduce around 10% of the sector's emissions by 2030 (vs. 2020 baseline) and the majority of emissions associated with aviation by 2050 (SYSTEMIQ, 2021). Today, the sector represents between **2% and 4% of the global total**, with the upper limit an estimate linked to radiative emissions (e.g. contrails).
- **Compress the SAF 'green' premium:** Governments could invest to drive a decline in the cost premium of SAFs, particularly as the cost of hydrogen declines.
    - HEFA (Hydrotreated Esters and Fatty Acids) **costs fell 10x between** 2012 and 2020.
    - At $2/kg hydrogen, **synthetic jet fuel** carries a **+$0.90/l premium** (vs. $0.65/kg kerosene). Once hydrogen prices reach $1/kg H_2 (an achievable scenario), synthetic jet fuel could carry only a +$0.40/l premium or **as low as +$0.20/l** if low-cost sources of circular CO_2 are available.[53]

Investment barriers and policy levers

Investment barriers for electric and hydrogen-fuelled aviation include:

- **Certification schemes:** Even with technological maturity, new planes can only enter the market with certification, which can be a time-consuming process.

Investment barriers for Sustainable Aviation Fuels include:

- SAFs are likely to remain more expensive than fossil-based jet fuel over the medium term. **Blending mandates to create premium markets** are needed to enable SAFs to compete with kerosene jet fuel.
- **Tax exemptions for aviation fuel** in many countries acts as a de facto subsidy for kerosene jet fuel, making it harder for new sustainable fuels to compete (Bannon, 2019).
- **A global regulatory solution** is needed to create the enabling environment for SAFs to scale, given the global nature of aviation. Negotiations conducted through the International Civil Aviation Organization (ICAO) to address competitive distortions have been slow.

Policy levers that can be actioned by governments to drive the scale-up of green aviation include:

- **Update and streamline certification schemes** for new technologies in aviation.
- **Scale public investment in R&D** to drive down the cost of core technologies in electric aviation and SAFs (beyond HEFA). **Public support** would be most impactful in increasing **investment in electric aeroplanes** and in **less mature SAF technologies**, including in biofuels (beyond HEFA) and synthetic jet fuel derived from green hydrogen (Power-to-Liquids).
- Commit to green fuel **blending mandates to create market premiums** and with that provide incentives for SAFs. A target of **10% SAF blending by 2030** is achievable and would create market pull for solutions to come forward, spur innovation and bring down the cost premium. Blending mandates should include a **'carve-out' for synthetic jet fuel**. It costs more at present, thus cannot compete today vs. biofuels without a carve-out, but ultimately it could be the lowest cost and largest scale solution for SAFs.
- **Implement fuel taxes on kerosene jet fuel** to create a level playing field for SAFs to compete.
- Develop a **global regulatory solution to resolve competitive distortions** between different regions.

A2.3.3 Shipping

Investment rationale. Economic and environmental benefits arising from reducing emissions in shipping include:

- **Technology innovation and development of future industries:**

[53] Circular CO_2 refers to CO_2 that originated in the atmosphere and is released back into the atmosphere (i.e. when synthetic jet fuel is combusted). Potential source of super low-cost circular CO_2 could include for example capturing CO_2 exhaust from a biomass combined heat and power plant (critical to ensure source of biomass is sustainable). The **cost premium can drop to $0/l** if we can achieve $0.5/kg H_2 and $0/t capture of circular CO_2.

- **66 zero-emissions pilot and demonstration projects have been launched** in recent years, with the potential to scale in the next 5 to 10 years. This promises to open up future industries in green shipping fuels, engine manufacturing, storage tank manufacturing, vessel building, and verification and standards.
- By 2030, global demand for green ammonia could reach 33 Mt per year (5.8 Mt hydrogen), or a **$20 billion market**. By 2050, demand could reach **700 Mt** per year, or **$250 billion**.[54] The decline in the cost of green ammonia is projected to be driven by innovation as the market grows.
- Reaching **5% zero-emission shipping by 2030** would set up the industry for rapid diffusion.

- **Climate benefit:** Shipping accounts for 1.1 Gt CO_2e per year (3% global CO_2e emissions) (IMO, 2020) and could reach 1.7 Gt CO_2 per year by 2050 if current trends continue (ETC, 2018). If scaled, interventions in this investment area could reduce emissions associated with shipping by 5–10% by 2030 (vs. BAU with no investment) (SYSTEMIQ, 2021)[55] and up to 100% by 2050 (ETC, 2019).
- **Compress the green ammonia premium:** Governments' investment can be supported reflecting the projected compression of the **green shipping fuel premium** as green hydrogen costs decline. At $2/kg H_2 results in a +140% premium for green shipping fuel vs. heavy fuel oils (compared to a +300% premium today). This premium would decline to +70% at $1/kg H_2.
- **Avoided health costs linked to air pollution:** An investment of €1 billion in greening Europe's inland waterway fleet could save €7 billion in external costs linked to nitrous oxides and particulate matter across the 2020s (European Commission and Prominent, 2018).

Investment barriers and policy levers

The main **investment barrier** is that green shipping fuel is likely to remain more costly than conventional fuel, meaning **policy incentives are needed to create markets for premium green shipping fuels.**

Policy levers that can be actioned by governments to drive the scale-up of investment in this action area include:

- **Set a target of 5% zero-emissions shipping fuels by 2030 and 25% zero-emission vessels for domestic shipping by 2030.**
- Design and implement **regulatory standards for green fuel** to create a premium market.
- Scale up **public investment in R&D** to achieve cost reductions in green shipping fuels.
- **Launch public-private partnerships and/or blended finance** instruments to reduce capex and cost of capital for green ammonia production and fuel infrastructure.

A2.4 Innovation: green hydrogen (H_2) and carbon capture, utilisation and storage (CCUS)

A2.4.1 Hydrogen

Investment rationale. Economic and environmental benefits arising from innovation in expanding the role of hydrogen as an energy carrier include:

- **Longer-term job creation** through growing **H_2 industry and upstream solar/wind energy** used to feed electrolysers. For example, Australia's Asian Renewable Energy Hub is projected to create approximately 20,000 jobs during its 10-year construction period (asianrehub.com).
- **Climate benefit:** Hydrogen can play a central role in decarbonising steel, chemicals (refining, plastics), shipping and aviation. Together these sectors account for 12% of current emissions (6 Gt CO_2e in 2018) (ETC, 2018).
- **Productivity and efficiency:**

[54] SYSTEMIQ (2021)/Energy Transition Commission analysis. Market sizing for 2030 assumes cost of $0.56/kg green ammonia, based on $2/kg H_2 cost; for 2030, this assumes cost of $0.36/kg green ammonia, based on $1/kg H_2 cost.

[55] Assumes 5% green shipping fuel in international shipping and 25% zero-emissions vessels for domestic shipping by 2030. See accompanying Technical Note by SYSTEMIQ (2021)for further detail.

- **The premium associated with green hydrogen is set to decline** as the costs of electrolysers and renewable energy fall. With a learning rate of 18% (cost decline per doubling cumulative capacity), rapid reductions in the cost of electrolysers can be expected as economies of scale and innovations come through.
- Meanwhile, the costs of solar, wind and batteries are projected to fall 30–60% over the 2020s (IRENA, 2019a, b). As a result, the cost of green hydrogen **is projected to decline from $3–6/kg H_2 today to less than $2/kg H_2 or below before 2030.** This will decrease the cost premium for goods produced with green hydrogen, creating more investment and further propelling cost declines. At $2/kg cost of H_2, the premium to be covered for green shipping fuel would be +140% HFO cost (versus +300% today); for synthetic jet fuel it would be +160% kerosene cost (versus +280% today); for green steel it would be +40% fossil-steel cost (versus +75% today); and for green ammonia fertilizer it would be +20% ammonium nitrate cost (versus +60% today) (ETC, 2021).

- **Accelerating scale-up of future industries:**
  - Building on existing momentum: **Governments worldwide have already committed $70 billion in public funding** for hydrogen. There are over 30 countries with hydrogen projects and 228 large-scale projects across the value-chain. If all projects come to fruition, total investments will reach over $300 billion in spending by 2030 (Hydrogen Council, 2021).
  - Reaching scale: **Together, country commitments and investments** are creating the conditions for **industry scale-up**. If targets by the EU alone are met (40 GW of H_2 production domestically + 40 GW remote serving EU demand), this would translate into around 5–15 Mt of H_2 in 2030. To deliver on a net-zero target, around 40 Mt of H_2 will be required by 2030. This means **more investment is needed now to move H_2 down the learning curve, driving down costs**, to hit around 15 Mt of H_2 by 2026 and around 40 Mt by 2030.
  - Export opportunities: Countries that scale hydrogen production can benefit from an export market that is projected to scale to **$6–12 billion p.a. by 2030** (SYSTEMIQ, 2021; Strategy&, 2020).[56]
- **Enhanced resilience:** Hydrogen can be used to store energy locally, thus making power systems less prone to supply chain disruptions or the price volatility of fossil fuels.

Investment barriers and policy levers

Investment barriers include:

- Lack of **long-term policy framework** enabling support and certainty of H_2 off-take, including:
  - Mandates for **zero-carbon shipping fuels**
  - Blending mandates for Sustainable Aviation Fuel with **'carve-out' for synthetic jet fuel**
  - **Public procurement** requirements for use of **green steel** in public infrastructure projects (e.g. bridge construction), or in **wind turbine manufacturing**
- Unclear **infrastructure planning for H_2 transportation** (e.g. pipelines) **and storage** (e.g. salt or rock caverns; steel tanks)
- Lack of **infrastructure investment support** for end-use cases, i.e. **subsidies** for converting ships to burn green ammonia, or for building H_2-DRI steel plants[57]
- Lack of **certification schemes** for low-carbon hydrogen (i.e. maximum GHG emission intensity per kg H_2 and scheme to certify hydrogen produced with low/no emissions)

[56] H_2 export market in 2030 estimated at ~2-4% of 2050 projection (SYSTEMIQ, 2021).
[57] H_2-DRI = Hydrogen Direct Reduced Iron, which is a low-carbon process for zero-carbon steel production.

Policy levers to scale investment in increasing hydrogen production and use include:

- Leverage regulatory and policy tools to create a **long-term policy framework and signal demand for green hydrogen:**
    - Provide **long-term outlook for investors** by improving certainty on **decarbonisation strategies** (e.g. implementing laws) and preference for zero-carbon technologies via **clear governmental targets and policies**, as well as **national hydrogen strategies** (including targets on volumes and price points).
    - **Set long-term markets for investors** for green hydrogen (and products made with green hydrogen) and create incentives to scale production, including **green mandates** on public procurement of steel (e.g. in construction) and chemicals, blending mandates for synthetic kerosene, zero-carbon shipping fuel mandates.
- **Provide planning and support for H_2 production, transportation and storage infrastructure:**
    - Scale **subsidies for H_2 production plants.**
    - **Implement regulations for H_2 electrolysers that are grid-connected to pay electricity charges reflective of their value to the grid**, e.g. exclude H_2 plants from paying grid charges since electrolysers can often benefit the grid being used as a balancing factor.
- **Implement infrastructure investment support** for end use cases.
- **Introduce certification schemes** for low-carbon hydrogen.

A2.4.2 Carbon capture, utilisation and storage (CCUS)

Investment rationale. Economic and environmental benefits arising from CCUS investment include:

- **Jobs:** The construction and operation of CCUS infrastructure can generate jobs, particularly linked to industrial clusters. **Projects can be launched in the near term,** generating employment as part of the recovery (Unsworth et al., 2020). The carbon capture industry could support up to **50,000 jobs** in the UK by 2030 (UK Government, 2020). In Europe, an estimated 150,000 jobs could be directly or indirectly linked to the emergence of a CCUS market by 2050 (European Commission, 2019). This is compared to 450,000 indirect and direct jobs along the coal value-chain in the region (Czako, 2020).
- **Climate benefit:** CCUS will contribute to decarbonising steel, cement and chemicals (refining, plastics). Together, these sectors account for nearly 20% of current CO_2 emissions (Energy Transitions Commission, 2018). Additional GHG reductions could be achieved through the use of CCUS to serve in the production of blue hydrogen. It will also be important for negative emissions solutions. CCUS represents an opportunity to reduce current GHG emission rates.
- **Accelerate scale-up of future industries:** Scaling-up CCUS can equip countries to scale green industries and build a future carbon capture industry, with the potential to serve both domestic and export markets.
    - **Enhance competitiveness in future industries:** By facilitating the production of green power and industrial products, CCUS can enhance the long-term competitiveness of national industries in a global net-zero emissions economy.
    - **Build on existing momentum:** G7 countries are already taking steps to scale CCUS. The US accounts for almost half of commercial CCUS facilities globally. Japan is developing CCUS technology both for domestic use and as an export industry, with a central role for CCUS in the country's Environmental Innovation Strategy (Global CCS Institute, 2020). The UK aims to capture 10 Mt CO_2 p.a. by 2030 via CCUS and has committed £1 billion to support the establishment of CCUS in four industrial clusters (UK Government, 2020). The country's Feeder 10 pipeline may be repurposed to act as a backbone of CO_2 transport, not least given its connection to the North Sea, where carbon could be stored (SCSS, 2015).

Box A.1: Negative emissions technologies

Carbon dioxide removal is likely to be indispensable in decarbonising the economy in addition to, rather than as alternative to, an ambitious decline in sector emissions. Direct air capture (DAC) technologies are in their infancy, yet show promise. Hybrid solutions – including bioenergy with carbon capture and storage (BECCS) – provide investment opportunities, although the total potential is likely to be limited due to large constraints on the availability of biomass. Additional early-stage opportunities are being explored, including opportunities to leverage kelp to sequester carbon.

Nature-based solutions also offer the potential to sequester carbon. These are covered in Sections 3.2.6 and 3.2.7.

Investment barriers and policy levers

Investment barriers include:

- **Insufficient value on carbon dioxide** to generate revenues for private investors to secure a attractive return on investment.
- **Cross-chain risks** (e.g. whereby the developer of one part of the CCUS chain will not receive expected income due to failure elsewhere in the CCUS chain) and **liability risks** (e.g. insurance on leakage risk) **drive up the cost of capital** for CCUS projects. This presents a significant material cost to projects, given the capital intensity of CCUS facilities (Global CCS Institute, 2019).
- **Insufficient support for R&D and pilots** to bring down cost per tonne of CO_2 captured and stored.

Policy levers to scale investment in CCUS include:

- **Value carbon dioxide** by commitment to a carbon price, taking account of the findings of the High-Level Commission on Carbon Prices (Carbon Pricing Leadership Coalition, 2017), providing a clear, predictable price signal for CO_2 capture and storage.
- **Reduce cross-chain risks** by **implementing a legal and regulatory framework** that clarifies CO_2 storage operators' liabilities.
- **Provide support for R&D and pilots** into CCUS technology, including direct air capture solutions, improving CO_2 storage efficiency and security by advancing new and early-stage monitoring tools and models.

A2.5 Adaptation and resilience

Investment rationale. Economic and environmental benefits arising from investment in adaptation and resilience include:

- **High returns:** Based on the work of the Global Commission on Adaptation, investments in adaptation and resilience can deliver **high returns**:
  - Investment of **$1.8 trillion** in five areas is estimated to deliver **$7.1 trillion returns** over the next decade, with benefits ranging from **2 to 10 times** greater than original cost. These include: (i) strengthening early warning systems; (ii) making new infrastructure resilient; (iii) improving dry land agriculture crop production; (iv) protecting mangroves; and (v) making water resources management more resilient.
  - **Lower financial costs to attract investment:** By reducing the risks of physical damage, adaptation and resilience interventions enhance the viability of investments.
- **Productivity and efficiency:** Adaptation and resilience measures can reduce costs and open up business opportunities.
  - **Reduced disruptions** caused by extreme weather events on economic activity. Hurricane Florence (2018) caused $24 billion in losses in the US in industries including aerospace and pharmaceuticals (Global CCS Institute, 2020).
  - **$135 billion** disaster-related insured losses in 2017 globally (Munich RE, 2017).

- Extreme-weather-related losses in the **US are up 450%** since the 1980s, reaching **$810 billion** over the 2010s.
- **Annual flood damage** from sea level rise estimated at $12 trillion losses in 2ºC pathway (ibid.).
- Restoring upland forests and watersheds can save water utilities an estimated **$890 million p.a.** in the world's 534 largest cities (ibid.).

- **Business opportunities** in adaptation interventions such as flood dykes and drought-resilient seeds are estimated at **$236 billion** (Bartlett and Coleman, 2019).
- **Social impact:** Adaptation and resilience interventions are critical to securing a more stable world. Climate change could push more than **100 million people below the poverty line by 2030** without appropriate adaptation action (Global Commission on Adaptation, 2019). **Around 2 billion** people live in dry lands vulnerable to **desertification,** which could displace 50 million people by 2030.
- **Avoided health costs** by supporting populations to manage climate impacts.
  - **Half of the global population** is projected to be exposed to **more than 20 days p.a. of extreme heat** by 2100 in 2ºC pathway (Mora et al., 2017).
  - After the 2003 heat wave killed 15,000 people in France, the government implemented preventive measures and warning messages. As a result, despite exceeding temperatures in 2003, the death toll from the 2019 heat wave was 10 times smaller (Ford, 2019).

Investment barriers and policy levers

Investment barriers include:

- **Lack of understanding and/or under-appreciation of future costs** linked to climate scenarios (how close or far from being Paris-aligned) and lack of integration of anticipated impacts of global temperature shifts, which makes it difficult for investors to calculate returns on investment.
- **Lack of financial capacity** to take on high upfront costs in developing countries, exacerbated by high financing costs. This challenge applies to mitigation as well as adaptation solutions. As a result, developing countries have difficulty in unlocking the longer-term benefits of upfront investments in these solutions.
- **Lack of incentives to properly evaluate risks and integrate into planning and decision-making** for the finance community, businesses, and governments due to (i) limited availability of reliable and accurate data and weak technical capacity and (ii) regulatory requirements for insurers to provide insurance for certain highly exposed assets at regulated prices, therefore removing risk signal for these investments.

The Global Commission on Adaptation identifies three revolutions to bring climate adaptation and resilience action to scale:

A revolution in understanding

- **Support comprehensive risk assessments** to better understand the opportunities in adaptation and resilience by providing funding for publicly available sector- and geography-specific assessments. These should be underpinned by **better, open-access climate data.**
- **Develop** a **universally agreed set of metrics** for adaptation to track effectiveness of interventions.

A revolution in finance

- **Increase the scale and** catalytic use of international climate finance for adaptation**.** Finance should be issued in the form of grants rather than loans.
- **Scale-contingent finance and insurance,** including national disaster funds, social protection programmes, contingent credit lines and sovereign/sub-sovereign insurance.

A revolution in planning

- Create incentives to integrate **climate risk into spatial planning, economic policy, subsidies, technical codes and standards.**
- Leverage **public procurement** by including resilience requirements in all publicly funded infrastructure contracts (across all forms of construction, including bridges, roads, residential and commercial buildings, hospitals and schools) and highlighting opportunities to leverage nature-based solutions where possible.
- Ensure that the **role of nature-based solutions is factored** into each of the above, particularly risk assessments, spatial planning and early opportunities supported through public procurement.

A2.6 Nature protection and restoration

Investment rationale. Economic and environmental benefits arising from this investment area include:

- **Near-term jobs:** Protecting and restoring nature can generate direct jobs and job opportunities in adjacent sectors. The redirection of 5% of stimulus into nature-based solutions could create 7% more jobs globally than the BAU scenario (Vivid Economics, 2020).
    - Sustainable land management could deliver 23 million jobs by 2030 (World Economic Forum, 2020).
    - A sustainable ocean economy could generate 12 million new jobs by 2030, with 15–19 jobs per $1 million invested in the US (High Level Panel for a Sustainable Ocean Economy, 2019).
- **Climate and biodiversity benefit:** Halting and reversing the destruction and degradation of natural ecosystems, including tropical forests, is a key determinant to achieve the goals of the Paris Agreement and the Aichi targets on biodiversity.
    - **Halting deforestation and restoring** 450 million ha of natural land and forests would reduce annual net GHGs by over 5 Gt by 2030. A sustained halt of deforestation and restoration of 1.2 billion ha of natural land and forests would reduce GHGs by over 8 Gt by 2050, consistent with a 1.5°C pathway (FOLU, 2019a).
    - **Protecting and restoring coastal and marine ecosystems** could reduce annual net GHGs by 0.9 Gt by 2030 and by 1.4 Gt by 2050 (High Level Panel for a Sustainable Ocean Economy, 2019).
    - Without action, the **mounting risk of ecosystem collapse** threatens to transition the Earth's three remaining major tropical rainforests (the Amazon, Congo and South East Asia) from carbon sinks to carbon sources.
    - Forests are home to most of Earth's terrestrial biodiversity. They account for 80% of all known amphibian species, 75% of all birds and 70% of all mammals (IUCN, 2008).
- **Productivity and efficiency:** Stable natural ecosystems underpin productivity across sectors. The three largest sectors (agriculture, food and beverages, and construction) that are highly dependent on nature generate an estimated $8 trillion gross value added (World Economic Forum, 2020).
    - The **$4 trillion** food, beverage and agriculture sector is highly dependent on nature (including evaporation from forests, soil fertility, pollination and rainfall) (ibid.). Soybean yields in tropical countries could decrease by 10% with 4°C warming and by 20% with 6°C warming (Zeppetello et al., 2020).
    - **$200 billion annual business opportunities** in forest ecosystem services, including in sustainable forestry management approaches (e.g. sustainable timber), terrestrial carbon markets and payments for ecosystem services (Food and Land Use Coalition, 2019).
    - A **sustainable** ocean could support **six times more sustainable seafood** by 2050 than it does today (High Level Panel for a Sustainable Ocean Economy, 2019).
    - **75% of antibiotics** are derived from naturally occurring material (Claes et al., 2020).

- **Physical climate resilience**: Thriving natural ecosystems can reduce both the likelihood and impact of extreme weather events.
    - Deforestation, water scarcity and land degradation impose costs of almost **$1.7 trillion** from losses in output and biodiversity (Food and Land Use Coalition, 2019).
    - It is **twice as expensive to delay action to stabilise biodiversity** globally as it is to act immediately (Vivid Economics, 2020; Dasgupta, 2021).
    - Mangrove **forests** help to avoid over **$80 billion p.a.** in losses from coastal flooding and support **$40–50 billion p.a.** in fishery, forestry and recreation (Global Center on Adaptation, 2019).
    - In Indonesia in 2015 forest fires cost at least **$16 billion** in impacts on agriculture, environment, forestry, trade, tourism and transportation (World Bank, 2015).
- **Avoided health costs** through improved air quality and reduced exposure to disease.
    - Land-use change is a globally significant driver of pandemics and caused the emergence of more than 30% of new diseases reported since 1960 (IPBES, 2020).
    - **Improved air quality:** Indonesia's forest and peat fires of 2015–16 caused over **1 million** cases of respiratory illness and **100,000 premature deaths** (Koplitz et al., 2016).

Investment barriers and policy levers

Investment barriers include:

- **Lack of mechanisms to accurately account for the value of natural capital.**
    - **Accounting mechanisms:** the Dasgupta Review highlights the asset management problem that has resulted from the lack of consideration of natural capital in measures of economic growth and wealth – i.e. GDP.
    - There lacks an accepted framework to integrate carbon offsetting into decarbonisation strategies. This holds back the potential for **carbon markets** to emerge, making it difficult to attract private investment.
    - **Challenges persist in quantifying investor risk exposure** due to the complexity and opacity of supply chains.
    - **Weak access to finance** for projects, individuals and communities working to protect and restore nature as these groups often have insecure land tenure, are in remote locations and have no credit history. Similarly, there is **limited availability of the right kind of finance** (i.e. maturity, risk profile, ticket size and medium to longer term).
    - **Data gaps and inconsistent progress indicators** make it difficult to effectively target policies. In particular, there lacks comparable and consistent data on countries' progress in mainstreaming biodiversity into national and sector-level plans.
    - **Lack of political will and/or capacity:** weak political will, corruption and weak bureaucratic and enforcement capacity can undermine confidence in the credibility and sustainability of investments.
    - **Weak international rules and enforcement to create disincentives for unsustainable practices,** e.g. trade in illegal forest products and environmental crime.

Policy levers that can be actioned by governments to drive the scale-up of investment in this action area include:

- **Drive appropriate valuation of nature and ecosystem services:**
    - Commit to measure economic success using inclusive measures of wealth, including human-produced and natural assets, in line with the Dasgupta Review, and apply these to policymaking. Consider development of a System of Environmental Economic Accounting (SEEA) to support climate policy at all levels of government.

- Create and regulate effective carbon markets (including capacity-building in countries to spend funds from Payments for Ecosystem Services on continued protection and restoration) and engage in Taskforce on Scaling Voluntary Carbon Markets.
- Incentivise and support integration of climate and nature risk into investor decisions, including via engagement in the Task Force for Nature-related Disclosures. Governments can also commit to developing lists of green and brown investments to guide investors.

- **Improve access to finance for the protection and restoration of nature** by increasing the scale and catalytic use of public climate finance for protection and restoration of terrestrial and marine ecosystems via direct REDD+ aligned transactions, prioritising jurisdictional approaches where feasible. Work with MDBs and DFIs to develop mechanisms that improve access to finance for farmers, producers and rural communities.
- **Improve the coverage of existing biodiversity databases** and of open and coordinated data-sharing by all relevant institutions nationally and internationally.
- **Signal political will and fill capacity gaps** by providing support for developing countries via technical assistance and capacity-building.
- **Leverage market and legislative tools to strengthen international rules and enforcement and create disincentives for investment in unsustainable practices.**
  - **Commit to deforestation-free supply chains** through engagement with the Forest, Agriculture, Commodities Trade 'FACT' Dialogues at COP26.
  - **Implement import mandates** for deforestation-free products and preferential access to sustainable commodities
  - **Create a new global agreement on wildlife crime, setting disincentives for investment in unsustainable practices**, in line with the recommendations of the Global Initiative to End Wildlife Crime.

A2.7 Productive, sustainable and efficient agriculture

A2.7.1 Climate and nature-positive agriculture

Investment rationale. Economic and environmental benefits arising from sustainably enhancing agricultural yields and transitioning to regenerative agriculture practices include:

- **Productivity and efficiency:** Productive, regenerative agriculture can enhance livelihoods, boost productivity and growth, improve food security in food-stressed regions and reduce $1.2 trillion hidden costs linked to extractive farming practices today (FOLU, 2019a).
  - Improving agricultural yields can enhance the livelihoods of hundreds of millions of farmers worldwide by **boosting incomes and food security.**
  - **Deliver economic growth in agriculture-dominated developing economies**. Agriculture accounts for around 25% of GDP in some sub-Saharan Africa (up to 60% in some countries). Enhancing productivity is therefore key to delivering growth.
  - A study of 286 projects centred on sustainably enhancing yields across 37 million hectares in 57 developing countries found that farmers increased crop yields by an average of 79%, while simultaneously raising water use efficiency, improving carbon sequestration and reducing pesticide applications (Pretty et al., 2006).
  - Soil degradation costs the European Union around **€100 billion p.a.** due to declining yields, health costs and other factors (SYSTEMIQ, 2020). Land degradation – which is exacerbated by unsustainable agricultural and land management practices – is estimated to cost Asia and Africa $84 billion and $65 billion per year, respectively (IISD, 2018).
  - **Reduced input use via precision technology and regenerative practices can deliver higher margins.** Large-scale, productive farms in Europe can transition to regenerative agriculture while

achieving **30% reductions in agrochemical use**. For a British cereal farm, this translates into a **17% improvement in gross margin** (Soil Capital, n.d.).

- **Regenerative farming can create additional revenue streams.** Farmers applying agroforestry can sell produce from their trees, in addition to the main crop.

- **Climate benefit:**
  - **Reduce land use change emissions:** Boosting yields is critical to reduce the strain on natural resources. Land use change accounts for around 10% of global CO_2e emissions and deforestation linked to agriculture accounts for around 40% of tropical forest loss (New Climate Economy, 2018). Without a change in practices, agriculture's footprint is set to grow: global demand for food crops is projected to increase by 56% from 2010 to 2050 due to population growth and a growing global middle class (ibid.).
  - **Sequester carbon:** While there is currently no clear estimation of the **emissions reduction potential** of regenerative agriculture, there are opportunities to sequester carbon and avoid emissions associated with excessive fertiliser use.
- **Scale-up growing industry: A transition to regenerative agricultural practices is already underway.** By accelerating this transition, governments can unleash agricultural yield and innovation benefits seen in the Green Revolution, while avoiding environmental damage.
  - **$100 billion business opportunity** in increasing agricultural yields in Sub-Saharan Africa alone, including high-quality inputs, technology and infrastructure (FOLU, 2019b).
  - **Major agribusinesses** are driving growth. Since 2015, Cargill, Danone, General Mills and Walmart have each committed to regenerative farming at-scale (Cargill, 2020; General Mills, 2020; Walmart, 2020).
  - **The precision agriculture** market is set to triple to **$12 billion by 2025** (Agritech Tomorrow, 2019) and the **vertical farming** market to **double by 2030** (Terazono, 2020).
- **Climate resilience:** Sustainable, productive practices can build resilience to climate shocks by reducing **soil erosion**, supporting **watershed management** and promoting diverse crops that reduce the risk of crops being simultaneously destroyed by pests.
- **Social impact and avoided health costs:**
  - **Poverty reduction:** Agriculture has been found to be two to four times more effective at reducing poverty than growth originating from other sectors, due to the high shares of the world's poor that are farmers (World Bank, 2007).
  - **Improved food security and nutrition**: Undernutrition accounts for $1.8 trillion losses via health costs and reduced productivity due to illness and development issues (FOLU, 2019a).
  - **Improved air quality and reduced exposure to toxins**. Fertiliser use costs the UK an estimated **£1 billion** in health costs each year (Webster, 2020).

Investment barriers and policy levers

Investment barriers include:

- **Weak farmer access to finance and inputs to enhance productivity in EMDEs:** Lack of secure land tenure combined with the remote location of farming communities, weak infrastructure and limited access to markets and knowledge platforms limit their ability to access finance and inputs to invest in boosting productivity.
- **Lack of incentives or support for farmers** to adopt sustainable practices.
  - **Government agricultural** support often favours more input-intensive forms of agriculture and does little to drive better nutrition and environmental outcomes. Of the $300 billion of annual producer support, governments provide an estimated $35 billion to farmers for inputs and on-farm infrastructure via agricultural subsidies (Searchinger et al., 2020).

- **Transition risk:** Farmers face a transition risk and lack **clear demand signals** (although these are growing) and/or confidence that shifting to regenerative practices will not reduce yields in the short or long term due to a lack of familiarity with these practices.

- **Little or no pricing or regulation of external factors** to penalise unsustainable practices such as the contribution of excessive fertilizer use to raising nitrate levels in drinking water, which has to be removed (Folkens et al., 2020).
- **Lack of a shared definition of regenerative agricultural practices** around which to set guidelines and regulations.

Policy levers that can be actioned by governments to drive the scale-up of investment in this action area include:

- **Create incentives and support for farmers to adopt sustainable practices:**
  - **Commit to integrate agriculture into climate strategies**, including Long-term Low Emissions Development Strategies and Nationally Determined Contributions (NDCs).
  - Set target of **scaling climate and nature positive farming practices to 50% domestic farms by 2030**.
  - **Redirect national agricultural subsidies** to incentivise and support farmers to transition. Governments could redirect a portion of the $50 billion agricultural subsidies currently directed towards inputs and infrastructure for individual farms towards biological inputs and technology to support regenerative practices (Searchinger et al., 2020).
  - **Leverage public procurement** by committing to implementing 'sustainable production mandates' reflecting above international code for 100% publicly procured food and land-use-related products by 2025.
- **Account for negative externalities of unsustainable practices.** Levy payments on GHG emissions and over time extend levies to other types of pollution to price in externalities.
- **Create an international nature-positive farming code** that helps farmers and the food industry align on the best practices to use. This could build on emerging definitions based around soil carbon levels – a good proxy for soil health.
- **Work** with MDBs, DFIs and the private sector to design facilities that **enhance farmer access to finance and inputs** including credit, insurance, remittances, local banking capacity.
- **Increase investment in R&D** for public knowledge in technologies and practices that support productive regenerative agriculture and nature-based solutions – including precision agriculture technologies.

A2.7.2 Reducing food loss and waste

Investment rationale. Economic and environmental benefits arising from the reduction of food loss and waste include:

- **Productivity and efficiency:** Opportunity to increase agricultural value-chain productivity and efficiency by reducing losses. Reducing food loss and waste could deliver an economic return of **$455 billion p.a.** by reducing some of the value of food losses, currently estimated at **$1.2 trillion p.a.** (FOLU, 2019a).
- **Climate benefit:** Reducing food loss and waste would deliver **GHG** reductions by easing pressure to convert natural ecosystems for agriculture (ibid.).
- **Establish and scale cold-chain storage industries:** Reducing food loss and waste in the supply chain could deliver **$255 billion p.a.** of business opportunities by 2030, including in cold-chain storage provision, preservation technologies and using food waste to create new products (ibid.).
- **Enhance food security and nutrition:** Reducing food loss and waste can improve the quantity and reliability of food supply, and retain maximum nutritional content. **40% of fruit and vegetables is lost**

p.a. (by weight). Even perishable produce that survives can lose nutritional value across the value-chain (ibid.).

Investment barriers and policy levers

Investment barriers in advanced and emerging economies include:

- **Perverse incentives** resulting from unintended consequences of policies on food safety, quality, labelling, packaging and tax incentives that limit the potential for food to be redistributed and remove incentives for retailers to manage waste.
- **Lack of consumer motivation** to reduce food waste – due to low cost and ready availability of food – limits the commercial potential of business models that help consumers to reduce waste.
- **Insufficient forecasting capacity:** Disparate and complex agricultural supply-chains with **weak communication systems** mean that providers of cold-chain solutions lack certainty of demand, reducing the attractiveness of investment.
- **Lack of coordinated enabling environment:** Establishing uninterrupted cold storage and distribution facilities and activities requires coordination between multiple stakeholders. The predominance of small-scale producers and traders, and of informal trading links in developing economies can prevent this.
- **Limited farmer access to finance** and uncertainty of achieving a return can limit farmer ability/ willingness to make upfront investment in on-farm solutions.

Policy levers that can be actioned by governments to drive the scale-up of investment in this investment area include:

- Reassert goals to halve food loss and waste at retail and consumer levels, and support countries to reduce supply-chain losses by 2030.

Domestically in the G7:

- Implement **policy and regulatory measures** and address **perverse incentives** to enable waste reduction and redistribution of food within G7 countries, including reforming regulations on food safety that prevent redistribution and implementing requirements for retailers to reduce food waste (as pioneered in France) (Foodtank, 2019).
- **Increase consumer motivation to reduce food loss and waste by providing public funding** for consumer-oriented **behaviour change campaigns** within G7 countries.

In EMDEs:

- Increase **scale and catalytic use of development/risk capital and ODA** to support EMDEs to improve infrastructure and supply-chain communications, targeting **$20 billion p.a. by 2025**.

A2.7.3 Shifting to more plant-based, healthier diets

Investment rationale. Economic and environmental benefits arising from a shift to healthier diets include:

- **Productivity and efficiency.** Plant-based proteins can be more efficient to produce and more responsive to market demand, making them more resilient to external shocks.
- **Climate benefits:** Shifting food consumption patterns is **the most impactful step** G7 countries could take to reduce demands on nature from the food system.
    - A transition to plant-based healthy diets could reduce food- and agriculture-related emissions (including imported emissions) by **~50% globally** (Clark et al., 2020).
    - Livestock accounted for **67% of global agricultural land** in 2016. If crop production for livestock feed is included, the proportion rises to **77%**.
    - **Cattle is one of the biggest drivers of deforestation** globally. Pasture grazed by cattle occupies **45 million ha** of land deforested between 2001 and 2015, an area four times larger than that

replaced by oil palm in the same period (Goldman, 2020). At the same time, cattle-grazing represents a critical livelihood for millions and a source of collateral for poor farmers in developing economies. Supporting cattle ranchers to transition to sustainable grazing practices, though not the focus of this investment area, would play a critical role in mitigating emissions and reducing the negative impact on nature.

- **Establish and scale diverse protein industries:** Alternative protein industries are experiencing rapid growth, which is set to scale. At the same time, certain industries (such as meat and dairy) are likely to experience declines. Farmers and other agricultural workers in these value-chains will require support to navigate this transition.
    - **The U.S. alternative proteins industry** has grown by **~30% in two years to ~$5 billion** (Good Food Institute, 2020). Major fast-food chains are launching meat-free burgers, bringing this trend into the mainstream. By 2030, this market is projected to grow **18-fold to $85 billion** (UBS Group, 2019).
    - The UK saw sales growth of plant-based products of 40% between 2014 and 2019 (FMCG Magazine, 2020). Some projections show alternative and plant-based meat accounting for up to 60% of meat sales by 2040 (AT Kearney, 2019; Barclays, 2019[58]; Jefferies, 2019[59]).
    - In 2020, venture funding for plant-based and cultivated meat start-ups exceeded **$3.6 billion**, up 686% from 2019 (FAIRR, 2020).
- **Enhance food security and protein autonomy.** The scale-up of diverse protein production could reinforce a shift towards more local food production, helping to reduce vulnerability to volatile supply-chain risks.
- **Avoided health costs.**
    - US **meat and poultry** farms cost the economy more in **health costs linked to air pollution** than the value these sectors add (Tschofe et al., 2019).
    - Modern animal production systems are vulnerable to future pandemics and could contribute to the spread of disease. **75%** of emerging **infectious human diseases** are **passed on from animals**. Increasingly, these are coming from livestock due to high stocking density, indoor confinement, chronic stress, lowered immunity, and live transport (FAIRR, 2020). Research by FAIRR has found that **over 70% of animal agriculture firms are a high risk of fostering future pandemics** (ibid.).

Investment barriers and policy levers

Relative to other investment areas, the barriers to investment in diversification of protein supply are relatively low. Alternative protein products already attract venture and corporate capital. There are no insurmountable regulatory barriers, although many products will need approval in key markets. However, a number of barriers are slowing the transition away from unhealthy diets towards healthier ones. Without this transition, there is a risk that consumers will simply eat more protein rather than reduce consumption and move away from meat.

These barriers include:

- **Outdated dietary guidelines** do not factor in planetary and human health, setting the wrong standards for regulations, institutional meals (including school meals) and advocacy.
- **Agricultural subsidies** are currently geared more towards intensive agricultural systems, with Chatham House research finding that subsidies are highly concentrated on a few commodities, including highly-emitting animal protein products including pork, beef, and veal (Bellmann, 2019).

[58] Projected 10% of total protein market by 2029.

[59] Projected a lower 17% by 2040.

- **Inconsistent policies,** guidelines and public investment decisions encourage investment into and consumption of existing staples, including meat and dairy instead of innovation in more diverse products.
- While not a barrier to investment, the transition to more diverse diets will create **challenges for the workforce in declining meat and dairy industries,** as jobs are displaced. Individuals and communities linked to these value-chains will require support to transition to new roles in other sectors.

Policy levers to increase investment in this area include:

- Set a target of **transitioning to healthy, affordable, plant-based diets by 2030,** in line with country-specific recommendations across G7 countries.
- **Update national dietary guidelines** to align with planetary and human health and shift **marketing and advertising legislation,** working with civil society groups to translate these into awareness and healthy eating campaigns.
- **Redirect agricultural subsidies** to increase the availability and affordability of healthier and more sustainable food choices for consumers, e.g. redirecting a portion of the $300 billion annual market price support towards more diverse, nutritious crops and food products.
- **Streamline policies and provide clear and consistent investment support and demand signals.**
    - **Invest in R&D,** to provide an improved regulatory and enabling environment. The Indian government has dedicated funding to research in cellular agriculture as part of its work to establish India as a future protein production hub (Global Food Institute, 2020).
    - Leverage **public procurement** to create demand for diverse proteins by increasing social acceptability and reducing costs.
- **Support the meat and dairy industry workforce** to navigate the transition towards plant-based diets. Support will be needed to assist displaced workers move to other job opportunities, including in local food economies (which may not necessarily be at the scale of declining industries).

A2.8 Cross-sectoral: circular economy and digital

A2.8.1 Circular economy

Investment rationale. Scaling up the circular economy could create **6 million additional jobs** globally by 2030. Processing recyclables can sustain around **20 times more jobs** than landfill and plastic manufacturers (Goldstein and Electris, 2011). This assumes a shift in costs away from primary production towards labour (i.e. reduced CAPEX costs), in parallel with an increase in primary resource costs that account for externalities resulting from extractive practices and over-consumption of primary resources. Accounting for these externalities is critical to enable circular models to compete.

By decoupling productivity from resource use, circular systems can underpin efficient economies with lower resource dependency and costs. Transitioning to a circular economy could generate net **material cost savings of $380 billion p.a.** in Europe (during transition), and up to **$630 billion** if a fundamental economic shift across all sectors were achieved (i.e. once technologies and infrastructure to support circulation of materials is scaled and other enabling conditions such as customer acceptance, legal frameworks and cross-chain collaboration are in place) (Ellen MacArthur Foundation, 2013).

- **Potential for $0.2 trillion p.a. resource savings** from transition to circular systems in mobility, food and the built environment in the EU alone (Ellen MacArthur Foundation, 2015).
- **Digitalisation** of energy, water, buildings and communications via AI, driverless cars, closed loop services and crowd-sourcing – could deliver **$130 billion p.a. CAPEX savings** and an additional **$450 billion** in OPEX savings per year (ABI Research, 2017).
- **Declining cost premium:** Today, economic systems are strongly biased towards linear economic models (e.g. fiscal incentives do not promote enhanced resource efficiency; producers are not held responsible for a product's impact beyond point of sale; companies do not account for negative

externalities that result from extractive resource use). Realigning economic systems to remove this bias would enable circular business models to compete fairly, leading to **market tipping points when circular models outcompete linear models on convenience**, cost and quality of service (e.g. cost of batteries cheaper via circular model).

- **Reduced import dependency for raw materials**. This can help to avoid shortages and relieve companies from volatile prices of products and raw materials, such as cobalt and lithium.
- **Increased convenience can boost productivity.** The European Union expects to increase GDP by an additional 0.5% by 2030 by scaling circular economy interventions.

An economy-wide transition to circularity could **halve emissions by 2030** in geographies like the EU (Ellen MacArthur Foundation website). Material efficiency measures and greater circularity could reduce emissions by **40% in heavy industrial sectors** (plastics, steel, aluminium and cement) by 2050 (ETC, 2020). Together, these sectors account for **over 10% of emissions today (6 Gt in 2018).**

Investment barriers to the rapid development of the circular economy include:

- **Lack of international alignment around targets** in line with decoupling of virgin resource consumption of extractable materials globally.
- **Lack of enabling infrastructure** to support the circulation of materials through the economy, including:
    - **Weak collection systems** limit infrastructure available to support circular systems, particularly in the Global South.
    - **Lack of transparency and standardised information** on materials and products limit effective lifecycle management across the value chain.
- **Perverse incentives penalise circular models.**
    - **High labour costs in developed markets** penalise models that require labour inputs, amplified by high labour taxation rates. This undermines the potential for circular models to scale and compete on price, given their high labour intensity.
    - **Business risks associated with retaining** product liabilities over lifetime for product-as-a-service business models.

Policy levers to scale-up investment in this area include:

- **Work towards a formal multilateral resources forum to assess the need for a maximum budget of extractable materials globally**; determine targets in line with effective decoupling of virgin resource consumption from human wellbeing; and support joint innovation financing and technology transfer in circular approaches necessary to achieve this. Developed economies should be required to achieve absolute decoupling (total virgin resource consumption decreasing) while economies in transition could be given more flexibility (relative decoupling). Governments could draw on the lessons of the Paris Climate Agreement in working towards this convention.
- **Strengthen enabling infrastructure domestically and internationally:**
    - Work with the private sector to develop and invest in waste management systems supporting 'reverse logistics' systems – i.e. collection, disassembly and redistribution systems that enable the circulation of materials.
    - Scale-up digital technologies supporting circular material management (e.g. product passports, digital twins, automation for re-manufacturing).
    - **Engage internationally and allocate funds for EMDEs** to support collection systems.
- **Realign fiscal and regulatory incentives to support investment in circular models.**
    - **Shift taxes from human resources (labour) to physical and natural resources (i.e. primary products)**, supporting the economics of labour-intensive circular products and services while

creating social benefits. In the EU, 50% of tax revenues came from labour in 2019 and only 6% from green taxes (EX'Tax Project Foundation, n.d.).

  - **Introduce regulation and standards** to support emergence of markets for circular business models. Priorities include implementing Producer Ownership schemes; introducing mandatory 'material passports' in key economic ecosystems; mandating transparency on recycled content for products and/or spare parts; reviewing designation of end-of-life products as waste vs. reusable/refurbishable; restrict obsolescence and ban destruction of unsold products.

- **Scale up investment in R&D** to develop circular technologies and material (e.g. recyclable, compostable or reusable packaging; textiles made of regenerative materials; and robotics to disassemble products).

A2.8.2 Digital

The digital transformation will play a central role in transitioning to a low-carbon economy:

- **It supports a transformation in the energy system** to 'electrify everything' and scale up renewable generation. For example:
  - Demand-side response of millions of assets becomes more critical as transportation and heating get electrified, e.g. smart charging behaviour for millions of electric cars, similarly time-shifting when electric heat pumps run and using hot water storage tanks as a buffer. Digital solutions (e.g. IoT, AI forecasting and optimisation algorithms) are critical in enabling these assets to interact with the broader electricity system in a smart manner.
  - **As solar and wind become a larger share of generation**, accurately forecasting output and gathering live readings from the generation sources is important. Digital solutions (e.g. AI forecasting) are critical to this.
- **Digital technologies can support the transformation of food and land use systems** by enhancing traceability, increasing productivity on farms and strengthening value-chain linkages:
  - **New technologies make it possible to monitor land use**, track changes in forest boundaries and biodiversity levels, and identify and address deliberate deforestation.
  - **Digital precision agriculture** tools can significantly reduce input requirements and enhance yields on farms.
  - **The emergence of e-commerce** is creating routes for farmers to get to market, offer more specialised products and capture a product's final value chain.
  - **Access to online data offers consumers more power** to choose products based on health, ethical and sustainability standards.
- Advances in digital technology are expanding the opportunities for circular models, driving down costs and enhancing convenience relative to linear models:
  - **Digital technology underpins a sharing economy by enabling individuals and communities to connect, exchange and pool resources.**
  - **Digital tools enable closed loop solutions by tracking the location and characteristics of key materials.** For example, the European Union is planning to legislate the creation of digital 'product passports', starting with batteries, to underpin effective life-cycle management including recycling and reverse logistics (European Commission, 2020).

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