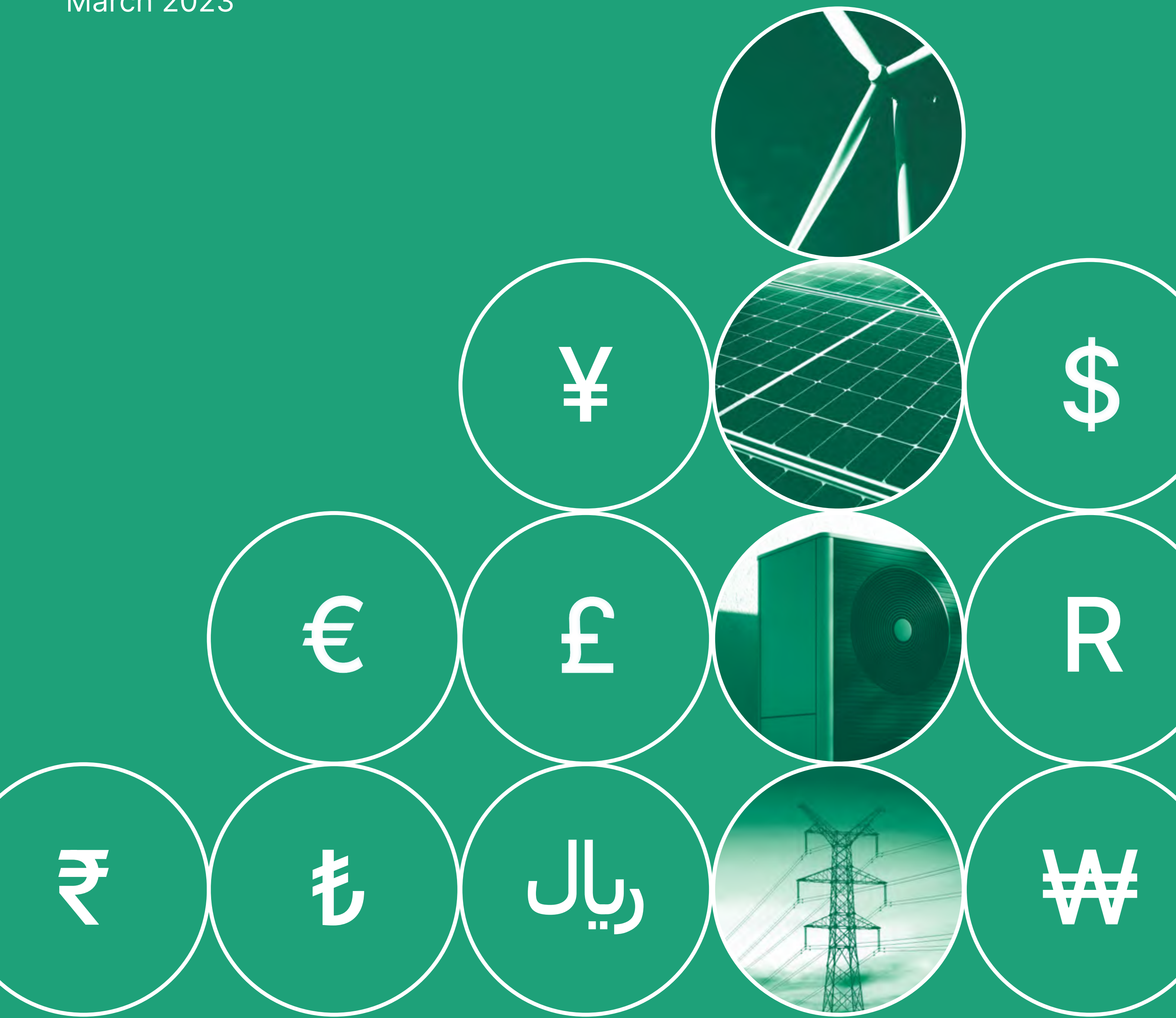
Financing the Transition:
How to Make the Money Flow for a Net-Zero Economy

March 2023



Energy Transitions Commission

Version 1.0

Financing the Transition:

How to Make the Money Flow for a Net-Zero Economy

The Energy Transitions Commission (ETC) is a global coalition of leaders from across the energy landscape committed to achieving net-zero emissions by mid-century, in line with the Paris climate objective of limiting global warming to well below 2°C and ideally to 1.5°C.

Our Commissioners come from a range of organisations – energy producers, energy-intensive industries, technology providers, finance players and environmental NGOs – which operate across developed and developing countries and play different roles in the energy transition. This diversity of viewpoints informs our work: our analyses are developed with a systems perspective through extensive exchanges with experts and practitioners. The ETC is chaired by Lord Adair Turner who works with the ETC team, led by Faustine Delasalle (Vice-Chair), Ita Kettleborough (Director), and Mike Hemsley (Deputy Director).

The ETC's *Financing the Transition* was developed by the Commissioners with the support of the ETC Secretariat, provided by SYSTEMIQ. This report constitutes a collective view of the Energy Transitions Commission. Members of the ETC endorse the general thrust of the arguments made in this publication but should not be taken as agreeing with every finding or recommendation. The institutions with which the Commissioners are affiliated have not been asked to formally endorse this briefing paper.

This report looks to build upon a substantial body of work in this area, including from the IEA, GFANZ, IRENA, BNEF, the Independent High-level Expert Group on climate finance chaired by Vera Songwe and Lord Nicholas Stern, and development finance experts such as the Blended Finance Taskforce.

The ETC team would like to thank the ETC members, member experts and the ETC's broader network of external experts for their active participation in the development of this report.

The ETC Commissioners not only agree on the importance of reaching net-zero carbon emissions from the energy and industrial systems by mid-century but also share a broad vision of how the transition can be achieved. The fact that this agreement is possible between leaders from companies and organisations with different perspectives on and interests in the energy system should give decision-makers across the world confidence that it is possible simultaneously to grow the global economy and to limit global warming to well below 2°C. Many of the key actions to achieve these goals are clear and can be pursued without delay.

Learn more at:

www.energy-transitions.org

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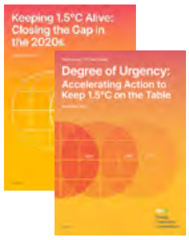
Major ETC reports and working papers

Global Reports

Mission Possible (2018) outlines pathways to reach net-zero emissions from the harder-to-abate sectors in heavy industry (cement, steel, plastics) and heavy-duty transport (trucking, shipping, aviation).

Making Mission Possible (2020) shows that a net-zero global economy is technically and economically possible by mid-century and will require a profound transformation of the global energy system.

Making Mission Possible Series (2021–2022) outlines how to scale up clean energy provision to achieve a net-zero emissions economy by mid-century.



Keeping 1.5°C Alive Series (2021–2022) COP special reports outlining actions and agreements required in the 2020s to keep 1.5°C within reach.

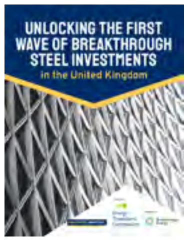
Barriers to Clean Electrification Series (2022–2023) recommends actions for stakeholders to overcome key obstacles to clean electrification scale-up, starting with streamlining planning and permitting.

Sectoral and cross-sectoral reports

These reports, which were published as a follow-up to the **Mission Possible** report (2018), provide detailed analysis of six of the harder-to-abate sectors.

As a core partner of the MPP, the ETC also completes analysis to support a range of sectorial decarbonisation initiatives.

MPP Sector Transition Strategies (2022): a series of reports that aim to guide the decarbonisation of seven of the hardest-to-abate sectors. Of these, four are from the materials industries: aluminium, chemicals, concrete, and steel, and three are from the mobility and transport sectors – aviation, shipping, and trucking.



Unlocking the First Wave of Breakthrough Steel Investments (2023): looks at how to scale up near-zero emissions primary (ore-based) steelmaking this decade within specific regional contexts: the UK, Southern Europe, France and USA.

Regional Reports

China 2050: A Fully Developed Rich Zero-Carbon Economy (2019) describes the possible evolution of China's energy demand sector by sector, analysing energy sources, technologies and policy interventions required to reach net-zero carbon emissions by 2050.

Canada's Electrification Advantage in the Race to Net-Zero (2022) identifies 5 catalysts that can serve as a starting point for a national electrification strategy led by Canada's premieres at the province level. This report is accompanied by 4 sector briefs covering energy, buildings, industry and transport.

A series of reports on the Indian power system and outlining decarbonisation roadmaps for Indian industry (2019–2022) describe how India could rapidly expand electricity supply without building more coal-fired power stations, and how India can industrialise whilst decarbonising heavy industry sectors such as steel.

Setting up Industrial Regions for Net-Zero (2022) and **Pathways to Industrial Decarbonisation** (2023) present industry backed pathways to net-zero emissions for five critical industrial supply chains in the Australian economy and identify the decarbonisation opportunities of key industrial regions.

Glossary

Article 6: Article 6 of the Paris Agreement outlines principles for how countries can "pursue voluntary cooperation" to reach their climate targets.[1]

BEV: Battery-electric vehicle.

Blended finance: The use of development capital (public or philanthropic) to mobilise external private commercial finance for SDG-related investments.

Callable capital: Capital pledged by shareholders to be used in the event that the MDB cannot meet its obligations. To date, no MDB has ever had to call on its callable capital.

Capital investment (CAPEX): Monetary investments into physical assets (e.g., equipment, plants).

Carbon Capture, Utilisation and Storage (CCUS): We use the term "carbon capture" to refer to the process of capturing CO_2 on the back of energy and industrial processes. Unless specified otherwise, we do not include direct air capture (DAC) when using this term.

Carbon credits: Reductions in emissions of carbon dioxide (CO_2) or greenhouse gases made by a company, sector or economy to compensate for emissions made elsewhere in the economy. These can be purchased via voluntary or compliance carbon markets.

Carbon dioxide removals (CDR): Sometimes shortened to 'carbon removals' refers to actions such as NCS or DACCS that can result in a net removal of CO_2 from the atmosphere.

Carbon price: A government-imposed pricing mechanism, the two main types being either a tax on products and services based on their carbon intensity, or a quota system setting a cap on permissible emissions in the country or region and allowing companies to trade the right to emit carbon (i.e. as allowances). This should be distinguished from some companies' use of what are sometimes called "internal" or "shadow" carbon prices, which are not prices or levies, but individual project screening values.

Concessional finance: Finance provided at terms more generous than the market, for example through below-market interest rates or longer terms than available on the market.

Concessional/grant payment: Payments made to induce economic actors to do something for which they would otherwise have no economic incentive (e.g., payments to achieve a just transition or loss and damage). The key difference with capital investment is that these payments will not generate any economic return.

Contract for difference (CfD): A contract between a buyer and seller that stipulates that the buyer must pay the seller the difference between the current value of an asset (spot price) and a pre-determined fixed contract value (strike price). Where public actors act as the buyer this model can be used to cover the cost premium faced by green commodity producers deploying low-carbon technologies that are higher cost than traditional fossil technology.

Cost of capital: A measure of the risk associated with investments; it expresses the expected financial return, or the minimum required rate, for investing in a company or a project.

Development Finance Institutions: Organisations set up to support private sector development. They are usually majority-owned by national governments and source their capital from national or international development funds or benefit from government guarantees. They include Multilateral Development Banks.

Green premium: The additional cost of a clean technology over a high-carbon alternative.

Guarantees: Risk reduction tools that protect investors against capital losses or provide credit enhancement. There are a number of different types of guarantees including: Partial risk guarantees (PRGs): cover risks to debt (loan or bond) repayment post government action or inaction; Partial credit guarantees (PCGs): cover all or part of the financial obligation regardless of the reasons for non-payment; Trade finance guarantees: cover a portion of a bank's portfolio of trade finance.

Internal combustion engine (ICE): A traditional engine, powered by gasoline, diesel, biofuels or natural gas. It is also possible to burn ammonia or hydrogen in an ICE.

Just Energy Transition Partnership (JET-P): A financial cooperation mechanism, established at COP26, to support coal-dependent emerging economies achieve a just energy transition.

Levelised cost of electricity (LCOE): A measure of the average net present cost of electricity generation for a generating plant over its lifetime. The LCOE is calculated as the ratio between all the discounted costs over the lifetime of an electricity-generating plant divided by a discounted sum of the actual energy amounts delivered.

Mobilisation ratio: Amount of private external commercial capital mobilised directly or indirectly, for example by MDB finance.

Multilateral development banks (MDBs): An international financial institution chartered by two or more countries for the purpose of encouraging economic development. They can include Global, Regional or Sub-Regional Banks (e.g. World Bank, EIB).

NDCs: Nationally Determined Contributions under the Paris Agreement.

Net-zero-carbon-emissions / Net-zero-carbon / Net-zero: We use these terms interchangeably to describe the situation in which the energy and industrial system as a whole or a specific economic sector releases no CO_2 emissions – either because it doesn't produce any or because it captures the CO_2 it produces to use or store. In this situation, the use of offsets from other sectors ("real net-zero") should be extremely limited and used only to compensate for residual emissions from imperfect levels of carbon capture, unavoidable end-of-life emissions, or remaining emissions from the agriculture sector.

Nominal (monetary value): Values expressed in terms of current market prices, unadjusted for inflation

Official Development Assistance (ODA): Government aid designed to promote the economic development and welfare of developing countries.

Operating Expenditures (OPEX): Expenses incurred through normal business operations to ensure the day-to-day functioning of a business (e.g., labour costs, administrative expenses, utilities).

Project preparation: Grant or concessional funding provided specifically to deploy resources for early stage project exploration.

Real (monetary value): Values are adjusted for price level changes over time.

Real economy policy: Policies which do not operate via regulatory or other interventions in the financial sector, nor via the use of publicly supported financial institutions.

REDD+: Term referring to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

1 CarbonMarketWatch.org (Accessed 2022), *FAQ: Deciphering Article 6 of the Paris Agreement.*

Contents

Introduction

Global warming poses severe risks to communities and ecosystems this century. To limit it to 1.5°C, the world must reduce CO_2 emissions to around net-zero by mid-century, with a decline of at least 40% achieved by 2030. Many countries and companies are therefore now committed to achieving net-zero by mid-century.

In a series of major reports over the last six years, the Energy Transitions Commission (ETC) has demonstrated how net-zero emissions can be achieved across all the energy, building, industry and transport sectors of the economy.[1] Massive clean electrification must be at the core of decarbonisation pathways, combined with a range of complementary technologies, including clean hydrogen, sustainable bioenergy, and carbon capture and storage. In addition, as set out in the ETC's recent report *Mind the Gap*,[2] significant carbon dioxide removal will be required to drive net emissions down fast enough to meet the 1.5°C objective.

Achieving this technologically feasible transition requires large-scale investment and in some cases international financial flows.

Several organizations have analysed key aspects of the financing challenge. Reports by IEA, IRENA, BNEF and others have presented detailed estimates of the investment required to transition to a net-zero economy. The Independent High-level Expert Group on climate finance, chaired by Vera Songwe and Lord Nicholas Stern, has described the need for greatly increased financial flows to lower-income countries and recommended actions which could achieve this; and the Blended Finance Taskforce has proposed ways in which public development finance could leverage additional private finance.[3]

This report builds on and complements other analyses in three ways:

- It sets out the ETC's detailed estimates of investment need by sector and country income group.
- It seeks to define the relative importance of real economy policies and specific financial sector action in mobilising finance, and how this differs between high-income and middle- and low-income economies.
- And it distinguishes between two conceptually different categories of financial flow:
    - **Capital investment in the technologies and assets required to create a zero-carbon economy.** In some cases, these investments will not occur without changes in policy which reduce risks and the cost of capital, but in principle, these investments deliver a positive return to investors and lenders.
    - **Concessional/grant payments to pay for decarbonisation actions which will not occur fast enough without payments** to economic actors to phase out (or phase down of load factors) exiting coal plants earlier than is economic, end deforestation, and remove carbon dioxide from the atmosphere.

Chapter 1 of this report assesses the scale of the financial challenge for both categories. We estimate that:

Capital investment requirements to achieve a zero-carbon economy will reach around $3trn a year by 2030, peaking at $4.5trn in 2040, and averaging around $3.5trn per annum over the next 30 years. This will be partly offset by a decline in the $0.8trn currently invested annually in fossil fuels, leaving an average net investment need of around $3trn per annum to 2050. Key elements within the total are:

- Investments in the power sector, which account for over 70% of the total. These are critical to enable a decline in fossil fuel demand and investment and to underpin decarbonisation in all other sectors. Around $2.4trn per annum could be needed on average between now and 2050, comprised of zero-carbon generation ($1.3trn per annum), transmission and distribution networks ($0.9trn per annum) and storage and flexibility ($0.2trn per annum).
- Investment in the building sector – estimated at $500bn a year to 2050, covering retrofit in high-income economies, renewable heating, and heat pumps.
- Investments within "hard to abate" sectors such as shipping and aviation, steel, cement or chemicals. Here the investments needed within the sectors themselves – for instance to buy new ships or build steel plants - are an order of magnitude smaller than in the power system. However, investment in the power system and in clean hydrogen

1 For example, see ETC (2020), *Making Mission Possible: Delivering a net-zero economy* and reports in the Making Mission Possible series.
2 ETC (2022), *Mind the Gap*.
3 For example, see IEA (2022), *World Energy Outlook 2022*, IRENA (2021), *World Energy Transitions Outlook 2021*, BNEF (2022), *New Energy Outlook 2022*, and The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action.*

production is vital to make decarbonisation possible in these sectors and it is essential that investments in the required sector-specific assets occurs fast enough to make full decarbonisation possible by 2050, for example, due to the long lead times to build such assets.

- Of the ~$3trn per annum needed by 2030, around $1.4trn per annum is required in high-income countries, about $0.8trn per annum in China and $0.9trn per annum in middle and lower-income countries.

Concessional/grant payments, to middle and low-income countries, may need to reach *at least* $300bn per annum by 2030:

- Around $25-50bn to phase out coal early – these payments would then decline significantly over time to 2040.
- At least $130bn to end deforestation by 2030, but with a much higher figure potentially required if red meat consumption does not decline.
- Around $100bn a year to fund carbon dioxide removals from natural climate solutions – these payments would increase gradually to around $200bn by 2050.[4]

In macroeconomic terms, there is no shortage of global capital to fund the required investment, although lower-income countries are not able to access this capital at a reasonable cost. The average net investment of $3trn per annum, when accounting for the expected decline in fossil fuel investments, equates to around 1.3% of projected global GDP over the next 3 decades and about a third of that would be required to support economic growth and energy system expansion in lower-income countries even if there were no need to develop a zero-carbon economy.

However, the investment and financial flows required will not occur without the policies and actions which we describe in Chapters 2–5. This report makes an important distinction between real economy policies and financial sector actions, highlighting where the former may not be sufficient in certain sectors due to material barriers to finance. This report covers:

- The **real economy policies** required in all countries to reduce risks and make investment profitable. Clear national strategies for the development of zero-carbon power systems and key technologies are required to create the context within which private financial institutions can confidently invest. Initial subsidies during the early stages of technology development, together with carbon pricing and regulation will also play crucial roles. Implementing these policies will require policymakers, regulators, financial institutions and the private sector to collaborate more closely.
- The **financial sector policies and actions** required in all countries, which include:
    - A targeted role for public finance (e.g., provided by publicly owned development/infrastructure banks) to scale up new technologies and first-of-a-kind developments, and to support to residential building retrofits.
    - A supporting role for financial regulation and perhaps central banks.
    - A supporting role for the voluntary net-zero commitments of financial institutions.
    - In China specifically, a need to reallocate capital investment away from wasteful real estate construction.
- The **additional actions required in middle and low-income countries** to address high cost of capital and other barriers to adequate investment. Overcoming these barriers will require the real economy and financial sector actions above, combined with a major increase in the scale of finance provided by Multilateral Development Banks (MDBs) together with changes in MDB strategy and approach which can help mobilise greatly increased private investment.
- **How to finance the concessional/grant payments** required to phase out existing coal, end deforestation and pay for carbon removals. Sources of this finance will need to combine payments from carbon credits purchased within voluntary or compliance markets, philanthropic funding, and high-income governments. For coal phaseout, the financing challenge looks manageable and specific projects/programs will often combine investment in renewables alongside payments to help phase out coal. In the case of deforestation, the scale of payments required - combined with the payments required for natural climate solution removals - looks daunting unless shifts in diet or new forms of protein production can reduce future global meat demand.

Chapter 6 summarises the actions required in the 2020s to unleash the investment and financial flows required.

4 As explored in Chapter 1.3, there will also be concessional/grant payments required for other CDR solutions (i.e. hybrid and engineered), but these are not expected to require external finance.

Energy Transitions Commission

FINANCING THE TRANSITION: CAPITAL INVESTMENT

Two distinct forms of financial flow are required for the energy transition:

CAPITAL INVESTMENT

$3.5 trillion a year to 2050 globally

+

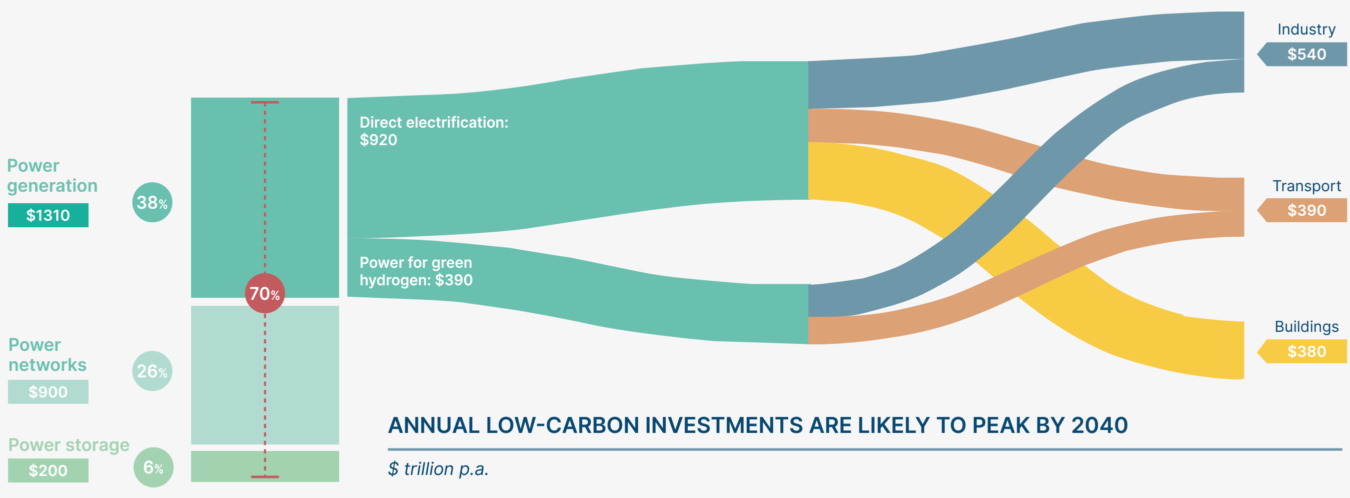
CONCESSIONAL/ GRANT PAYMENTS

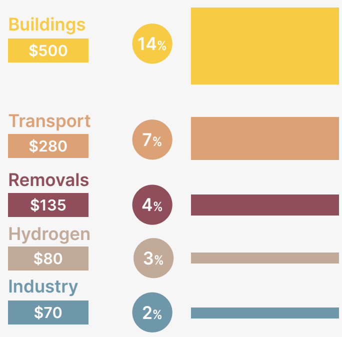
>**$300 billion** a year by 2030 in middle and low income countries

Capital investment: where should investment flow?

INVESTMENT IN LOW-CARBON POWER = 70% OF TOTAL INVESTMENT, SPURRING DECARBONISATION IN OTHER SECTORS

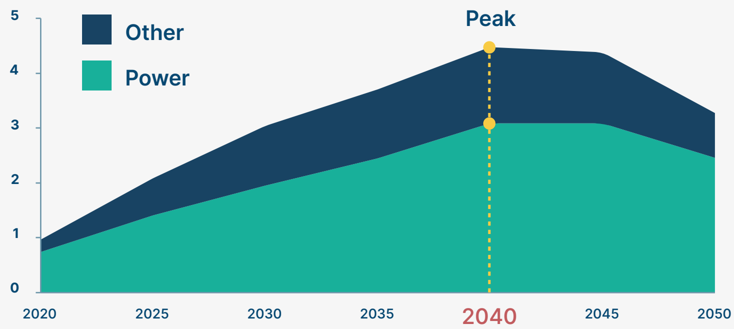
$ billion p.a. 2021-2050





ANNUAL LOW-CARBON INVESTMENTS ARE LIKELY TO PEAK BY 2040

$ trillion p.a.



Other investments includes buildings, transport, removals, industry and hydrogen.

Power investment includes generation, networks and storage.

INVESTMENT IN MIDDLE AND LOW INCOME COUNTRIES NEEDS TO INCREASE 4-FOLD BY 2030

$ billion p.a. in 2021 and 2030

$3 trillion — Clean investment (minus declining fossil fuel investment)

1.3% — Equivalent to 1.3% of global GDP a year to 2050

x3 — Scale up needed by 2030 globally

Energy Transitions Commission

FINANCING THE TRANSITION: CONCESSIONAL/GRANT PAYMENTS

Two distinct forms of financial flow are required for the energy transition:

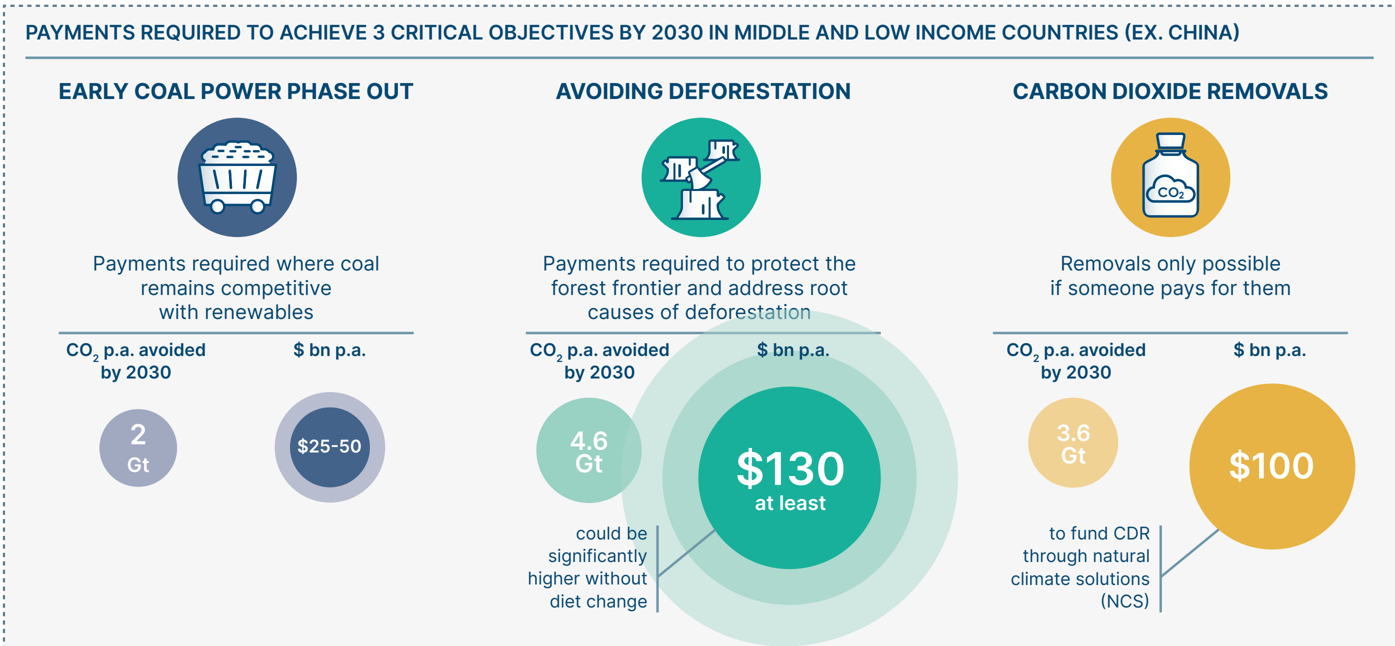
CAPITAL INVESTMENT

- Spending by businesses or public sector on assets, technology, infrastructure
- Delivers future returns

CONCESSIONAL/ GRANT PAYMENTS

- Required where there is no economic incentive
- Does not deliver a return or payback

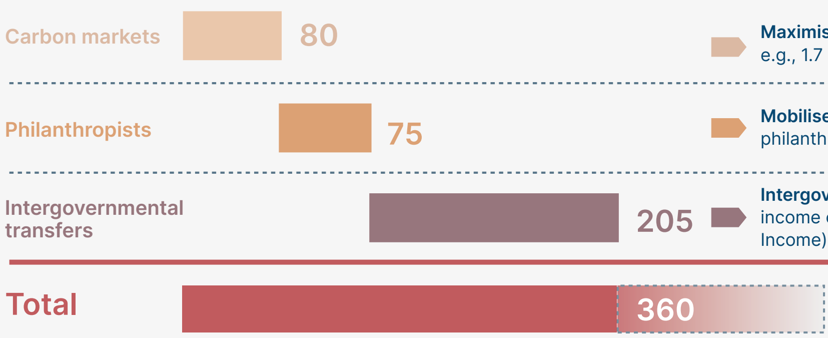
Concessional/grant payments: >$300bn for 3 critical purposes



IN HIGH INCOME COUNTRIES AND CHINA

- Accelerated coal phase out in China could cost $20-50bn a year over the next 10-15 years – but this cost will not be borne by external concessional/grant finance
- Remaining tropical forest land exists almost exclusively in middle and low income countries
- Payments for CDR from engineered and hybrid solutions (e.g., direct air capture) could reach $50bn a year by 2030

Where will the finance come from?



- **Maximise participation of corporates in voluntary carbon markets** – e.g., 1.7 Gt/year of credits at an average cost of $45-50 tCO_2
- **Mobilise more action from philanthropists** – increasing share of philanthropic capital devoted to climate mitigation from 2% to 10%
- **Intergovernmental transfers of climate-related funding** – if high income countries met the UN's aid target (0.7% of Gross National Income) and devoted half to climate
- **But without diet change, concessional/grant payments to end deforestation could be significantly higher**

Chapter 1

The net-zero financing need – capital investments and concessional/grant payments

Achieving a global net-zero economy fast enough to avoid severely harmful climate change will require two conceptually distinct types of financial flow (see Box 1 for more detail):

- **Capital investment**, which we estimate needs to average about $3.5trn a year to 2050, partially offset by a $0.5trn per annum reduction in fossil fuel investments to leave a net figure of $3trn per annum.[5,6] This compares with estimated current low-carbon investment levels of around $0.9-1.2trn.[7]

- **Concessional/grant payments** to middle and low-income countries, which might need to reach *at least* $300bn a year by 2030. These payments are required to achieve the types of emissions reductions which will not occur unless some existing asset owners are paid to do things for which there is no private economic incentive (e.g., accelerated coal plant close down, ending deforestation, carbon dioxide removals, and paying for a just transition).[8] The scale of payments required to end deforestation would be significantly reduced if there were a major shift away from animal meat consumption and towards plant-based diets or synthetic meat.

This report focuses on the finance required for climate mitigation and the energy transition, but it is important to note that additional costs will be borne by countries across the world for adaptation and resilience, as well as for investing in nature.[9]

This chapter sets out the details of this challenge, covering in turn:

- Summary of the global investment needed.
- Breakdown of investment by country income group.
- The need for concessional/grant payments.
- Current scale of investment and concessional/grant payments – far short of need.
- Mobilising adequate investment - real economy and financial system levers.
- Ensuring adequate concessional/grant flows – a crucial political issue.

Box 1

Defining capital investment and concessional/grant payments

Capital investment (also referred to as Capex) is used in this report in line with typical national income accounting conventions and refers to the purchase of assets – whether by businesses or the public sector – which are not consumed immediately, but which create a stream of future consumption benefits over time and thus a future investment return. It covers physical infrastructure such as power plants, buildings and transport systems, and plant and machinery of all types.

Capital investment can be calculated on either a gross basis (i.e. how much gross investment is needed to deliver a net-zero carbon economy) or a net basis (i.e. how much incremental investment is required above what would in any case occur). In this report, we seek to assess the net incremental investment required, but with a different approach sector by sector:

- In the energy-producing sectors, we present estimates of gross investments required for zero-carbon electricity, but recognise that this would be partially offset by declining investments in fossil fuel production and power plants.
- In the road transport sectors:
  - Investments in charging infrastructure for electric passenger cars and light commercial vehicles is shown on a gross basis, even though part of this investment would be made in a business and usual (BAU)

5 The $0.5trn is the difference between current investment in fossil fuels ($0.8trn) and projected average annual investment in fossil fuels 2021-50 ($0.3trn). Source: BloombergNEF (2022), *Counting Cash in Paris Aligned Pathways* – analysis based on IEA Net Zero scenario.

6 The ETC do not consider including investment in oil and gas supply or in climate adaptation in these estimates, but instead focuses on investment in low-carbon solutions to mitigate emissions.

7 BNEF (2022), *Energy Transition Investment Trends*; IEA (2022), *World Energy Investment 2022*.

8 Some of these annual payments may only be required over the next decade (e.g., for early coal phaseout).

9 The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action* - estimates that in middle and low income countries, additional finance needs by 2030 could amount to $200-400bn to cope with loss and damage, $220-250bn to invest in adaptation and resilience, $100-150bn to develop sustainable agriculture, $75-100bn for biodiversity, and $40-60bn to mitigate methane emissions.

scenario given the favourable economics of electric driving for light vehicles.[10] In comparison, a larger part of the investment in charging and refuelling infrastructure for electric or hydrogen trucking will be incremental; this is because a smaller share of this investment would occur in a BAU scenario as it will take longer for these vehicles to reach cost parity with internal combustion engines (ICE).

  - Consumer expenditure to purchase EVs is not included since EVs are expected to reach cost parity with ICE vehicles during the 2020s, and car purchase would occur on the same scale under the BAU scenario. Some other published estimates of required investment do include the consumer purchase of EVs or efficient appliances. We also exclude consumer purchase of more efficient electrical appliances on the same basis.

- For the building sector, investment required to retrofit existing buildings to improve insulation and to install new forms of heating equipment, is included, since much of this is likely to be incremental to BAU. But we do not include any incremental costs entailed in constructing new buildings in an energy efficient rather than inefficient fashion since these will be small if building regulation and design ensures a "right-first-time" approach.

- In industry (cement, chemicals, steel and aluminium), shipping and aviation, our estimates draw on the Sector Transition Strategies produced by the Mission Possible Partnership.[11] These seek to reflect the level of incremental investment needed to build zero-carbon assets rather than high carbon, in situations where investment in either low or high-carbon assets will occur in any case (e.g., due to retirements).

These approaches result in an estimated net investment figure of $3trn on average per annum. It should be noted, however, that this overstates the true incremental investment need at the macro-economic level, particularly for the power sector in lower-income countries where economic growth would require very significant investment in expanded electricity systems even if there were no climate change objectives.

The true incremental investment required in these countries is therefore likely to be much lower than the ETC's gross and net estimates imply. The recent Songwe–Stern report estimates that of the $1.3-1.7trn needed annually by 2030 for the energy transition in middle- and-low income countries (excluding China), just $500-600bn is additional investment.[12]

Concessional/grant payments are payments made to induce economic actors to do something for which they would otherwise have no economic incentive. The key difference with capital investment is that these payments will not generate any economic return. In this report, we particularly focus on estimating the potential concessional/grant payments required to achieve:

- An earlier phase-out of coal power than would be economic given the relative costs of new renewable energy generation and existing coal plant operation.

- An end to deforestation even where the short-term economics create incentives for its continuation.

- Carbon dioxide removals whether through natural climate solutions (e.g., reforestation), engineered solutions (e.g., direct air carbon capture and storage [DACCS]), or hybrid solutions (e.g., bio-energy with carbon capture and storage [BECCS]).

These concessional/grant payments are not in themselves "capital investment" and in many cases, no capital investment is required to support them – for example, payments for avoiding deforestation will often not require any significant form of capital investment. But in the case of carbon dioxide removals, upfront capital investment will typically be required; for example, a reforestation project will usually entail significant investment in the purchase of land,[13] and this investment will then receive a return through future payments (e.g., arising from the purchase of carbon removal credits). Our calculations for carbon dioxide removals therefore show both the annual current payments for removals and the upfront investment required.

It is important to note that for many projects, such as Just Energy Transition Partnerships (JET-P), the right financing strategy will combine both capital investment and concessional/grant payments (i.e. for community benefits and consultation).

10 For light duty vehicles, there is reason to suggest that in a BAU scenario there is also some level of electrification, given the favourable economics of owning and operating electric vehicles, and the fact there are already ICE bans in key geographies in place. To illustrate,bnEF expects that in their Economic Transition Scenario, unsubsidised price parity between ICE and electric passenger vehicles is reached in most segments and countries in the late 2020s. They consequently assume slower but substantial EV sales penetration in this scenario, as they believe upfront sticker price parity is the most important determinant for EV adoption.

11 Mission Possible Partnership - Sector Transition Strategies.

12 Report of the Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action*.

13 The purchase of land is included in our estimates of NCS removals, even though strictly speaking purchase of land is not capital investment in fundamental economic terms since it simply transfers the ownership of an already existing asset from one owner to another. Nonetheless, it is included in our estimates since achieving these removals will require financial flows to support significant upfront investment in land purchase.

Exhibit 1

Sector	Investment need	Average capital investment ($bn p.a. 2021-50)	Share of total capital investment
Power $2400bn	Renewables and other zero-carbon generation	1300	38%
	Networks	900	26%
	Storage and flexibility	200	6%
Hydrogen $80bn	Production	40	1%
	Transport and storage	40	1%
Buildings $500bn	Retrofits	230	7%
	Heat pumps	130	4%
	Renewable heating	140	4%
Transport $240bn	Road charging infrastructure	130	4%
	Aviation	70	2%
	Shipping	40	1%
Removals $130bn	Hybrid and engineered	30	1%
	NCS	100	3%
Industry $70bn	Chemicals	40	1%
	Steel	10	<1%
	Cement	10	<1%
	Aluminium	10	<1%

Gross total	**~$3.5 trillion**
Offset by declining investment in fossil fuels	**~$0.5 trillion[1]**
Net total	**~$3.0 trillion**

SOURCE: Systemiq analysis for the ETC (2023); BloombergNEF (2022), *Counting Cash in Paris Aligned Pathways* – analysis based on IEA Net Zero scenario.

NOTE: Numbers may not sum to totals due to rounding.
(1) Difference between current investment in fossil fuels ($0.8tr) and projected average annual investment in fossil fuels 2021-50 ($0.3tr).

1.1 Global investment requirements: a manageable macro-economic challenge

The ETC's estimates suggest that around $110trn in capital investment will be required between 2021 and 2050, implying an average annual level of $3.5trn.[14] This is offset by a reduction of $0.5trn per annum in fossil fuel investment, to give a net figure of $3trn per annum. This is equivalent to around ~1.3% of prospective average annual global GDP over the next 30 years.[15] This capital investment will be further offset by savings in operating expenditure from the transition away from an opex-heavy fossil fuel system (discussed further in this section); depending on fossil fuel prices, these savings could average $0.4-0.8trn to 2050.

By far the largest element within the total $3.5trn per annum are investments in the power system, to support a dramatic increase in electricity generation and use, enable a decline in fossil fuel demand and investment, and underpin decarbonisation in almost all other sectors of the economy (by producing hydrogen and hydrogen-based fuels for transport and industry). The Annex sets out the ETC's detailed assumptions on investment by sector. The key elements are [Exhibit 2]:

- **Power:** $1300bn per year to develop zero-carbon power generation capacity, $900bn per year to extend, upgrade and replace transmission and distribution networks, and $200bn per year to improve grid flexibility, including battery and seasonal storage capacity.
- **Hydrogen:** $40bn per year to develop large-scale global production of green hydrogen, to produce greenfield blue hydrogen and retrofit grey hydrogen with carbon capture and storage (CCS), and $40bn per year to build pipelines, refuelling stations, import and export terminals, and storage capacities.
- **Buildings:** $230bn per year to retrofit buildings (e.g., better insultation), $130bn per year to install renewable heating (e.g., boilers and solar thermal water heating) and $150bn per year to install heat pumps.
- **Transport:** $130bn a year to develop the charging and refuelling infrastructure required to support uptake of electric road transport, $70bn per year in sustainable aviation fuel production plants and new hydrogen and battery-electric aircraft, and $40bn yearly to decarbonise shipping with investment in ammonia or methanol synthesis, storage and bunkering infrastructure, and new/retrofitted ships.
- **Industry:** $10bn per year to decarbonising steel using technologies such as hydrogen-based direct reduced iron (DRI) facilities and CCS, $10bn per year to apply CCS to cement plants, $40bn each year to develop and integrate CCS, pyrolysis and other technologies in chemical industry processes and $10bn per year to build and deploy low-carbon technologies at aluminium smelters and refineries.
- **Removals:** $130bn per year to remove carbon dioxide from the atmosphere (as noted recently in the ETC's *Mind the Gap* report), for example, to pay for land acquisition for natural climate solutions or build direct air capture plants.[16] This is discussed in more detail, in relation to the concessional/grant payments needed to enable this investment, in Section 1.3.3.

The Annex also describes the likely and required decline in fossil fuel investments and sets out the comparison of the ETC's estimates of investment needs with those published by the IEA and IRENA.

14 Figures referenced throughout the report are expressed in real terms (constant 2021 USD). They do not include the cost of finance.

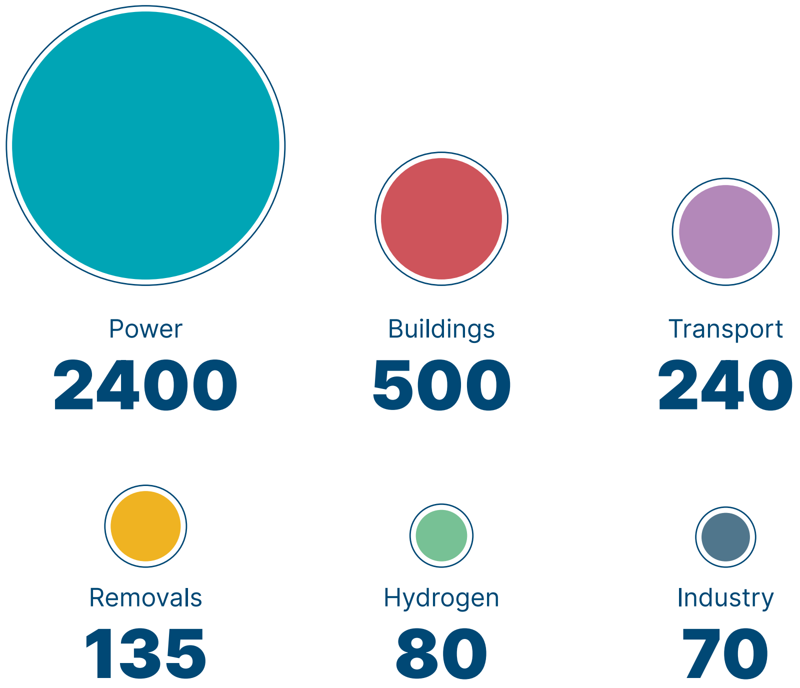
15 Calculated based on IMF data of current global GDP in PPP terms, and projected using annual growth rates assumed by the IEA in their 2021 *Energy Technology Perspectives* report.

16 ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*

Exhibit 2

By far the largest investment will be required in the power system, which accounts for ~70% of the global total, followed by ~15% for buildings

$bn p.a. 2021-50



SOURCE: Systemiq analysis for the ETC (2023).

Investments over time

The profile of required global investments over time is indicated in Exhibit 3. From today's level of about $1trn per year, annual investments need to triple to $3trn per year by 2030, before peaking at more than $4.5trn annually in 2040. This reflects the need in several sectors to ramp up investment rapidly in the next decade to ensure subsequent decarbonisation pathways are feasible. In particular:

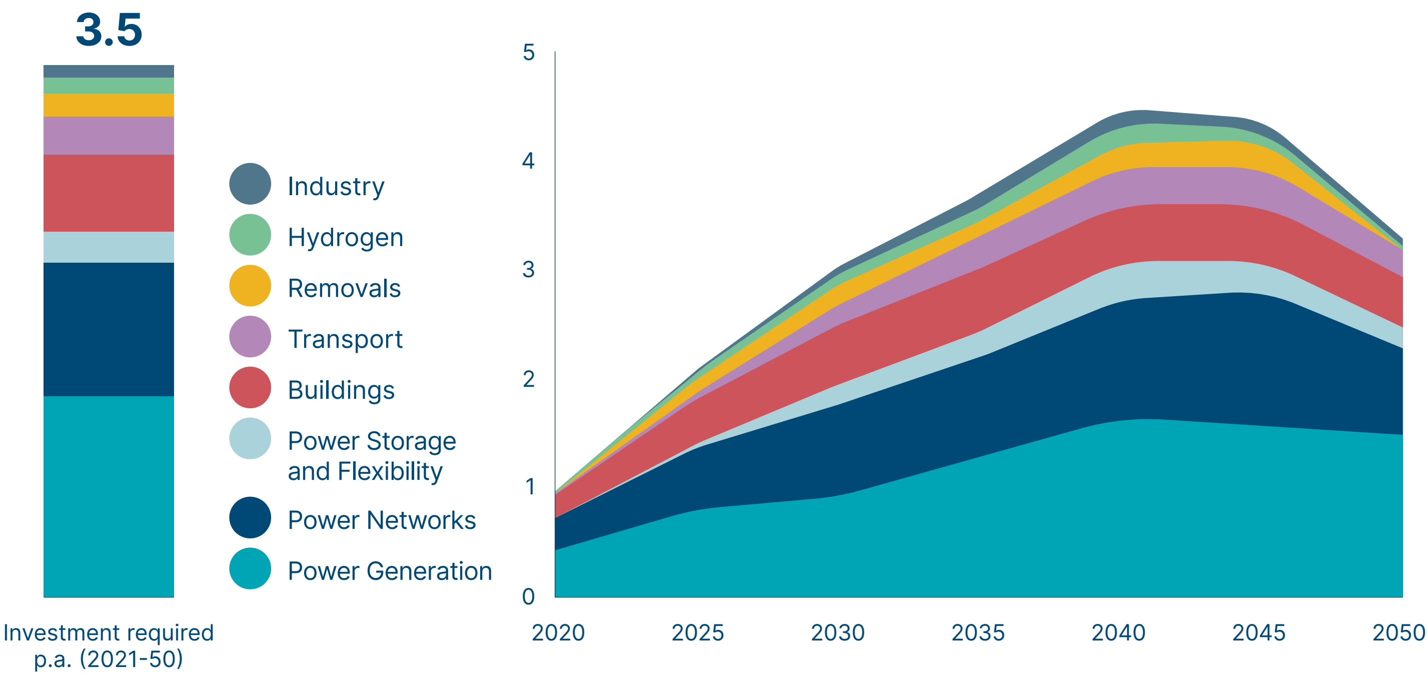
- **Power:** Investments in networks must be front-weighted to ensure that grid capacity is built ahead of increasing electricity generation and demand. In addition, zero-carbon electricity generation must increase ahead of need, as many sectoral decarbonisation pathways critically rely on the availability of abundant clean power.
- **Buildings:** Frontloading investment in buildings is critical due to the long lifetimes of building stock.
- **Industry and shipping:** Investments to develop new industrial decarbonisation technologies must happen at least as fast as existing assets come to the end of their technical lives; by 2030, 30% of existing assets in heavy industry will be around 25 years of age and will face an investment decision (e.g., replacement or adaptation).[17]
- **Hydrogen:** Low-carbon hydrogen is critical for the decarbonisation of sectors such as steel and heavy-duty trucking, creating significant demand from 2030 onwards. Early investments will be vital to deliver sufficient capacity and drive cost declines.
- **Removals:** Large investments to support NCS removals are critical in the next 5 years, given the long lead times before projects such as reforestation achieve peak rates of carbon removal, and the need for significant removals soon if the world is to stay within a 1.5°C compatible carbon budget.

17 IEA (2021), *Net Zero by 2050: A Roadmap for the Global Energy Sector.*

Exhibit 3

Annual investments are expected to peak by 2040

Capital investment for the energy transition
$ trillion p.a.



SOURCE: Systemiq analysis for the ETC (2023).

Globally, total investment is projected to decline after 2040 as the bulk of the low-carbon assets required for net-zero by 2050 will already have been built; although this profile will differ regionally. Beyond 2050, the level of investment required is both difficult to quantify and conceptually difficult to interpret:

- Some investment may continue to be needed to ensure an ongoing stream of removals: how much will depend on how close the global economy has got to achieving net-zero emissions before removals.
- Ongoing investment will also be required as items of capital equipment (e.g., wind farms, solar panels or grid stations) need to be replaced or upgraded: but this is no different from the replacement capital expenditure required in any economy.
- Additional capital investment might be made in the power system in the latter half of the century if society discovers attractive new uses of electricity entirely unrelated to the climate change challenge and chooses to invest to seize that opportunity.

With these caveats, however, the broad picture shown in Exhibit 4 captures the essence of the macroeconomic story: a 30-year period of high investment to build a new zero-carbon energy system and much lower required investments thereafter.[18]

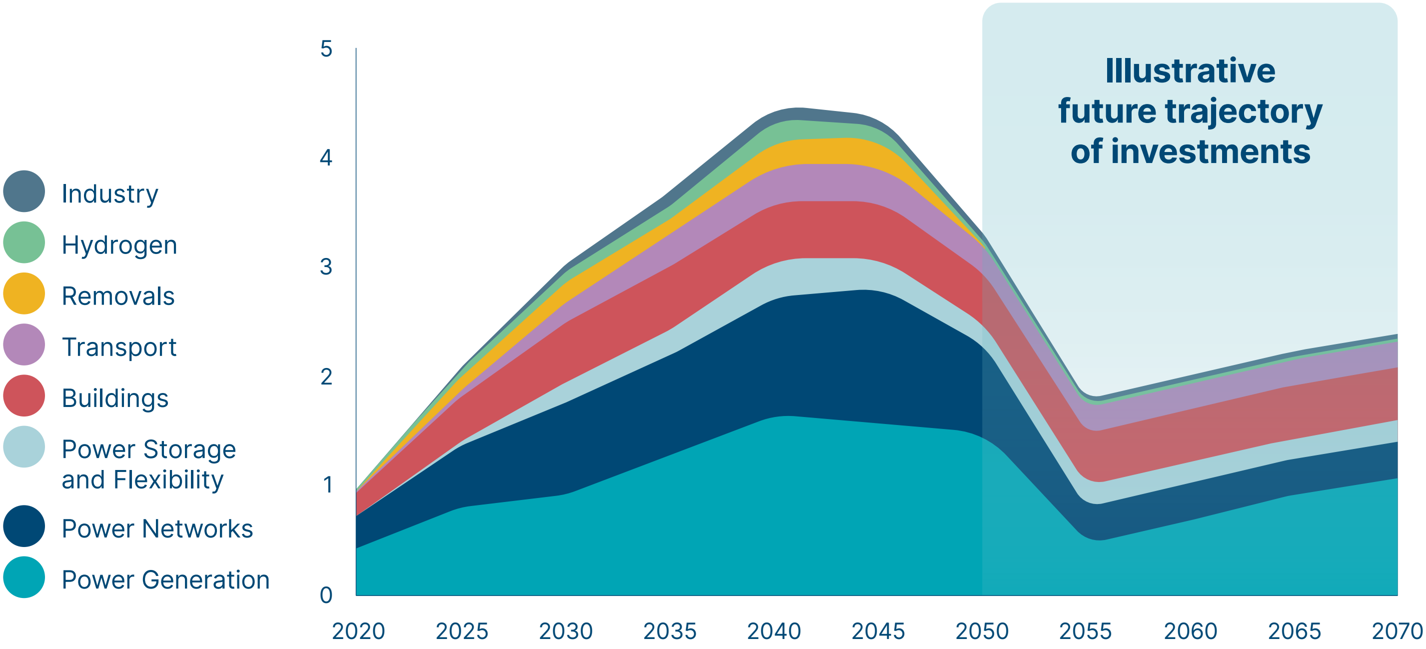
18 Investments post 2050 are showed for illustrative purposes only, and only show varying data for power generation, networks and storage – other investments are assumed constant as of 2050. Power generation and storage investments are necessary to replace retired assets from the 2020s and 2030s. Power network investments scale down towards 2055 when it is assumed the grid is built, after which only replacements are necessary.

Exhibit 4

Investments are expected to tail-off beyond 2050, but stock turnover of renewables will drive investments in the latter half of the century

Capital investment for the energy transition, 2021-70

$ trillion



SOURCE: Systemiq analysis for the ETC (2023).

NOTE: With the exception of power, post 2050 investment in all other sectors is held at 2050 levels.

Costs and benefits in the energy transition

The high investment needed does not represent a long-term "cost" to the economy or imply a long-term reduction in living standards. This is because:

- They represent a major private investment opportunity, in particular in the power sector where investments are increasingly bankable and more attractive than investments in fossil fuels.
- They offer long-term benefits to society as a whole, including less variable energy costs and energy security.
- Over the long-term, and even during the next 30 years, they will deliver a significant decrease in operating costs.

This operating costs arise in particular in the power sector, since clean electricity systems (whether renewable or nuclear) are characterised by high upfront initial capex but far lower operating cost than fossil fuel-based systems. Exhibit 5 shows ETC estimates of potential savings in fossil fuel spending when comparing today's demand to future demand projections, under three different IEA scenarios for how fossil fuel prices might evolve. Depending on the fossil fuel price assumed, this saving could average $0.4-0.8tr per year between now and 2050, reaching $2-3tr per annum by 2050 and continuing thereafter.[19]

19 These estimates are an average of the low and mid price scenarios; this is because in the high prices scenario, a large amount of the savings represents reduced economic rent paid from users to producers, which is a distributional impact as opposed to a net saving.

- **Low-price case**, using prices from the IEA Net Zero scenario in which fossil fuel prices decrease drastically by 2050 (with 75% for oil, 65%, for natural gas and 55% for coal), driven by steep demand reductions (90%, 70% and 80% respectively).

- **Mid-price case**, using prices from the IEA Announced Pledges scenario in which fossil fuel prices decrease less excessively, as demand reduces less steeply too.

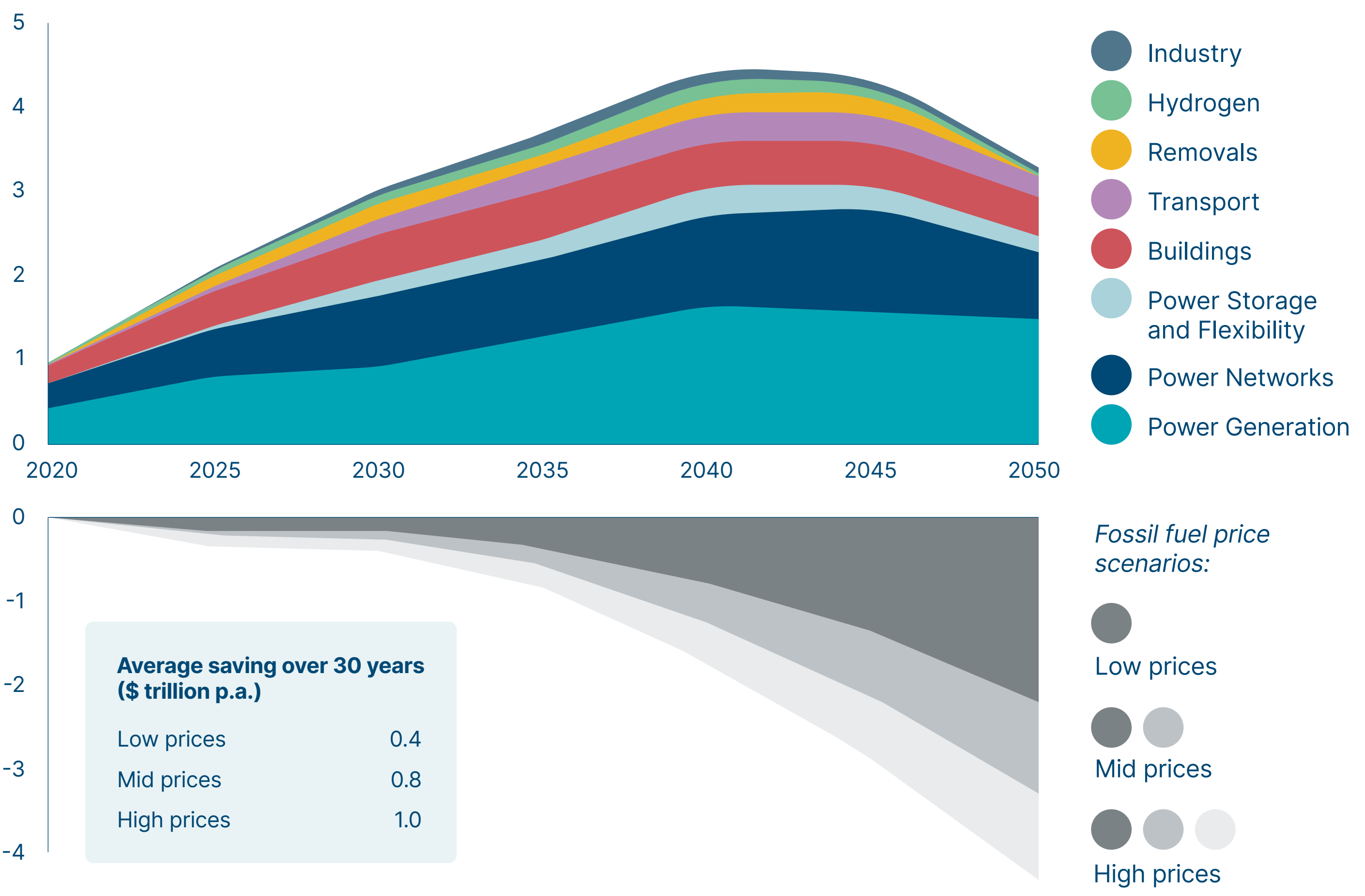
- **High-price case**, using prices from the IEA Stated Policies scenario in which prices stay comparable to today – computed savings are therefore highest.

Exhibit 5

Savings on fossil fuel spending could be around $0.4-0.8 trillion a year, on average between now and 2050, depending on how fossil fuel prices evolve

Annual capital expenditure in the energy system, and annual savings from reduced spending on coal, oil and gas under different price scenarios

$ trillion



SOURCE: ETC (2021), *Making Clean Electrification Possible* [demand projections]; IEA (2022), *World Energy Outlook 2022* [fossil fuel prices, non-weighted averages or regional projections].

NOTE: Demand projections are based on the ETC Supply Decarbonisation Only scenario. This scenario sees an increase in gas consumption until 2045 vs 2020 demand, meaning there are no natural gas savings projected until 2046. Estimated fossil fuel savings are based on fossil fuel price projections under different IEA scenarios (i.e., low prices = Net-zero scenario, mid prices = Announced Pledges scenario, high prices = Stated Policies scenario). We focus on the low and mid price scenarios; this is because in the high prices scenario, a large amount of the savings represents reduced economic rent paid from users to producers, which is a distributional impact as opposed to a net saving.

The overall macro consequences of moving to a zero-carbon economy can therefore be understood by considering Exhibits 3 to Exhibit 5, plus the complexities involved in the assessment of true incremental investment:

- Exhibit 3 shows investment needs of $3.5trn per annum on average over the next 30 years, but this is offset by $0.5trn per annum less investment in fossil fuels, and by the fact that around $0.7–1.1trn each year would have been required to support growth in developing countries even if there were no climate imperative. True incremental investment needs may therefore average around $2trn per annum.
- Even over the next 30 years this is increasingly offset by the fossil fuel opex savings shown on Exhibit 5.
- Beyond 2050, the global economy continues to enjoy the benefit of fossil fuel opex savings, while also making replacement capital investments on the sort of scale shown on Exhibit 4; most of these investments are not incremental to what would be required in any case.

The combined economic effect of higher upfront investment but lower operating cost is captured in estimates of the levelised cost of electricity (LCOE) and reflected in the prices at which investors in renewable projects are willing to deliver electricity. These LCOEs and prices suggest that renewables are already the cheapest source of new bulk power generation in countries comprising two-thirds of the world's population and nine-tenths of global electricity generation.[20] And modelling suggests that the total system cost of future power systems, where 75-90% of the power supplied will come from wind and solar, will be no higher than - and possibly lower - than today's fossil-fuel-based power system.[21]

The investments needed, in particular in the power system, therefore represent both a major private investment opportunity and an attractive investment for society as whole. In addition to significant operating cost savings, the investments in Exhibit 3 will deliver:

- **More predictable and less variable energy costs** than is possible in a fossil fuel-dominated energy system. This increased stability reduces risks and can lower the cost of capital for investments in energy infrastructure.
- **Energy security.** A renewable power system offers a way out of import dependency for the 80% of the global population living in countries which are net-importers of fossil fuels.[22,23]
- **Jobs.** The IEA estimates that the energy transition will create a net gain of 25 million jobs by 2030.[24]

Implications of current macro circumstances

Despite the offset of reduced fossil fuel capex and opex, the challenge of mobilising additional investment and reallocating investment from high to low-carbon technologies is a huge one. Until recently that challenge seemed to be made easier by the macroeconomic context of very low real nominal interest rates: indeed, some economists argued that the need to invest heavily to achieve the energy transition was a welcome development in the world where a deficit of privately generated investment relative to desired aggregate global saving was producing a danger of "secular stagnation".[25]

The high energy prices, resurgent inflation, and higher interest rates which have arisen in the recovery from COVID and as result of Russia's invasion of Ukraine, have created a new context at least for a transitional period (see Box 2). This has an ambivalent impact on the pace of the energy transition:

- On the one hand, higher fossil fuel prices and greater awareness of their inherent volatility, have created incentives to accelerate the energy transition – both in terms of investing in clean electricity generation and energy efficiency improvements - to build energy security and reduce future consumer costs, as well as delivering near-term financial benefits to renewable generators that have low marginal costs.
- On the other, inflation in key supply chains has produced a temporary increase in the cost of some inputs and high-interest rates have increased the nominal cost of capital which is a key determinant of the relative cost of renewable versus fossil fuel investments. Fiscal stresses in developed and developing countries may also reduce the potential to support the transition via government expenditure.

The most important implication for climate finance is the priority discussed in Chapter 4 – the need to ensure financial flows to lower-income countries at an adequately low cost of capital – is even more important in the current environment.[26]

20 BNEF (2022), *Cost of New Renewables Temporarily Rises as Inflation Starts to Bite.*

21 ETC (2021), *Making Clean Electrification Possible.*

22 IRENA (2022), *World Energy Transitions Outlook 2022*.

23 Although it is important to note that clean energy supply chains will have their own energy security due to access to critical minerals, for example to produce solar panels and batteries. However, these can be overcome by a range of measures including strategic planning and development of recycling systems – the ETC's forthcoming report on *Resource and material use* will explore these in more detail.

24 IEA (2022), *World Energy Outlook 2022*.

25 Rachel, L., and L. Summers (2019), *On Falling Neutral Real Rates, Fiscal Policy, and the Risk of Secular Stagnation*.

26 The disincentivising effect of increasing interest rates on investments is likely even stronger in low and middle income countries, where high cost of capital tends to increase further because of higher economic uncertainty, and high indebtedness post-COVID.

Box 2

Inflation, interest rates and the long-term cost of capital

From the fiscal crisis of 2008 through to 2020, inflation rates in most high-income countries were at historically low levels, often falling below central bank inflation targets (typically set at 2%). Since 2020, a major resurgence in inflation has occurred, with inflation at 10% percent in the eurozone area, 8% in the US, and around 5-8% in key emerging markets such as India, Brazil and Mexico as of Q4 2022.

Central banks responded by increasing short-term policy interest rates, which have reached 2% percent in the eurozone, 3% percent in UK and 4.5% in the US; this compares with rates close to zero in the decade before 2020. Long-term nominal interest rates on government bonds have also increased, with US 30 year bonds now seeing borrowing costs of 3.5% versus 1.8% percent in January 2021. This leads through to an increase in the nominal cost of debt capital, and thus the weighted average cost of capital faced by investors in energy transition-related projects.

The impact on real interest rates has so far been more ambivalent or muted. With current inflation rates well in excess of short-term interest rates, short-term real rates are significantly negative. Comparing nominal bond yields with central-bank long-term inflation targets suggests long-term real rates in major developed countries in a range from 0% (Germany) to 1.5% (US and UK); this is far below the averages observed before the 2008 financial crisis. Real yields on index-linked government bonds are similar, with US long-indexed bonds yielding around 1.5%, while French and UK index liked bonds continue to have negative real yields.

It is therefore possible that there has not been a long-term structural shift away from the pre-COVID pattern of historically low real interest rates. But even if that does turn out to be the case, higher nominal rates and increased awareness of macroeconomic volatility will create more challenging conditions for energy transition investment for a number of years.

1.2 Investment by country income group

The nature of the investment challenge will tend to differ between countries with different levels of income. In this section, we present estimates of the breakdown of investment by income group, as per the World Bank's classifications. Investment in China is separated since its very high total savings and investment rates as a percent of GDP makes the challenges it faces distinct from other middle-income countries.

Exhibit 6

ETC groups	High income	China	Upper middle excl. China	Lower middle income	Low income
World Bank classification	High income	Upper middle	Upper middle	Lower middle income	Low income
Gross National Income (GNI) per capita	>$13,200	$12,000	$4,300 – $13,200	$1,100 – $4,200	<$1,100
% of global GDP	60%	18%	10%	11%	~1%
% of global emissions	35%	30%	15%	19%	1%
% of population	16%	18%	16%	40%	10%
Country examples	Australia Canada Chile Japan Korea Most of Europe New Zealand Saudi Arabia Taiwan United States	-	Argentina Botswana Brazil Colombia Malaysia Mexico Namibia Russia South Africa Thailand	Bangladesh Bolivia Cambodia Egypt Ghana India Indonesia Kenya Nigeria Pakistan Philippines Vietnam	DRC Gambia Ethiopia The Gambia Mali Madagascar Sierra Leone Sudan Uganda Yemen Zambia

SOURCE: IMF (2022), *World Economic Outlook – October update*; World Bank (2022), *Country and Lending Groups*.

NOTE: % of global GDP calculated in 2021 US$ market exchange rate terms.

Exhibit 7 presents estimates of the regional balance of annual investment by sector and income group between 2026 and 2030. During this period, high-income countries will account for nearly 45% of all investment, with China over 25%, other middle countries around 30% and lower-income countries only 1%. This pattern reflects:

- The need for high-income countries and China to make rapid progress in decarbonising currently high carbon power systems.
- The concentration of industrial assets in high-income countries and China where investments in first-of-a-kind developments, such as sustainable aviation fuel (SAF) or green steel plants, can unlock learning effects and economies of scale which drive down costs, allowing these technologies to be deployed subsequently in the rest of the world.
- The need for high-income countries to rapidly retrofit existing buildings to improve energy efficiency.
- Limits to the feasible pace at which investment can grow in lower-income countries in particular located in sub-Saharan Africa, where the challenge is not to decarbonise an already existing modern energy system but how to achieve economic growth and energy system expansion in countries with trivial current levels of energy use per capita.[27]

27 IEA (2022), *Africa Energy Outlook 2022*.

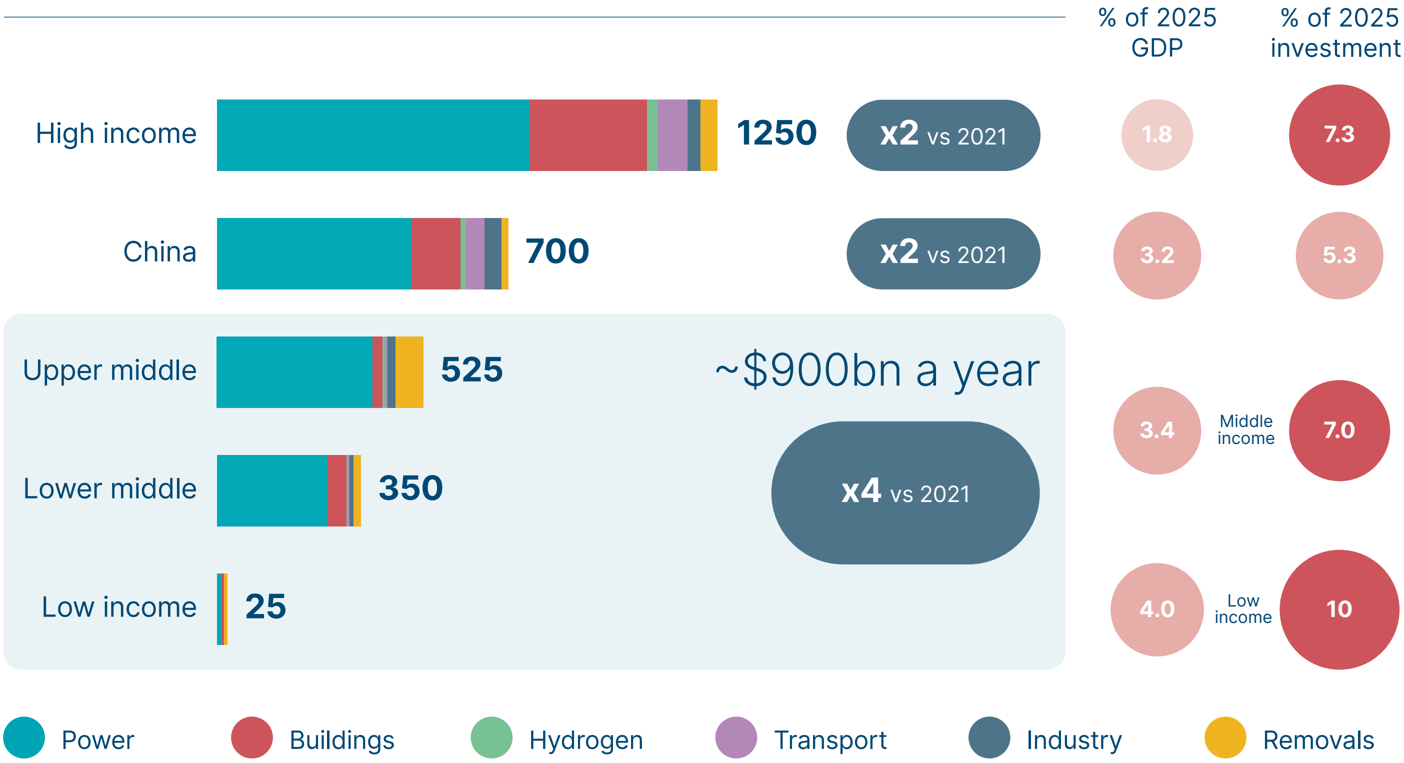
Investment needs in middle and lower-income countries outside China are, however, still very large in absolute terms and are larger relative to GDP than in high-income countries. As a percentage of projected total investment, low-carbon investment needs are highest in lower-income countries, and lowest in China, where China's extremely high total investment rate of over 40% (compared to an average global investment rate of 25-28% of GDP) means that energy transition investment is lower as a percentage of total investment than in high-income countries.

Exhibit 7

Capital investment in middle and low income countries needs to reach ~$900 billion a year on average between 2026-2030

Estimated annual investment by region and sector, 2026–2030

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); SYSTEMIQ (2021), *Investments for green recovery and transformational growth 2020–30: Technical Note*; IMF (2022), *World Economic Outlook October 2022.*

NOTE: 2025 GDP projections based on GDP in market exchange rate terms. Total investment is assumed to grow in line with GDP.

Over time, the balance of investment will shift towards middle and low-income countries. This may in part reflect new patterns of energy trade, with some lower-income countries emerging as low-cost locations for iron, ammonia and fertiliser production given abundant cheap renewable electricity and green hydrogen supply.

The key driver of the changing balance between different country groups will be the different time pattern and scale of investment in the power system, from a starting point of widely varying electricity uses per capita [Exhibit 8]:

- Most high-income countries are now committed to fully decarbonising their power systems by 2035. Achieving this will require a big increase in the rate of wind and solar capacity expansion over the next 10 years (see Exhibit 9) followed by gradual expansion of the electricity system to mid-century. Power use per capita could by then be 2 to 2.5 times current levels.

- China's electricity consumption per capita is already close to some high-income country levels and, as in developed countries, will likely double by 2050.[28] As shown in Exhibit 9, China is currently the only major country/country group

28 For example, see ETC (2020), *Achieving a Green Recovery for China* and ETC (2019) *China 2050: A Fully Developed Rich Zero-Carbon Economy.*

which is building renewable power capacity at the pace needed to meet 2030 targets.[29] This pace will only need to increase slightly in the 2030s to deliver a fully decarbonise d power system before 2050 if done in parallel with a phase-down of coal plants.

- In many middle-income countries power supply per capita will need to increase 5 to 6 times by mid-century to support economic growth and rising prosperity. Achieving the first stage of this increase by 2030 will require a fourfold increase in annual power generation and network investment (from $160bn to $670bn) with further significant increases in subsequent decades as economic growth and electrification continues.[30]

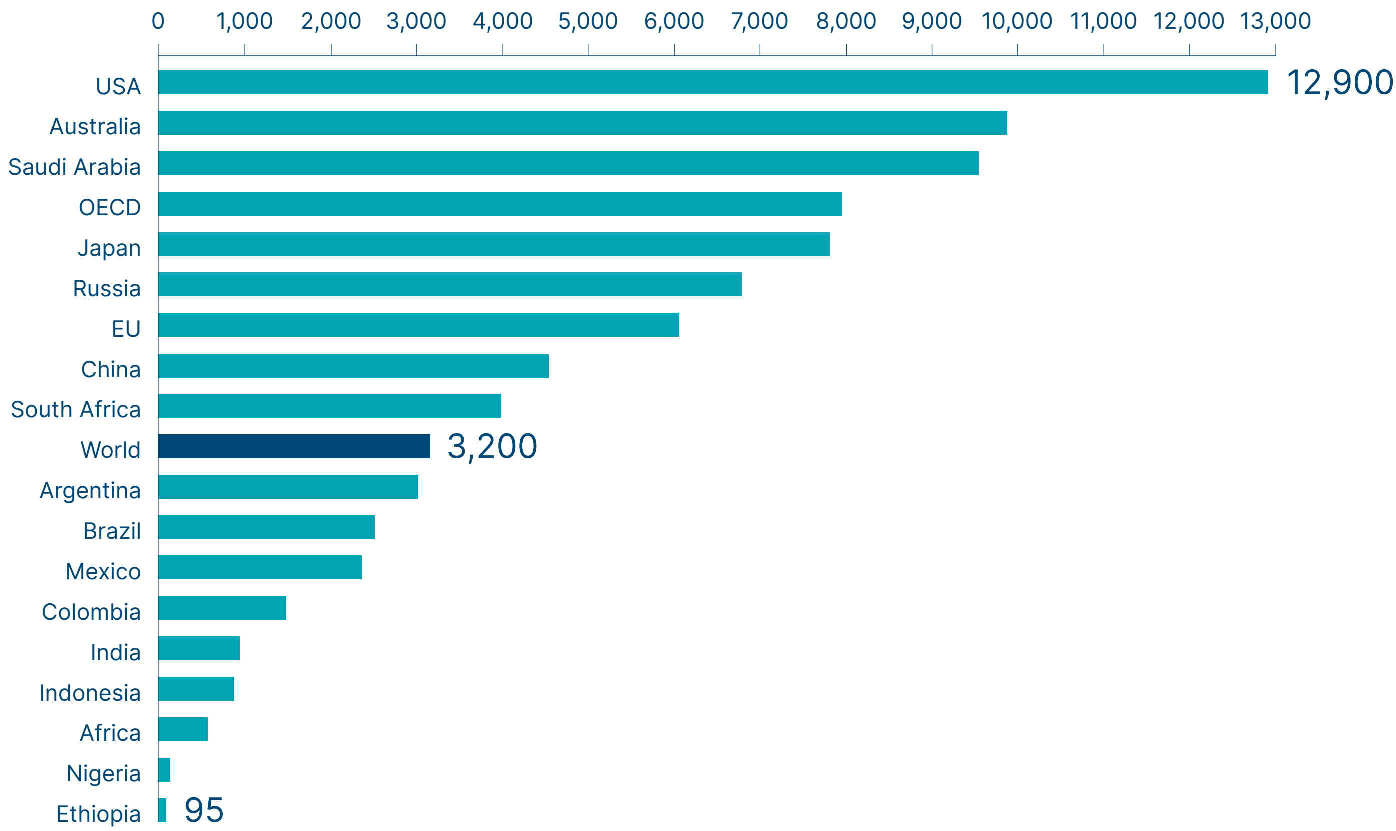
- In lower-income countries, initial investment growth in the 2020s needs to be followed by rapidly rising investment for several decades thereafter, both to support economic growth and to drive electrification, some aspects of which (e.g., in road transport) will occur considerably later than in developed economies, China, and middle-income countries. Eventual electricity use per capita could be 15 or more times current levels. The critical challenge is to ensure this significant growth in electricity generation occurs in a low-carbon fashion.

Exhibit 8

Electricity use per capita varies significantly across countries, with lower-income countries typically below the global average

Electricity consumption per capita

kWh per capita, 2018



SOURCE: IEA (2019), World Energy Outlook.

29 ETC (2023), *Streamlining Planning and Permitting to Accelerate Wind and Solar Deployment.*

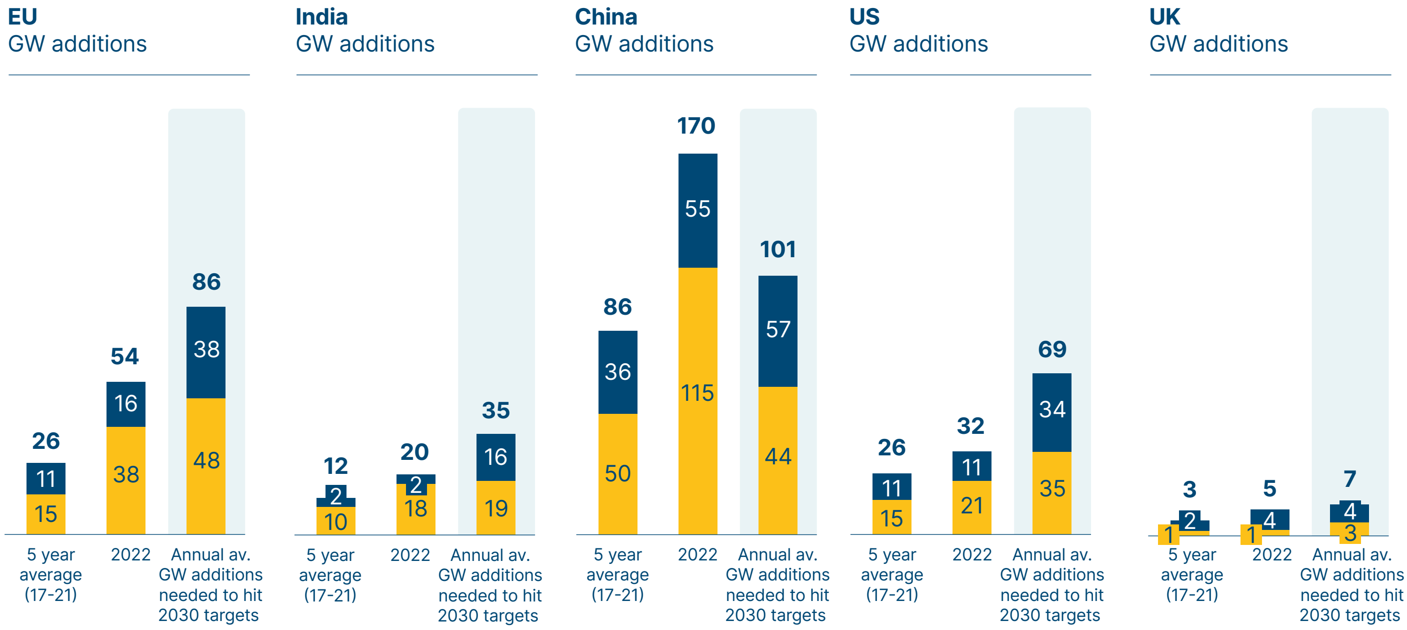
30 IEA (2022), *World Energy Investment 2022.*

Exhibit 9

Most countries are currently far behind the pace of renewables build needed to meet, let alone exceed, 2030 targets

Wind and solar capacity additions in key regions – historic and required to meet 2030 targets

GW per annum



2030 targets derived from:

EU	India	China	US	UK
REPowerEU – Commission working document targets from May 2022	**TERI Renewable Power Pathways** – High Renewable Energy Scenario (HRES)	**RMI China Zero-Carbon Electricity**	**Princeton Net Zero America Report** – E+ high electrification scenario	**UK Climate Change Committee** 6th carbon budget

SOURCE: BNEF (2022), *Global installed Capacity*; Renewables Now (2021) *UK's annual solar installs grow to 730 MW in 2021*; Wind Europe (2022) *Wind energy in Europe: 2021 Statistics and the outlook for 2022-2026*;CCC (2020) *Sixth Carbon Budget*; SolarPower Europe (2021) *EU Market Outlook for Solar Power 2021-2025*; European Commission (2019) *Fit for 55*; European Commission (2022) *RePowerEU*, TERI (2020) *Renewable Power Pathways: Modelling the Integration of Wind and Solar by 2030*; Renewables Now (2021) *India installs 10GW of solar, wind in Jan-Sep 2021*; RMI (2021) *China Zero Carbon Electricity Growth in the 2020s: A Vital Step Toward Carbon Neutrality*, BNEF (2022) *The 2022 Sustainable energy in America Factbook*; Princeton (2021) *Net-zero America*; RECHARGE (2022) *'Made in Britain' energy strategy boosts offshore wind target to 50GW by end of decade.*

1.3 Concessional/grant payments and supporting investment

The ETC's pre-COP27 *Degree of Urgency* report highlighted two key areas where current progress on emissions reductions falls far short of what is needed to stay on a 1.5°C compatible path - these are early phase-out of existing coal generation and ending deforestation.[31] Our *Mind the Gap* report showed that carbon removals would be required, in addition to rapid emission reductions, if the world is to cut net emissions fast enough to limit global warming to 1.5°C.[32]

Delivering each of these three priorities – early coal phase-out, ending deforestation and removals – will require some form of concessional / grant payments to induce asset owners or potential project developers to take actions for which there is no private market incentive.

The required level of such payments is highly uncertain, but we estimate that required concessional/grant payments to middle and low-income countries could total *at least* $300bn a year in 2030, but could be much higher without concerted efforts to end deforestation:

- Around $25-50bn per year to phase out coal early – these payments would then decline over the 2030s, towards zero by 2040.
- At least $130 bn per year to support an end to deforestation by 2030, but in reality, this cost could be significantly higher without a shift to plant-based diets or the development of synthetic meat reducing the demand for animal meat, which is the main driver of deforestation.
- Around $100bn a year to fund carbon dioxide removals from natural climate solutions – these payments would increase gradually to 2050.

The transition to a net-zero economy will also create other categories of stranded assets and require other forms of payments for removals, but which do not require or justify external finance of a concessionary/grant form. In particular:

- Like all processes of economic change, the energy transition will create stranded assets and losses for some existing asset owners; coal power plants will become uneconomic to run once new renewables are cheaper than the marginal cost of coal, and some oil and gas reserves will become uneconomic and will have to be written off in the face of declining demand. But there is no need for concessional/grant payments to ensure that these assets become uneconomic.[33]
- Earlier than economic coal exit may be required in some high-income countries and China, but relevant country governments should manage that challenge. This could cost around $20-50bn a year over the next 10-15 years. However, there is no case for international concessionary/grant finance to support high or upper middle income countries meet their climate commitments.
- And our *Mind the Gap* report projected that a significant scale up of "engineered" solutions (e.g. direct air capture) will be required to meet climate goals, potentially requiring $50 billion per annum payments by 2030, increasing to over $500bn by mid-century.[34] But these payments will primarily be made by companies in high- and middle-income countries to project developers. They will be required to enable companies to achieve net zero emissions, offsetting the 5-10% emissions which cannot be eliminated by within company action; this should be mandated via some combination of compulsory targets, carbon taxes and emissions trading schemes.
- Concessional/grant payments will also be required to deliver a just transition but this report does not provide estimates of how much these could be.[35]

31 ETC (2022), *Degree of Urgency: Accelerating Action to Keep 1.5°C on the Table.*

32 ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*

33 Nor is there any general "climate justice" case for compensating owners of stranded assets, many of which will be companies in high / middle income countries. Indeed any suggestion that owners of stranded assets will be compensated creates perverse incentives for continued investment in carbon emitting fossil fuels.

34 ETC (2022) *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*

35 Recent estimates suggest the cost of targeted programmes and safety nets could reach $50-100bn a year in middle- and low-income countries by 2030. See The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action.*

1.3.1 Early coal phase-out

Renewables are the cheapest source of new bulk power in countries accounting for two-thirds of the world's population and nine-tenths of electricity generation.[36] The economic case for building new coal power plants has therefore disappeared. And as renewables costs continue to fall relative to the marginal cost of operating existing coal plants, it will become increasingly economic to retire some existing coal plants ahead of their technical end of life. The ETC, in line with the IEA, expects all unabated coal power plants to come offline by 2035 at the very latest in all high-income countries and by 2045 in middle and low-income countries. RMI analysis suggests that by 2025 only 25% of the world's coal fleet will still be competitive with renewables on a marginal cost basis.[37]

However, to limit global warming to 1.5°C, this phase out or significant phase down to low load factors, must happen faster than the relative economics would dictate. It is therefore essential to develop mechanisms to encourage the early phase-out of existing coal plants even where renewables cannot yet compete on a marginal cost basis.

Some of this early phase-out may occur without concessional finance or grants:

- Various mechanisms are being developed which seek to incentivise existing owners to phase out coal operations in return for finance to develop replacement low carbon capacity (see Chapter 1.4.2 and Chapter 5.1).

- And voluntary net-zero commitments, whether made by existing coal operators or by the investors and financial institutions which finance them, can motivate early action.[38]

But some forms of concessional/grant payment will also be needed. Estimating how much is inherently complex, reflecting the following:

- Average levelised costs mask varying cost competitiveness at certain times of day. It may be cheaper to run coal at certain times of the day, for example at night when solar power generation is not possible. This means that coal plants continue to operate but at a reduced capacity.

- In many countries, power purchasing agreements (PPAs) will keep coal plants running for some years to come. It is estimated that around 93% of the current operating global coal fleet operate in markets with some form of legacy contracts or tariff structures, for example, an agreement that offers a guaranteed stream of income through PPAs, or a government mandate to a state-owned enterprise. Not all of these may be long-term agreements or have many years of contract left,[39] but where they do have years to run and if they cannot be renegotiated under other arrangements, buying out PPAs adds additional costs to the early phase-out of coal.

- In some cases, additional costs may also be required to mitigate the adverse impacts on workers, including those in the upstream mining sector. This subsidy could come in a number of different forms, including the provision of concessional loan finance to support existing coal operators or governments in the development of renewable energy capacity.

Any precise estimate of required payments would therefore need to reflect detailed country by country analysis, using power dispatch models to assess the full range of phaseout options and allowing for all PPAs in place, but broad orders of magnitude can be identified.

Results from detailed analysis of the South African power system,[40] if simply scaled up in line with South Africa's share of coal power generation, imply a global figure of around $45bn per annum of concessional/grant payments, but other ETC illustrative analysis suggests the global cost could reach $100bn per annum.[41] Of this, around $25-50bn per annum could be required in middle and lower-income countries (excluding China).

The ETC will address this in more detail in our forthcoming workstream on *Fossil Fuels in Transition*, including analysis of the implications of the phase-down of high-emitting assets. Ahead of that more detailed analysis, our current assessment concludes that early coal phase-out could require concessional/grant payments of $25-50bn per annum, reducing gradually over a 10-15 year time period as some plants reach end of planned life and as the relative economics between fossil fuels and renewables increasingly favour the latter.

36 BNEF (2022), *Cost of New Renewables Temporarily Rises as Inflation Starts to Bite*.

37 RMI (2020), *How to Retire Early*. Based on the Rocky Mountain Institute's analysis of almost 2,500 coal plants and represents the difference in cost between running coal plants and building new renewable energy capacity. This analysis considers any implemented carbon-pricing regime, but not any unpriced health or environmental costs. RMI consider wind and solar with four-hour storage rated at half the renewable capacity.

38 For example, the Powering Past Coal Alliance.

39 RMI (2020), *How to Retire Early*.

40 Blended Finance Taskforce (2022), *Making Climate Capital Work* – analysis of the incremental cost, relative to the least-cost scenario, of early closure.

41 ETC (2021), *Keeping 1.5°C Alive* – estimate based on an additional cost incurred of coal assets early of two cents per kWh of electricity produced, taking the cost per Gt of emission reductions to $20-25bn. With the annual emission reductions possible from coal phase out estimated at around 4.6 Gt by 2030, this takes the total cost of early phase out to around $100bn a year.

1.3.2 Avoided deforestation

At COP26 in Glasgow, more than 100 countries pledged to halt and reverse forest loss and land degradation by 2030. Halting deforestation is critical because of the carbon that is released from cut down trees and the sequestration potential of forests which is lost when forest is cut down. If current rates of deforestation continue, this would release over 40 $GtCO_2$ into the atmosphere during the 2020s. Ending deforestation, as well as conserving coastal wetlands and peatlands, has the potential to reduce annual emissions by around 4.6 $GtCO_2$ by 2030.[42]

Past progress on ending deforestation has been slow. This reflects both the major short-term gains which can accrue from converting forest land to agriculture (for instance to soy production or cattle grazing), as well as uncertainties over existing land tenure rights, the need to ensure emissions are genuinely reduced and not simply displaced, and misaligned incentives of actors along the value chain.

Halting deforestation could, in principle, be achieved without concessional/grant payments via some combination of:

- A reduction in consumer demand for the main products which make deforestation profitable (in particular, animal meat and palm oil).
- The development of alternative businesses which can profit from standing forests (e.g., eco-tourism and various forms of sustainable agroforestry).
- Government actions to make deforestation illegal, if combined with effective enforcement.

However, these levers will either take time to develop (e.g., consumer demand change), provide only a partial solution (e.g., new business opportunities), or are unlikely to be wholly effective in the short term (e.g., making deforestation illegal). Stopping deforestation by 2030 will therefore require significant concessional/grant payments. Even if in the long term the other levers can and must deliver a more permanent solution.

Many reports have estimated the cost per tonne of CO_2 saved which might be entailed in achieving an end to deforestation,[43] but few have attempted to estimate what it would cost to put a total end to deforestation. This report, and the *Financing the Transition: Supplementary report on the costs of avoiding deforestation* present a high-level analysis of the order of magnitude of these costs and illustrates that the reasonable range of those estimates massively exceeds financial commitments made so far to help halt deforestation.

We use two different methodologies to present a range of estimates for how large concessional/grant payments would need to be if they were the only lever deployed to reduce deforestation:

- One focuses on estimates of what might need to be spent each year to prevent deforestation in specific locations and draws upon an IPCC estimated cost curve for the rising cost per tonne of preventing a rising annual amount of deforestation. Interpretation of this cost curve suggests that out of the current 5 $GtCO_2e$ per annum of emissions produced via deforestation,[44] 2.3 $GtCO_2e$ a year might be eliminated at a cost of around $30bn per annum, but that eliminating 4 $GtCO_2e$ a year might cost over $130bn per annum while eliminating the final 1 $GtCO_2e$ per annum might cost at least another $100bn per annum. Without action on the three alternative levers mentioned above, these payments might be needed in perpetuity.
- The other focuses on what might be needed to put a complete and (close to) permanent stop to deforestation by 2030, via payments which would secure all of the so-called "forest frontier" against deforestation, and which, as a result, might keep the forest interior safe from deforestation pressures. Here the estimated range stretches from $130bn to $900bn per annum between now and 2030, but with the possibility of a greatly reduced financial requirement thereafter.

Even the lower ends of these ranges are massively higher than the flows of finance currently available to help end deforestation. Domestic and international mitigation finance for forests currently averages around $2.3bn a year.[45]

Meanwhile, the upper ends of the ranges are so high that it is simply not credible to assume that concessional/grant payments on this scale will ever be forthcoming. Without action on the other three levers mentioned above, there will be no end to deforestation.

But without a significant flow of concessional/grant payments, any reduction in deforestation will come too late to make it possible to limit global warming to well below 2°C, let alone to 1.5°C.

Chapter 5 discusses the implications of these estimates, how the lower range of these costs could be financed, and the policies and private sector actions required.

42 Ibid.

43 See ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive;* ETC (2021) *Keeping 1.5°C Alive: Closing the Gap in the 2020s*. See also IPCC (2018), *Special Report: Global Warming of 1.5°C*.

44 Including the loss and degradation of peatlands, coastal wetlands and grasslands.

45 Forest Declaration Assessment (2022), *Are we on track for 2030?*

1.3.3 Carbon dioxide removals

Even with the most ambitious possible reduction in gross emissions, it is almost certain that cumulative CO_2 emissions between now and 2050 will exceed the "carbon budget" consistent with a 1.5°C climate objective. This means that in addition to dramatic decarbonisation to meet the 1.5°C climate objective, a significant volume of carbon dioxide removals (CDR) will be required.

The ETC's recent report on carbon dioxide removals, *Mind the Gap*, estimates that 70-225 $GtCO_2$ needs to be removed between now and 2050 to stay within a carbon budget compatible with a 1.5°C temperature limit.[46] As described in that report, this can be achieved by a combination of:

- **Natural Climate Solutions (NCS)** which apply natural photosynthesis processes to capture CO_2 from the air and store CO_2 in the biosphere either above or below ground.
- **Engineered solutions**, in particular DACCS, which uses direct air capture to remove CO_2 from the atmosphere and then stores the CO_2 in geological formations.
- **Hybrid options**, such as Biomass with Carbon Removal and Storage (BiCRS), which bridge natural and engineered approaches, using photosynthesis to capture the CO_2 but technological intervention to store it, for example in mineral or geological forms.

Removals will only occur if there is an annual flow of money from purchasers of removal credits to providers who undertake the investments required to generate subsequent flows of removals. In the ETC's *Mind the Gap* report, we estimated the profile of required payments over time:

- Payments for NCS solutions developing rapidly in the 2020s to reach $100bn per annum in 2030 and $200bn by 2050.
- Payments for removal via DACCS and BECCS playing a growing role in the 2030s (reaching around $50bn per year), scaling up quickly to reach around $200bn per year in 2040 and further to around $550bn annually by 2050.[47]

In the case of NCS projects, these subsidies will primarily flow from governments or companies in high-income countries to support projects in middle and low-income countries; but in the case of engineered solutions, many projects will be located in developed countries, and a large share of total payments may flow internally within them.

Unlike in the case of many coal phase-out and avoided deforestation projects, where there is no actual new capital investment, many carbon dioxide removal budgets will also require significant upfront investment. This capital investment is required:

- **In NCS solutions** to pay for land acquisition, labour and equipment for ground preparation and tree planting.
- **In Engineered solutions** to build DAC plants and CO_2 transport and storage capacity.

Exhibit 10 presents estimates of the required upfront capital investment with $4trn potentially invested over the next 30 years, representing an average annual rate of $130bn, but with a major shift in composition over time as:

- NCS projects dominate in the first decade since early investment is needed to start the gradual build-up of sequestration volumes achieved over time.
- DACCS project development becoming dominant later as the potential for further NCS projects declines, and as DACC costs fall.

46 ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*

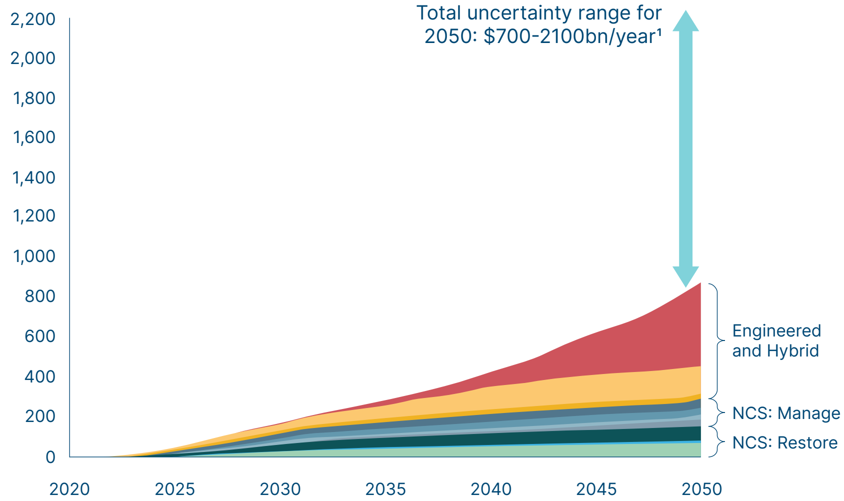
47 In the ETC's *Mind the Gap* report from early 2022, we assumed costs for DACCS would range from $100-300/tCO_2$ in 2050. Since then, in more detailed work in the ETC's (2022), *Carbon Capture, Utilisation and Storage in the Energy Transition* report, our latest best estimate is that costs are likely to average $100/tCO_2$ in 2050 and be lower than this in higher income countries.

Exhibit 10

Total market for CDR could reach $200bn p.a. by 2030; concessional/grant payments required for NCS solutions, not hybrid/engineered

Expected annual cost of CDR solutions

$ billion p.a.



	Cost estimate (2030)	Cost estimate (2050)	Cumulative potential (2020-2050)
Engineered and Hybrid/ BiCRS solutions	\$100-600/t CO_2	\$100/tCO_2	45 GtCO_2
NCS: Improved management solutions	\$0-100/t CO_2	\$0-100/t CO_2	60 GtCO_2
NCS Restoration solutions	\$5-100/t CO_2	\$25-100/t CO_2	60 GtCO_2
TOTAL			165 GtCO_2

NCS: Restore
- Restore forests
- Restore blue carbon
- Restore drained peatlands

NCS: Manage
- Improve forest management
- Agroforestry
- Enhance soil carbon sequestration in croplands
- Enhance soil carbon sequestration in grazing lands

Hybrid and engineered approaches
- Apply biochar
- BECCS
- DACCS

SOURCE: ETC analysis based on Fuss et al. (2018) *Negative Emissions Part 2 – Cost, Potentials and Side Effects*; Royal Society (2018) *Greenhouse Gas Removal Report; APS (2011), Direct Air Capture of CO_2 with Chemicals*; Roe et al. (2021) *Land-based measures to mitigate climate change.*

NOTE: 1) Cost estimates for different solutions vary significantly - chart shows the weighted average between the low and high estimates, uncertainty range based on high estimates and low estimates for all solutions. Current funding for removals estimated to be less than \$10bn/year. Additional funding would be required for emissions reductions (e.g., avoided deforestation).

1.4 Current scale of investment and concessional/grant payments

Current levels of both capital investment and concessional/grant payments fall far short of what is needed. In addition, commitments from high-income countries and from private finance to fill the gaps remain vague and insufficient.

1.4.1 Current capital investment

Low-carbon investment needs to more than double by 2025 to reach $2trn per annum, and triple to reach $3trn annually by 2030. BNEF estimates that global investment in the energy transition reached $900bn in 2022,[48] while the IEA suggests that the world invested around $1200bn in 2021 in clean energy and energy efficiency.[49]

After remaining flat for several years, global clean energy spending is finally picking up and is expected to exceed $1.4trn in 2022.[50] However, almost all of the growth is taking place in high-income economies and China, which attract more than 80% of current clean energy investment.[51] In 2021, clean energy related capital investment in low and middle-income countries amounted to only $225bn; this is about 20% of the global total, but these countries account for almost 70% of the global population.

Reallocating O&G capital investments

A further $800bn is currently invested in fossil fuels each year – including both the supply of fossil fuels and investments for fossil fuel power generation assets.[52] This has fallen from its peak of around $1.3trn in 2014 and is expected to fall to around $0.5trn in 2030 in line with the IEA's Net Zero scenario.[53] This reduction represents capital that can be reallocated to low-carbon investments.

Some of the skills, competencies and resources of oil and gas companies are transferrable to low-carbon technologies, in particular CCS, low-carbon fuels (e.g., hydrogen, biofuels and methanol), and offshore wind power. This makes it easier for these companies to reallocate their financial resources towards the energy transition. This capital reallocation is underway but is not occurring at the pace or scale needed. Capital expenditure by O&G companies on clean energy supply is set to grow from just over $2bn in 2018 to more than $16bn in 2022.[54] While this is a substantial increase, the share of capex allocated to clean energy is expected to remain only 5% of the total capex deployed by O&G companies, driven primarily by European companies. And the $16bn is only ~2% of the total clean power and hydrogen investments expected in 2022 and less than 1% of what is needed by 2025. The ETC will further consider this issue in its forthcoming work on *Fossil Fuels in Transition*.

1.4.2 Country and private finance commitments

Government and private sector commitments to help close the gap are lacking in either ambition or clarity.

Country commitments

At COP15 in Copenhagen in 2009, and reaffirmed at COP21 in Paris, high-income countries made commitments to mobilise $100bn a year of so-called "climate finance" by 2020 to support climate mitigation and adaptation in middle and low-income countries. By 2020, estimates from the OECD suggest only $83bn had been delivered.[55] The goal was extended to 2025 at COP26 in Glasgow but has not been adjusted for inflation.

It is important to note that the $100bn pledge is a high-level political goal and that the quantity promised has not been based on analysis of the investment need in lower-income countries, nor of gaps in the ability of the private sector to make these investments. This means the $100bn cannot be compared to the numbers presented in this report. In addition, there is no official definition of what "climate finance" includes. The OECD, for example, tracks whether the $100bn pledge has been delivered by looking at four possible categories of finance source:[56]

48 BNEF (2023), *Energy Transition Investment Trends* – excludes spending on electrified transport sales and includes investment in power grids.
49 IEA (2022) *World Energy Investment 2022.*
50 IEA (2022), *World Energy Investment 2022.*
51 IEA separates Advanced Economies (OECD, Bulgaria, Croatia, Cyprus, Malta and Romania), China and EMDE's in their reporting. Clean energy investments cover non-fossil fuel related investments.
52 BloombergNEF (2022), *Counting Cash in Paris Aligned Pathways* – analysis based on IEA Net Zero scenario. Current fossil fuel investment of $800bn a year is the annual average between 2016 and 2020.
53 IEA (2017), *World Energy Investment 2017.*
54 IEA (2022), *World Energy Investment 2022.*
55 OECD (2022), *Climate Finance and the USD 100bn goal.*
56 Ibid.

- **Bilateral public climate finance** provided by developed countries' institutions, notably bilateral aid agencies and development banks.
- **Multilateral public climate finance** (provided by MDBs and multilateral climate funds), attributed to developed countries.
- **Climate-related officially supported export credits**, provided by high-income countries' official export credit agencies.
- **Private finance mobilised by bilateral and multilateral public climate finance**, attributed to developed countries.

This categorisation is, however, not universally accepted and, there is little clarity on the balance between mitigation and adaptation which the $100bn is supposed to support. Future pledges of financial support should set out clearly:

- The types of finance which are covered by the pledge.
- The shares devoted to mitigation and to adaptation.
- And the balance between finance to support capital investment versus concessional/grant payments.

Private finance commitments

COP26 delivered a major step forward in terms of private sector commitments. Through the Glasgow Financial Alliance for Net Zero (GFANZ), financial institutions representing over $150trn of private capital committed to achieve net-zero.

However, much greater clarity is needed regarding how much of this capital will be redirected to the energy transition, how this finance will be allocated across countries and sectors, and how the financial sector will operationalise their net-zero commitments and ensure finance is flowing to the right places and the right projects. This is discussed in Chapters 3 and 4.

1.4.3 Current concessional/grant payments

Some of the finance provided as a result of the public and private commitments discussed above will be devoted to phase out coal, end deforestation, and support carbon removals. While it is challenging to accurately quantify how much money is currently being mobilised, it is clear that flows of finance fall far short of what is need.

- Schemes to support early phase-out of coal are in the very early stages of development, with progress complicated by current record high gas prices, undermining the case for switching from coal to gas fired generation. The development of South Africa's Just Energy Transition Partnership (JET-P) – which is also now being replicated in Vietnam and Indonesia - represents an ambitious new approach to bringing together public and private finance to deliver a tailored decarbonisation strategy, including phasing out coal. The partnership has identified $98bn in financial requirements over five years, with an initial $8.5bn currently being mobilised.[57] Other finance for coal exit schemes are also underway.
- Just $19.2bn of funding to help end deforestation has been pledged by high-income countries (of which, $12bn will be public funds, $7.2bn will be private investment) – and this is spread over the period to 2024.
- The private sector is beginning to develop initiatives, in conjunction with governments and civil society, to scale up investment in forests and nature, including an initial $1bn of public and private funds from the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition and the Innovative Finance for the Amazon, Cerrado and Chacho, which aims to reach $10bn.[58] As with government commitments, these are insufficient and there is considerable uncertainty over how and when they will be delivered.
- Estimates suggest the value of voluntary carbon credits jumped from around $350m in 2020 to around $1.2bn in 2022.[59] The scale of the voluntary market, though increasing, will eventually reduce over time as companies reduce gross emissions (assuming companies pay for offsets in relation to their ongoing carbon footprint), or with the development of compliance markets and regulation of voluntary carbon markets which places restrictions on either the quality or quantity of credits.

57 UK Foreign, Commonwealth and Development Office (2022), *Press release - South Africa Just Energy Transition Investment Plan: joint statement.*
58 UK Government (2021), *Press release – Major shifts in private finance, trade and land rights to protect the world's forests.*
59 Trove Research (2022), *Review of the Voluntary Carbon Market.*

1.5 Mobilising adequate capital investment – real economy and financial system levers

At the global macroeconomic level, it is clearly feasible to achieve the net $3trn a year of capital investment described in this report. This amounts to around 1.3% of projected average annual global GDP over the next 30 years, and a significant part of this investment – particularly in the power sectors of middle and low-income countries – would be needed in any case to support economic growth independent of any climate change objectives.

The 1.3% of GDP figure compares with a global savings and investment rates of around 25-28% of GDP over the last decade.[60] Assuming global investment grows in line with GDP, $3trn a year of low-carbon investments is equivalent to around 7% of global investment this decade.

However, this feasible increase in low-carbon investment – which requires either an aggregate increase in global savings/investment or the reallocation of investment away from other less productive sectors – will not occur without well-designed policies and supporting actions, many of which are not currently in place.

In all countries, mobilising or reallocating capital investment on this scale will require:

- Well-designed real economy policies to make private investment economic. These are described in Chapter 2.
- Targeted roles for public finance, including to accelerate the scale-up of new low-carbon technologies (see Chapter 3).
- Supporting roles from financial regulation and net-zero commitments of financial institutions to accelerate capital reallocation (see Chapter 3).
- In China, where current savings and investment rates exceed 40% of GDP and significant investment is spent on excessive real estate and related construction, only a small reallocation of capital would deliver all of the investment required to deliver a zero-carbon economy at no cost to Chinese consumption levels. Chapter 3.4 describes this opportunity.
- In middle and low-income countries apart from China, the challenge differs greatly by individual country. But in many, there is a need to mobilise international financial flows to ensure adequate investment at a competitive cost of capital. Achieving this will require an expanded role for MDBs. These challenges are discussed in Chapter 4.

1.6 Mobilising adequate concessional/grant flows – a crucial political issue

The capital investments required to achieve a zero-carbon economy will, in almost all cases, deliver some return to investors and offer significant opportunity to businesses, governments and citizens.

By contrast, the $300bn per annum of concessional/grant payments that could be required in 2030, while much smaller, are a cost of the transition because in most cases they will not deliver any return to those making the payment. Instead, they represent transfers of income in return for emissions reductions or removals. As a result, these payments will only occur if some combination of companies, philanthropists or governments are willing to make payments with no prospect of getting their money back, let alone of earning a positive rate of return.

Chapter 5 illustrates a potential financing strategy from these three actors. The scale – particularly as it relates to intergovernmental transfers in today's current economic and political climate – underscores the critical importance of any actions, such as shifts away from animal meat-based diets, which can limit the size of the payments needed.

60 IMF (2022), *World Economic Outlook, October 2022.*

Chapter 2

Real economy policies to unleash investment

As section 1.5 argued, there are no fundamental macroeconomic impediments to achieving the level of capital investment required and, in most countries, private finance will deliver the vast majority of the required investment. This requires strong "real economy" policies to create the incentives and provide an adequately low-risk operating environment within which private finance can allocate capital efficiently.

"Real economy" policies refer to policies which do not operate via regulatory or other interventions in the financial sector, nor via the use of publicly supported financial institutions. Well-designed real economy policies instead maximise the potential role of private finance by:

- Establishing a clear strategic vision.
- Addressing the "green premium" challenge.
- Reducing downside risks.
- Removing supply side bottlenecks to the pace of transition.

Over the past year, new public policy actions in key economies have strengthened the investment case for many of the investments outlined in this report:

- The US Inflation Reduction Act (IRA) commits $369bn in spending for the energy transition and climate change, with significant support for renewables scale-up, green hydrogen, carbon capture utilisation and storage (CCUS), infrastructure upgrades, and electric vehicles.
- The EU's REPowerEU package responded to the Russian invasion of Ukraine by increasing the 2030 ambition for renewables and hydrogen.
- China's 2022 14th Five-Year-Plan for Renewable Energy is leading to ambitious rollout of wind and solar, which if continued at the current pace would enable China to peak carbon emissions before its NDC target of 2030.

But in many countries, there are gaps in real economy policy framework or a lack of certainty that policies will be maintained over time.

Sections 2.1-2.4 therefore describe the real economy policies needed in all countries, and section 2.5 identifies specific challenges and priorities facing some middle and low-income economies. Box 4 comments on the processes required to develop optimal real economy policies. Accompanying this report, is a series of sector-specific policy toolkits, which detail the key policies required in the power, hydrogen, transport, industry and buildings sectors.

2.1 Establishing a clear strategic vision

The more that investors can be certain that countries are irrevocably committed to achieving a zero-carbon economy, with key aspects of the required transition clearly identified, the lower the perceived risk and therefore the cost of capital, and the more certain that sufficient private finance will be forthcoming.

All high-income countries, and many middle and low-income countries, have committed to achieve net-zero emissions by mid-century. However, in many countries, significant risks remain because of:

- A lack of consistency across political cycles and/or credibility in climate change policymaking.
- Uncertainty over what decarbonisation is likely to mean and by when, sector by sector.

Key actions to deliver a clear strategic vision and offer certainty to investors include:

- **Clear medium-term targets** on the path to net-zero emissions, overall and for specific sectors, such as:
  - Commitments to the total decarbonisation of electricity systems by, for instance, 2035 (e.g., as in the US, UK).
  - Quantitative targets for renewable capacity or generation, such as those set for 2030 by Australia (82% of generation), Spain (74% of generation) or India (500 GW of renewable energy capacity).
  - Firm legislated dates for the total prohibition of light-duty internal combustion engine vehicle sales (e.g., by 2035 at the latest).

- **Development of sector transition pathways** outlining key milestones, decarbonisation strategies, and investment requirements, ideally with industry and stakeholder buy-in.

- **Ambitious standards and regulations**, such as buildings standards and energy codes, underpinned by robust monitoring frameworks to ensure compliance and underpin incentives to invest.

2.2 Addressing the green premium challenge

In some sectors of the economy, low-carbon technologies are, or will become, lower cost than existing high-carbon technologies. However:

- In many sectors, the low-carbon option will be higher cost during the early stages of development, before economies of scale and learning curve effects have been achieved. This was true of renewable electricity in the early years of deployment.

- And in some sectors, this "green premium" will exist even over the long-term. In aviation, for instance, sustainable aviation fuel is likely to remain significantly more expensive than conventional jet fuel for several decade and if, as is likely, the decarbonisation of cement requires the application of carbon capture, this will always add to cement production costs.

Clear and effective policies are therefore essential to bridge the green premium via some mix of:

- Carbon pricing, complemented in internationally exposed sectors by border carbon adjustments.

- "Contract for difference" mechanisms which subsidise low carbon producers (e.g., green or blue hydrogen producers competing with grey).

- Quantitative mandates to drive demand for low-carbon alternatives; for instance, requiring an increasing share of shipping and aviation fuels to come from zero sources, reaching 100% in 2050.

- Regulations which make it mandatory to use the cleaner technology.

- Direct consumer subsidies (e.g., to households for heat pump installations).

- Using public and private procurement to create demand for low-carbon alternatives.

2.3 Reducing downside risks

Policies that bridge the green premium can ensure attractive expected returns on low-carbon investment even when costs of production are higher than for high-carbon alternatives. However, investor confidence and willingness to invest are also heavily influenced by the variance of possible future returns and, in particular, by whether there are significant downside risks. Policy should therefore include a specific focus on reducing such risks.

This is particularly important in the power sector where zero-carbon technologies (whether renewable or nuclear) are characterised by high upfront costs and minimal operating costs. This cost structure has two consequences:

- First, that levelised costs are highly influenced by perceived risks and thus the cost of capital.

- Second, that approaches to power market design which remunerate investors solely via future wholesale market revenues, with prices likely to vary dramatically by time of day and season, mean that investors have to construct inherently uncertain projections of revenues far into the future.

Even if these projections indicate that expected returns are adequate under most scenarios, the higher resulting risk and cost of capital can undermine the pace of investment. Indeed, for debt providers, the certainty of cash flows is often as important as maximising profit margins or even more so.

Given the size of the investments required in the power sector and the fact that they will in turn enable investment and decarbonisation in other sectors, reducing downside risks in electricity markets is a crucial policy priority. In the ETC's 2021 report on *Making Clean Electrification Possible*, we described key features of an optimal approach; Box 3 summarises key points.

Box 3

Power market design to reduce downside risks

To date, rapid growth in renewables in many markets has been driven by long-term structures/frameworks which have both provided investors with future revenue certainty, therefore lowering the cost of capital, while also delivering targeted subsidies for emerging renewables technologies.

The need for subsidy is now disappearing as the levelised cost of renewables electricity falls below that of fossil fuel based power generation. But the cost of capital for renewables investment can be increased by uncertainty about future revenues even if average expected returns are attractive. Electricity contracts which reduce risk but do not provide subsidy are therefore a desirable feature of long-term power market design. As outlined in the ETC's *Making Clean Electrification Possible* report, such contracts should: [61]

- Give investors the option of revenue certainty over a significant proportion of production through long-term contracts (e.g., 15 years) which reduce downside risks in return for sacrificing upside potential (e.g., via symmetric CFDs).
- Have strike prices set competitively, for example, via auctions.
- Expose generators to wholesale market signals at the margin through sliding premiums with "medium" duration settlement times (e.g., daily, weekly, monthly).
- Allow for time of day/year/or locational components.
- Provide incentivise for long-term use and repowering of existing assets (e.g., by allowing existing wind or solar farms whose contracts for difference contracts have expired to participate in new auctions).

Other actions to reduce downside risk which are applicable across many sectors include:

- **De-risking investment in early stage technologies**, R&D, and first-of-kind plants by guaranteeing revenues or utilisation.
- **Ensuring that policymaking is credible and consistent**, minimising the risk that contracts could be undermined in the face of short-term political pressures; this can be achieved, for example, by committing targets and initiatives to law and providing certainty on carbon price market design.

2.4 Removing supply-side bottlenecks

Even if expected returns are sufficient and revenue risks manageable, the pace of investment in low-carbon technologies may be slowed by supply-chain bottlenecks which delay or prevent project development and implementation.

These barriers can exist because of:

- Planning and permitting processes which increase the time required for project development and implementation, or which in extremis stop desirable projects completely (e.g., development of new mines in Europe and the US required for critical raw materials for the energy transition).

61 ETC (2021), *Making Clean Electrification Possible: 30 Years to Electrify the Global Economy.*

- Failure to develop electricity transmission and distribution networks ahead of the growth in electricity supply and demand, leading to expensive delays in grid connection, or limiting the pace at which heat pumps or EV charging infrastructure can be rolled out.

- Inadequate supply of relevant skills or the slow development of supply chains of critical raw materials and capable business suppliers. In the UK for instance, building insulation and heat pump installation could well be delayed by an inadequate labour resource of appropriately skilled plumbers, electricians and construction workers even if finance were available from either private or public sources. Globally, there is a risk that the pace of the transition could be held back by the availability of critical raw materials (e.g., copper, lithium) due, for example, to slow mine development; however, this risk can be managed and the ETC will explore this issue in an upcoming report in mid-2023.

The ETC's workstream on *Barriers to Clean Electrification* is identifying actions to remove these bottlenecks in the electricity sector:

- Our proposals on how to overcome Planning and Permitting barriers to renewable energy capacity growth were published in January 2023.[62]

- We will also publish a report on how to overcome potential supply-chain bottlenecks in 2023.

- And we will publish a report setting out actions required to facilitate adequately fast development of transmission and distribution grids.

In industrial sectors, public policy should also focus on the development of clusters which can support the integrated development of multiple parts of a value chain. Work by the Mission Possible Partnership is now identifying actions which could facilitate the development of hydrogen production and use clusters in Houston and Los Angeles.

2.5 Specific real economy challenges in middle and low-income economies

Many of the challenges and policy responses discussed above apply equally to all countries; in some middle and low-income economies barriers to sufficient investment are no more severe than in high-income countries. But some face more acute challenges along each of the 4 key dimensions discussed in this chapter.

Establishing a clear strategic vision

- **Quality of national strategies:** Most middle and low-income economies have put forward nationally determined contributions and set targets for emissions reductions towards net-zero, but these vary considerably in scope, detail and ambition, with some too vague to create investor confidence.

- **Government capacity:** To give investors sufficient confidence, strategies and action plans must be regularly assessed, progress monitored, and results transparently communicated.[63] But in some lower-income countries, lower technical and administrative capacity, plus a lack of civil service independence, makes this challenging.

Addressing the "green premium" challenge

- **Relative competitiveness of renewables with fossil fuels:** In several important emerging markets, fossil fuel use continues to be subsidised, delaying the phase-down of uneconomic fossil fuel assets (e.g., coal fired power generation). This skews price signals for investors and reduces expected returns for renewable projects.

- **Limited carbon pricing:** which remains relatively rare in middle and low-income counties. This reflects concerns that carbon pricing will impose a harmful burden on household or business energy bills, but also in some cases inadequate administrative capability in taxation in general.

- **Energy market design:** Many middle and low-income economies lack appropriately designed electricity markets or adequate system operator capabilities to support rapid development of power systems with high renewable shares.

62 ETC (2023), Streamlining Planning and Permitting to Accelerate Wind and Solar Deployment.
63 Forthcoming World Bank White Paper (2023), *Scaling up to Phase down: Financing Energy Transitions in the Power Sector.*

Reducing downside risks

- **Economic or political instability:** middle and low-income economies with less stable economies (e.g., high and unpredictable inflation, or volatile exchange rates) or with a history of political instability, create greater perceived and actual risks for investors.
- **Legal risks:** Less certain rule of law and property rights creates suboptimal or unclear risk allocation between parties and significantly increases downside risks.
- **Lower creditworthiness of utilities:** which reduces their creditworthiness as counterparties for long-term renewable power supply. This can result from past bad management, the sale of electricity at uneconomic prices for political reasons, or difficulties in collecting revenue from end customers. In India, for example, it is estimated that distribution companies lose about a fifth of their revenue to theft and meter-tampering, as well as leaks from faulty power lines.[64]

Removing supply side bottlenecks

- **Slower licensing and permitting:** Lower civil service and institutional capacity can lead to poorly designed and burdensome planning permissions and processes for obtaining licenses, permits and rights to build, own or operate new assets. Delays can add significant costs to project development. In India for instance, delays and uncertainties relating to land acquisition could become an impediment to the scale of solar PV deployment required.[65]
- **Underdeveloped supply chains:** Supply chains to support the energy transition, whether relating to availability of critical raw materials, construction capabilities, equipment manufacture, distribution maintenance, or other are often underdeveloped due to small overall low levels of income per capita.

Alongside addressing the more specific financial challenges which will be discussed in Chapter 4, it is therefore essential for middle and low-income economies to address these real economy challenges. In many cases indeed, as outlined in Chapter 4, it is essential to address these real economy challenges at the same time as enabling a greater flow of finance, and MDBs, along with other publicly supported financial institutions need to play a key role in ensuring that real economy and more purely financial sector related challenges are addressed in an integrated fashion.

Box 4

How can policymakers develop well-designed real economy policies?

Real economy policies which will unleash private investment on the scale and at the pace needed must be based on detailed understanding of the specific barriers which could delay progress and increase risk. Policymakers therefore need to establish strong dialogue with the relevant business and finance providers, in some cases involving them in policy development at an early stage.[66]

This engagement should aim to provide policymakers with a rich understanding of the sector, the business case for investment, and the project economics from an investor’s perspective.

In turn, dialogue helps provide investors with confidence that the necessary policies are or will be in place, that investments have a suitable risk/return profile, and that the policy regime will be maintained over time.

This can be critical in all countries but especially in middle and low-income countries, which lack experience in policymaking for a clean energy economy and where it can be harder to build trust with investors and businesses. In these countries, MDBs have a particularly important role as trusted partners of both government and the private sector.

64 The Economist (May 2022), *Electricity in India – Heat and no light.*
65 ETC (2020), *Wind and Solar in India by 2030.*
66 IMPAX (2020), *Clean Investment Roadmaps: A Framework for Building Clean Energy Economies.*

Chapter 3

Financial sector actions applicable in all countries

As discussed in Chapter 2, most finance will come from private financial institutions if incentivised through well-designed real economy policy. If national power sector strategies are clear and power markets well designed, finance will flow into renewable energy deployment and transmission and distribution networks. If public policies drive people to buy electric cars, the private financial sector will (and indeed, already does in many markets) provide competitive car purchase finance. And provided policies such as carbon pricing or fuel mandates drive decarbonisation of steel, shipping, and other hard to abate sectors, significant finance will likely be forthcoming either from company retained earnings or from private external finance.

However, many of these required policies are not yet in place - and without them, finance will not flow adequately or fast enough. Getting them in place is therefore a crucial priority. In addition, even with well-designed real economy policies and even in higher-income countries, investments in some sectors may be limited by material barriers to finance.

This means that the optimal policy mix also includes:

- Targeted roles for public finance, whether via direct fiscal expenditure/loans or via publicly owned development/infrastructure banks.
- Net-zero or other voluntary commitments made by private financial institutions, where the development and implementation of transition plans influences asset allocation, or stimulates financial innovation to support net-zero transition strategies in the real economy.
- Supporting roles from financial regulation to support transparent disclosure and effective management of climate-related risks.
- In addition, in China, there is a specific need to achieve a reallocation of capital investment away from excessive investment on real estate and related infrastructure construction.

3.1 Targeted roles for public finance

Even with well-designed real economy policies, and even in higher-income countries, there are specific types of capital investment need where private finance alone may not be sufficient. These include for instance:

- **Residential building retrofits:** As highlighted in Chapter 1, after the power system, the building sector accounts for the highest investment need. While in most middle and low-income countries, the main challenge is to ensure that new builds are done in a carbon efficient fashion, in many high-income countries the retrofit of existing buildings will be a major investment requirement.[67] Real economy policies such as regulations to ban gas boiler installation can play a role, and carbon pricing (e.g., on gas bills) will increase incentives to change, but such policies alone are likely to prove ineffective or to have adverse distributional implications given, (i) the significant upfront investment required to improve energy efficiency, (ii) the greater relative size of both energy bills and required investments for many low-income households, (iii) huge differences in the cost of capital faced by households in different economic circumstances, and (iv) the small size but large volume of individual investments which increases transaction costs for financial institutions.
- **First-of-a-kind technologies and business models:** In the hard to abate sectors (e.g., steel, aviation), Sector Transition Strategies by the Mission Possible Partnership have outlined the technologies and investments needed to reach net-zero emissions in these sectors.[68] However, currently many of these investments are "first-of-a-kind" (or similar early stage) and highly capital intensive projects, which can struggle to secure finance as financial institutions can be unwilling to take on the overall risk of the project. This reflects the significant time and effort required to assess risks, with a resulting preference for financing large and established green projects such as renewables.
- **Scale up of key infrastructure:** As discussed in Chapter 2, one of the key risks and bottlenecks to investments can be slow or insufficient rollout of key supporting infrastructure (e.g., hydrogen transport, CO_2 networks and distribution network expansion) due to high upfront capex and operating costs. In many cases, investment depends on a chicken and egg situation – for example, investment in EV charging infrastructure depends on confidence in consumer demand for EVs, but demand for EVs depends on there being sufficient charging infrastructure already being rolled out. This creates a stalemate which can prevent private finance from mobilising fast enough.

67 For Instance, for the UK, the Climate Change Committee estimates that annual additional investment in buildings renovations will need to amount to about 0.4% of GDP by 2035, only slightly less that the 0.7% of GDP required for additional investment in UK electricity generation. See, Climate Change Committee *Sixth Climate Budget*.

68 MPP (2022), *Sector Transition Strategies*.

In addition, there may be sectors/application where private finance should be able to meet the need, but where transitional challenges need to be overcome. For instance, in the passenger EV leasing market, uncertainty about future residual values may increase provider risk and therefore prices in the early years before experience becomes clear.

There are actions that financial institutions can take to overcome these barriers, including financial product innovation (see Section 3.2), but public finance should also play a targeted role in two ways:

- **Direct public financial support:** while in theory, all long-term policy support could be provided through "real economy" policies (such as carbon prices and product regulations), public finance support – whether through grants or concessional loans – is in some circumstances a more effective way to stimulate the early stages of technology development and deployment. This reflects the high sensitivity of initial investors to market uncertainty and potential downside risks.

    - Direct grants, loans or tax incentives to support early stages of battery or green hydrogen have therefore been put in place by the US federal government, the EU and the UK, replicating previous schemes which incentivised the build out of renewable electricity.

    - Public grants and low-cost loans should also be used to achieve the scale of investments required in residential buildings retrofits and targeted towards low-income households.

- **A role for public investment banks:** Even in high-income countries publicly owned development/infrastructure banks – such as the European Investment Bank, KfW in Germany and the UK Infrastructure Bank – should also play a significant role. This should be guided by mandates which commit them to support green investment, and which exclude new fossil fuel investment unless combined with credible CCS projects. And it should be focused on financing challenges where private finance alone might be insufficient or too costly to support rapid energy transition:

    - Unlike in earlier stages of development, this is unlikely to include investments in wind and solar power generation, where mature technologies, business models and regulation mean that adequate private finance will almost certainly be available at an attractively low cost of capital.

    - Instead, the focus should be on investments such power market storage and flexibility, first-of-a-kind industrial applications, infrastructure assets where investment is held back by difficulties in coordinating supply and demand development, and residential building retrofit.

3.2 Actions from private financial institutions – net-zero and other commitments

Private financial institutions, whether asset managers, banks or insurers, will in part reallocate capital to green investments and away from fossil fuels because real economy policies create incentives to do so. Though financial institutions have a clear fiduciary duty to their clients, many have also been making commitments to align their capital allocation with pathways to net-zero emissions, in part driven by the launch of the Glasgow Financial Alliance for Net Zero (GFANZ) in November 2021 [Exhibit 11].

Exhibit 11

Through GFANZ, more than 450 major financial institutions have set net-zero commitments

Banks	Asset managers	Insurers	Asset owners
Align operational and financed emissions to net-zero and 1.5°C by 2050 pathways	Support investment along a 1.5°C pathway to net-zero by 2050	Align insurance underwriting portfolios to net-zero and 1.5°C by 2050 pathways	Align investment portfolio to net-zero and 1.5°C by mid-century pathways, and interim targets for 2025 and 2030
40% of banking assets **70** trillion AUM	**66** trillion AUM (60% of global total) **291** asset managers	**14%** of global premium volume **29** leading insurers	AEGON PensionDanmark
J.P.Morgan Credit Suisse HSBC citi Bank of America	Lazard Amundi Asset Management BlackRock	Allianz Lloyd's AXA Swiss Re	

SOURCE: GFANZ – correct as of December 2022.

These voluntary commitments cannot replace the need for strong public policy, but they can play a useful ancillary role in driving an allocation of capital favourable to the energy transition if they deliver these interdependent objectives:

- An end to investment in activities which are incompatible with achieving the required energy transition (e.g., new coal mines or power plants).
- Increased investment in the technologies and assets required to deliver a prosperous net-zero economy – this in turn will drive a fall in demand in fossil fuel use and support reduced investment in fossil fuel supply (see next point).
- A gradual reduction of high-carbon investments (e.g., oil and gas production or use), in line with feasible and necessary declines in demand.

The mechanisms by which financial institutions can influence this reallocation differ by type of institution. Asset managers can make decisions about which equities or debt instruments to buy or sell and may also be able to influence company strategies via direct engagement with management or via shareholder votes. Banks must decide to which projects/ companies they are willing to lend, and at what rates.

In all cases, net-zero commitments will only be effective if they are turned into a net-zero transition plan which outline goals, actions and accountability mechanisms to align a financial institutions' activities with a pathway to net-zero that delivers real economy emissions reductions.[69]

GFANZ is developing guidance on what financial institutions must set out in transition plans, including:

- **Objectives and priorities**, including clearly defined and measurable interim and long-term targets.
- **Implementation strategy**, including existing and new products and services will support their client's transition efforts, how net-zero objectives will be embedded into evaluation and decision-making processes, and policies and conditions on sectoral activities (e.g., coal).
- **Engagement strategy**, including how to proactively and constructively influence clients, industry and the government and public sector to influence the real economy.
- **Metrics and targets** to drive the execution of net-zero transition plans and monitor progress.
- **Governance**, including role and responsibilities for ownership, oversight and implementation of plans, as well as how teams, skills and culture will be developed.

Such metrics and targets should include:

- The emissions produced by the projects/companies which the institutions finance. Such "financed emission" targets need to clearly specify what will be achieved by 2030 and 2040 as well as 2050 so that they can influence financing decisions being made today which have an emissions impact over these timescales. However, although useful, targets for financed emissions should be accompanied by other metrics due to the risk that these targets will incentivise financial institutions to withdraw capital away from high-emitting sectors (which crucially need finance to transition), as opposed to financing a managed phase out within these sectors.
- The balance between investments in new clean technologies and in the old fossil fuel based system. Estimates by BNEF suggest that this ratio should rise from 0.7:1 today to ~4:1 by 2030, ~6:1 by 2040 and ~10:1 by 2050.[70]

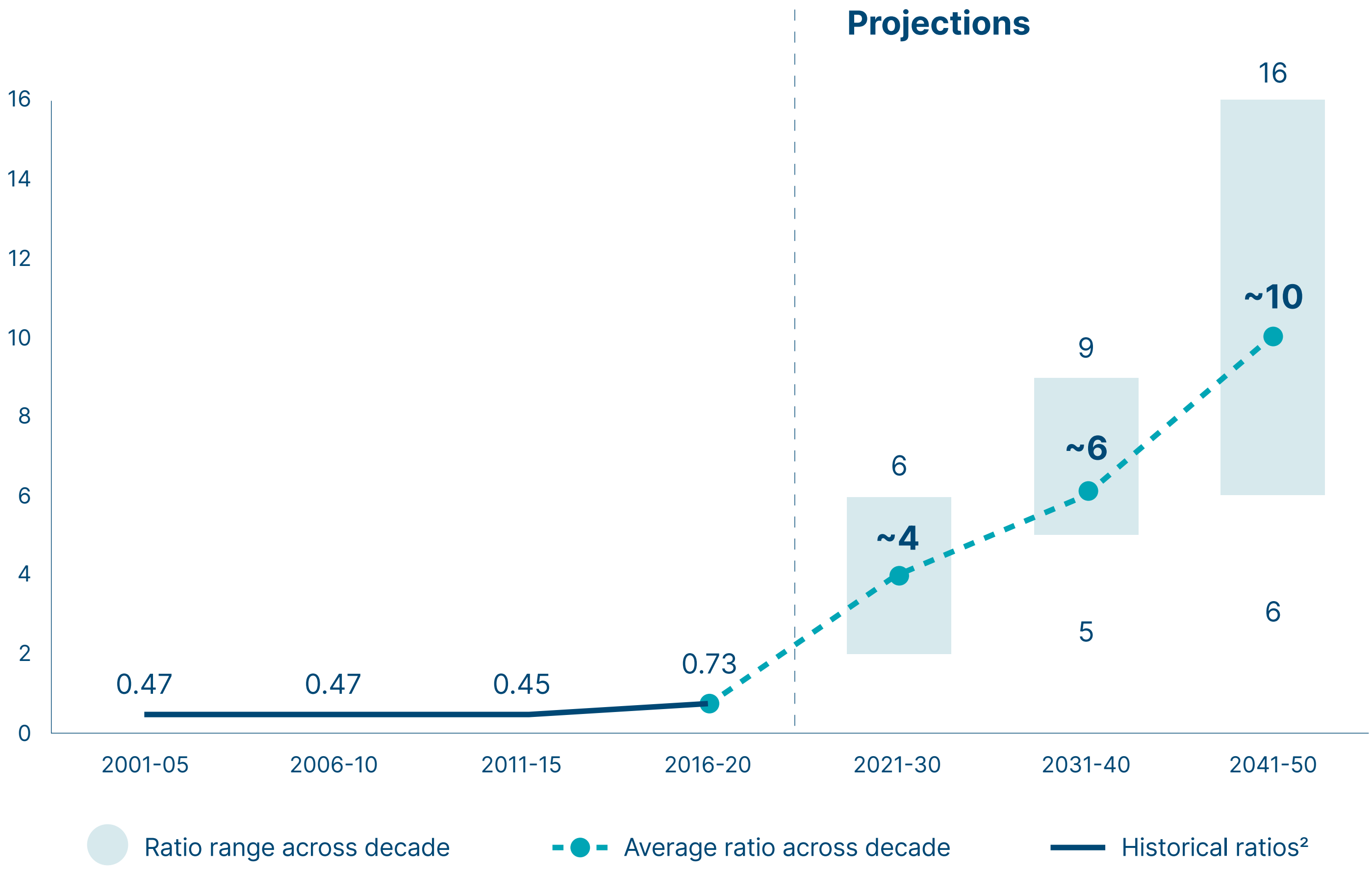
69 GFANZ (2022), *Financial Institution Net-zero Transition Plans.*

70 The ETC will be developing its own estimates of how the ratio between clean energy investment and fossil fuel investments should evolve over time in a forthcoming report on *Fossil Fuels in Transition*. Given similarities between the ETC and IEA/BNEF clean energy investment estimates, we expect estimates of ratios to be aligned.

Exhibit 12

The ratio between clean energy and fossil fuel investments should increase from less than 1 today, to 10 in the 2040s

Ratio of clean energy investments to fossil fuel investments, 2001-2050; projections show the range of various net-zero scenarios[1]



SOURCE: BloombergNEF (2022), *Investment Requirements of a Low-Carbon World: Energy Supply Investment Ratios.*

NOTE: 1) Results are an average of outputs from various net zero scenarios - BloombergNEF, IEA, IPCC and NGFS. 2) The historical 5-year average ratios denote estimated values based on IEA World Energy Investment reports.

Development and implementation of financial institution net-zero transition plans should be supported by the clear definition of sector pathways which are compatible with overall climate targets, and which can be used to guide financing decisions.

- For the oil and gas sectors, this requires a definition of the pace at which oil and gas demand/supply must be expected to fall over time. The IEA's Net-zero scenario has been adopted by some financial institutions as a guideline. The ETC's current work on *Fossil Fuels in Transition* will also provide guidance, and the Science Based Target Initiative (SBTi) will be defining what it believes is an acceptable path of emissions decline for oil and gas companies which seek to be SBTi endorsed.

- For the hard-to-abate sectors, the Mission Possible Partnership, with significant ETC input, has developed sector by Sector Transition Strategies (STS) for emissions reduction from now to 2050. STSs for steel, aluminium, ammonia, trucking and aviation have already been produced and endorsed by a wide range of companies within each sector, and pathways for cement and petrochemicals/plastics are under development.[71] These pathways can provide guidance on the projects/companies which financial institutions should seek to finance, and on appropriate targets for the reduction of financed emissions in these sectors. Achieving these strategies will require both real economy policy and financial actions, as outlined in this report. Effective financial sector action can also be strongly encouraged by the development of standards or principles specific to each end use sector - such as the Poseidon Principles agreed by major lenders to the shipping industry.

- It is also important for financial institutions to set out clearly their approach to the funding of building construction and retrofits, recognising that for some major institutions (e.g., many commercial banks), real estate funding is by far their biggest asset category. This could result in specific product offers to speed vital decarbonisation priorities; for example, making it easy for households to top-up existing mortgages to pay for energy efficiency improvements, with major mortgage banks potentially working in collaboration with the public infrastructure banks discussed in Section 3.1.

- In the zero-carbon power sector, the vital need is for financial institutions to recognise the huge scale of the financing need/opportunity described in Chapter 1, and to develop strategies for increased investment in this sector.

- Several financial institutions based in high-income countries are also seeking to support decarbonisation efforts in lower-income countries, whether through financing new capital investment or through engagement in plans to phase out existing coal plants. These activities are discussed in Chapter 4.

Voluntary net-zero or other commitments must ultimately be made by individual financial institutions. But the more financial institutions make these commitments and the greater the consensus about the broad shape of the required energy transition to be achieved, the greater the impact will be:

- Multiple commitments, covering as large a share of investing and lending as possible, are essential to ensure that decisions by one institution to reduce finance for harmful activities do not simply result in the business shifting to other asset managers or banks.

- And the greater the consensus within industry sectors and among financial institutions about the feasible pathways for each sector, the more likely that finance will be available to support appropriate decarbonisation strategies.

Widespread commitment and transparent communication of commitments, strategies and assumptions, which in turn makes possible effective monitoring, can all be encouraged or required by effective financial regulation.[72]

71 www.missionpossiblepartnership.org/our-approach/sector-transition-strategies/

72 For example, in 2022, the UK became the first G20 country to make it mandatory for the largest businesses to disclose their climate-related risks and opportunities, in line with the Taskforce on Climate-related Financial Disclosures (TCFD) recommendations. See Chapter 3.3 for more information on TCFD.

3.3 Supporting roles for financial regulation

Financial regulation should support and encourage action by private financial institutions to reallocate capital to achieve the energy transition. This should entail:

- Ensuring transparent disclosure of climate risks and strategies.
- Ensuring that financial institutions assess and manage climate-related risks.

Prudential regulators and central banks could also play a role in deliberately forcing the allocation of capital away from fossil fuel related assets – however, there are pros and cons of doing this.

Exhibit 13

Different types of financial regulation are emerging across the world that help equip the financial system for the transition to a net-zero economy

Type	Description	Regulations in development *(not-exhaustive)*
Financial disclosure, including green taxonomies	Reporting and monitoring rules for public companies and large financial institutions to disclose climate-related risks and opportunities This includes taxonomies; a classification system that identifies which economic activities can be considered environmentally sustainable (including associated reporting requirements)	**TCFD aligned financial disclosure regulation** is developed in e.g., EU, Brazil, Japan, Singapore, the United States.[1] **Green taxonomies** • **EU** Taxonomy • **China** Green Bond Endorsed Projects Catalogue (China Taxonomy) • **Mexico** taxonomy plans in development
Climate scenario analysis and stress tests	Regulatory tool of central banks to identify and reduce systemic physical and transition climate risk exposure of the financial sector as drivers for financial risks	• **EU**: The European Central Bank (July 2022) • **UK**: The Bank of England (May 2022)
Direct capital allocation levers	Regulation to favour low-carbon investments and discourage those in fossil fuels: 1. Increasing capital weights of entities exposed to climate-related risks 2. Adjusting monetary policy and liquidity provision frameworks to climate-related risks	1. No climate-specific capital weights adjustments have been made to date 2. Monetary policy framework adjustments include: • **EU**: The European Central Bank has announced a revision of their collateral framework and proposed a green tilt in its bond purchases • **UK**: The Bank of England has "greened" its framework for corporate bond purchases

SOURCE: Systemiq analysis for the ETC (2023).

NOTE: 1) EU: the Corporate Sustainability Reporting Directive and Sustainable Finance Disclosure Regulation. Brazil still in development stage. US: SEC climate risk disclosure rule (proposal). 2) TCFD = Taskforce for Climate related Financial Disclosure

Financial disclosure by companies and financial institutions

Financial disclosure rules set by securities market regulators can be used to ensure that:

- Non-financial companies clearly disclose their own emissions and strategies for reduction, to enable investors and lenders to assess the climate change risks arising and to inform their own financed emission reduction strategies.

- Financial institutions clearly communicate their own approach to managing climate related-risk and opportunities arising from the net-zero transition, and disclose their own exposure to different sectors, in particular fossil fuels.

Accounting standards can also play an important role in ensuring that the disclosed figures – e.g., of Scope 1, 2, and 3 emissions – are produced on a standardised and auditable basis and can be used in climate stress tests (see below).

Steps towards this approach, in some cases for all companies and in others specifically for financial institutions, have already been taken by:

- The **Taskforce for Climate-related Financial Disclosure** (TCFD),[73] which aims to define a gold standard for disclosure by companies in all sectors, to provide financial institutions with the information they need to assess and price material risks in company or asset valuations. These disclosure standards were originally applied on a voluntary basis but should become compulsory over time (e.g., as has been introduced for large companies in the UK).

- The **US Securities and Exchange Commission** (SEC) is developing new rules on disclosures for all public companies, based on the TCFD recommendations. The rules, expected to be finalised in 2023, would cover reporting and governance of climate-related risks and emissions, and details of company transition plans and targets.[74]

- The **European Union** has established a Taxonomy which requires financial institutions to disclose the share of revenue obtained from Taxonomy aligned (low-carbon) activities.[75] The effectiveness of this approach is debated (see Box 5). In addition, it has developed a Sustainable Finance Disclosure Regulation for financial institutions and is developing a Corporate Sustainability Reporting Directive for corporates.

Regulations to date have primarily focused on improving the availability and quality of emissions data. Going forward they could also cover the disclosure of metrics such as revenue from and capital allocated to low-carbon products and services and the trend of these metrics over time. In addition, they should require transparency on the use of offsets to meet "net-zero" claims, disclosure of the use of an internal carbon price,[76] and include compulsory audits.

73 The TCFD is the Task Force on Climate-Related Financial Disclosure, created in 2015 by the Financial Stability Board to develop consistent risk disclosures for companies, banks and investors. The TCFD provides recommendations to how companies should disclose information, around four thematic areas: governance, strategy, risk management and metrics and targets.

74 US Securities and Exchange Commission (2022), *SEC proposes rules to enhance and standardise climate-related disclosures for investors.*

75 McKinsey (2022), *Understanding the SEC's Proposed Climate Risk Disclosure Rule.*

76 An internal price places a monetary value on greenhouse gas emissions, which companies can then factor into investment decisions, specifically relevant where external carbon prices do not exist or are perceived as too low. Companies use internal carbon pricing as a strategy to manage climate-related business risks and prepare for a transition to a low-carbon economy. Disclosing the internal carbon price, how it is set, and what it covers, provides an insight into what extent a company considers and mitigates transition risks.

The Role of Green Taxonomies

The EU has established a “Taxonomy” which defines which investments (by sector of the real economy) can be considered as aligned with the required energy transition. Financial institutions of all sorts are first identifying which of their investments, loans or insurance contracts are relevant to the taxonomy definitions and will subsequently disclose what proportion of their relevant finance supports aligned and non-aligned activity.[77]

China has developed a Green Bond Endorsed Projects Catalogue, which classifies which technologies are eligible for green bond issuance.

The definition of these technologies may help provide clarity for financial institutions on what activities should be considered green. In this way, it may help discourage “greenwashing” by financial institutions using their own opaque definition of what they consider to be climate aligned.

But the process of defining “green” versus “non-green” activities has proved contentious, with extensive political debate and lobbying – e.g., on the role of gas (where the issue is how large and how long lasting a transitional role is acceptable) and nuclear (which is clearly green from a climate point of view, but which some groups oppose on other grounds).

Given these inherent difficulties, other approaches to financial institution disclosure are likely to be more effective including:

- Clear and standardised disclosure of exposure to all categories of fossil fuel investment, leaving it to counterparties and other stakeholders to judge whether this finance is climate aligned.
- Clear and standardised definitions of financed emissions.
- Disclosure of climate-related scenario analysis and stress testing, including stranded asset risk.

Climate scenario analysis and stress tests of bank and insurance companies

Prudential regulators use scenario analysis and stress tests to assess the ability of banks or insurance companies to survive extreme economic conditions which could result in asset or loan losses which might threaten their solvency or liquidity. The results of the stress tests identify specific or systemic vulnerabilities in the financial sector, and also inform assessments by both regulators and financial institutions of capital required.

Potential losses arising from climate risks and the energy transition should and are already being included in the stress tests, with a focus on both:

- Adaptation and resilience risks where investments, loans or insurance contracts may be exposed to the increasing severity of climate change related weather events.
- The danger that fossil fuel related assets will become uneconomic (“stranded”) as a result of progress towards a zero-carbon economy.

These stress tests are an important regulatory tool, and it is appropriate that climate risks are fully reflected in them; and in some circumstances they may induce action to reduce fossil fuel related exposure. Over time, the results of stress tests could begin to have a material effect on capital reallocation, particularly for long-term holdings, but also for shorter term holdings that would then be refinanced.

77 European Commission (2022), *EU Taxonomy for Sustainable Activities.*

Direct capital allocation levers: capital weights and central bank financing

Prudential regulators and central banks have more forceful policies in their toolkits to deliberately favour investment in the low-carbon economy and to discourage fossil fuel investment. These tools include:

- Increasing capital risk weights for fossil fuel investments, forcing banks and insurance companies to hold more capital against them, even if they are not convinced that these exposures create greater prudential risk within the capital planning horizon.[78]

- Adjusting monetary policy and liquidity provision frameworks, where relevant tools include the provision of credit against collateral and direct asset purchases. In their credit operations, central banks could provide liquidity to commercial banks more favourably when extended against "green" assets than against fossil fuel related assets. Equally, if and when, central banks conduct direct asset purchase operations (quantitative easing), it could be possible to limit this to the purchase of specific categories of "green" assets.[79] Alternatively, they could require climate-related disclosure, including transition plans, from their counterparties and on the bond issuers whose assets are used as collateral.

The argument against deploying such tools is that central banks and prudential regulators should focus on their primary objectives of financial and monetary stability, and should use climate-related scenario analysis and stress tests to identify vulnerabilities in the financial system. In addition, any financial policy to support the energy transition should be designed by the democratically accountable government, using fiscal resources or operating via publicly owned development/ infrastructure banks.

The argument for these tools is that the inherent cost structure of low-carbon technologies, with high upfront capital investments and low marginal costs, makes the relative cost of capital an extremely strong economic lever; this means that central bank/regulatory authorities can have a big impact at low cost. The report of the Independent High-Level Expert Group on Climate Finance (discussed further in Chapter 4) therefore proposes that central banks should not focus solely on safeguarding the financial system from climate related risks, but instead actively seek to mobilise the financial institutions which they supervise to support and finance the net-zero transition.[80,81]

In many high-income economies, the former argument is likely to be supported. Some central banks in these economies have at times made liquidity provision available on a basis which varies by sector. The European Central Bank's "Targeted Longer-Term Refinancing Operations" programme, for instance, provided commercial banks with credit at favourable interest rates and for long-term maturities, but only for on-lending for purposes other than real estate investment. But this sector preference could be justified by reference to the ECB's core objectives of financial and macroeconomic stability, given the differential macro consequences of lending to real estate versus to other sectors.

In some other economies, including China, central banks have at times played a more directive role in capital allocation, favouring sectors which are believed particularly important to economic growth. In these countries, central bank/prudential levers to favour the energy transition are more likely to be deployed.

78 Risk weights to determine capital requirements are driven by credit risks assessments. As these are heavily based on short-term risks, and can be updated quarterly, fossil companies typically have high credit ratings as they are currently still in the money with low risk. In addition, the weights are company based rather than asset linked. The risk-weight of a particular project loan from a bank to a O&G company, is therefore based on the overall short-term credit risk, rather than the specific risk associated with the investment in respective project.

79 European Parliamentary Research Service (2022), *Green Central Banking*.

80 The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action.*

81 Indeed, many central banks have already included climate change and the transition within their remits. For example, the Bank of England's climate objective is to "play a leading role, through policies and operations, in ensuring the macroeconomy, financial system, and the Bank of England itself are resilient to the risks from climate change and support the transition to a net-zero economy".

3.4 China – reallocating capital investment to green and efficient objectives

The actions discussed in sections 1-3 are applicable to all high-income countries and to many middle and low-income economies as well. However, China's unique economic and policy environment present a distinctive challenge and opportunity for policymakers.

China's economic model and its financial system are based on a unique combination of market and planning mechanisms and entail biases which result in very high rates of national savings (currently running at almost 45% of GDP) and investment (around 43% of GDP).[82] These savings and investment rates – maintained over the last two decades – have helped drive China's rapid growth rate, with a significant share of investment devoted to valuable growth enhancing capital accumulation. But they have also been accompanied by significant misallocation of capital to low-return investment as evidenced by both:

- Macro level measures which indicate a rapidly increasing incremental capital output ratio, meaning increases in investment are achieving proportionately less growth.[83]
- Huge overcapacity in real estate, with People's Bank of China (PBOC) analysis showing that 20% of all Chinese apartments are unoccupied, and likely to remain so over the long term, as China's population peaks and then slowly declines, and as the movement of people from countryside to city reaches maturity.[84]

Chinese policymakers at the PBOC and the banking regulator (CBIRC) have long recognised that this focus on real estate and infrastructure investment poses risks to both economic efficiency and financial stability and have used numerous policy levers in an attempt to deter leveraged property speculation. But construction stimulus is still used as the default policy response to a slowdown in Chinese economic growth. Real estate and other infrastructure investment continue to account for around 25% of GDP.[85]

This structural bias in the Chinese economy also has major adverse effect on carbon emissions, with construction driving high cement and steel production which together account for 35% of all Chinese emissions, and which produce per capita emissions form these sectors far above those seen in any other major economy.

China's investment challenge is not therefore to increase total savings and investment to finance the energy transition but more simply to reallocate capital investment away from "old economy" infrastructure to green and digital investment, in the way described by the ETC/RMI 2020 report on *Achieving a green recovery for China*.[86]

Several Chinese policies already support this shift, and China is already the leading installer of renewable electricity in the world. Moreover, the Chinese central bank and financial regulator have been more willing than their Western counterparts to use central bank and prudential regulation levers to favour green investment, for instance through preferential access to PBOC loan discounting facilities for commercial bank loans which meet green criteria.

Further intensification of these and other policies, together with stronger measures to discourage excessive real estate investment, are desirable to put China on a more economically and environmentally sustainable growth path.

82 IMF (2022), *World Economic Outlook Database – April 2022.*
83 For example, see Yu Yongding (2015), *China's Slow-Growth Opportunity.*
84 China Urban Households Asset and Debt Survey, People's Bank of China, April 2020.
85 Penn World Tables – Capital Stock database.
86 ETC (2022), *Achieving a Green Recovery for China.*

Chapter 4

Additional actions required in middle and low-income countries

For middle and low-income countries, the investments outlined in this report are not just a necessary route to achieve net-zero emissions; they are also a necessary path to sustainable and inclusive growth and development. These investments have the potential to unlock an economic transformation which can deliver huge co-benefits for economic and social wellbeing. Decisive action this decade, which mobilises the right scale and types of finance, is critical.[87]

Middle and low-income countries are not homogeneous. In some middle-income economies, the barriers to low-carbon investment are not significantly more severe than in high-income countries, and the policies needed to address them are as described in Chapters 2 and 3 above.

But to different degrees, many middle and low-income economies face additional challenges which increase the cost or limit the flow of finance required to achieve a rapid, sustainable and just energy transition. These include:

- Low domestic savings and underdeveloped financial systems and capital markets, which limit the extent to which domestic capital denominated in local currency can be mobilised by the private sector. This is a bigger issue in smaller, lower-income countries, than in large middle-income counties such as India or Indonesia.[88]

- Past or present macro-economic or political instability which increase perceived risk and therefore limit the ability to attract external private sector finance and/or increase its cost.

- Weak government fiscal positions, which limit the scope to use public balance sheets to support investment.

- Project-specific risks, which can arise from either:

  - Weak policy or regulatory environments for low-carbon investments.

  - The low creditworthiness of key potential counterparties, such as electricity distribution companies.

Many of these barriers and consequences are well familiar from past studies of economic development, and have been impediments to economic growth in many low-income countries long before there was a focus on the need to achieve an energy transition. But they are particularly important impediments to zero-carbon power system development, given the inherent cost structure of zero-carbon generation and transmission and distribution investments of high upfront capital costs and minimal operating costs.

As a result of this cost structure, the economics of zero-carbon are heavily dependent on the weighted average cost of capital (WACC), compared with fossil fuel investments [Exhibit 14]. The levelised cost of renewable electricity is therefore far higher in lower-income countries which face a high cost of capital than it is in the developed world [Exhibit 15].[89] The IEA finds that nominal financing costs in middle and low-income countries can be up to seven times higher than in the US and Europe.[90]

87 The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action*.

88 The cost of capital is a measure of the risk associated with projects in different jurisdictions; it expresses the expected financial return, or the minimum required rate, for investing in a company or a project.

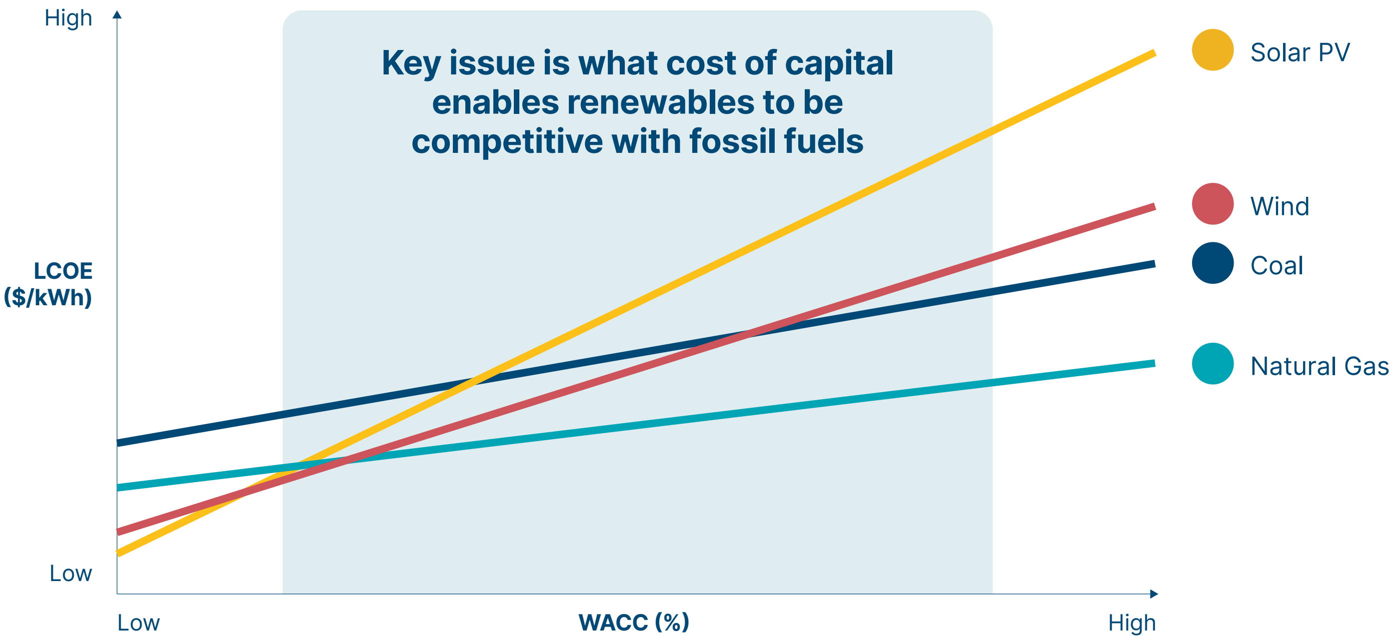
89 It is important to also note that LCOEs in middle and low income countries will fall as deployment brings down costs due to learning curve effects.

90 IEA (2021), *Financing Clean Energy Transitions in Emerging and Developing Economies.*

Exhibit 14

Competitiveness of wind and solar is very sensitive to the cost of capital, which is significantly higher in middle and low income countries

Impact of weighted average cost of capital (WACC) on cost of power generation
$/kWh

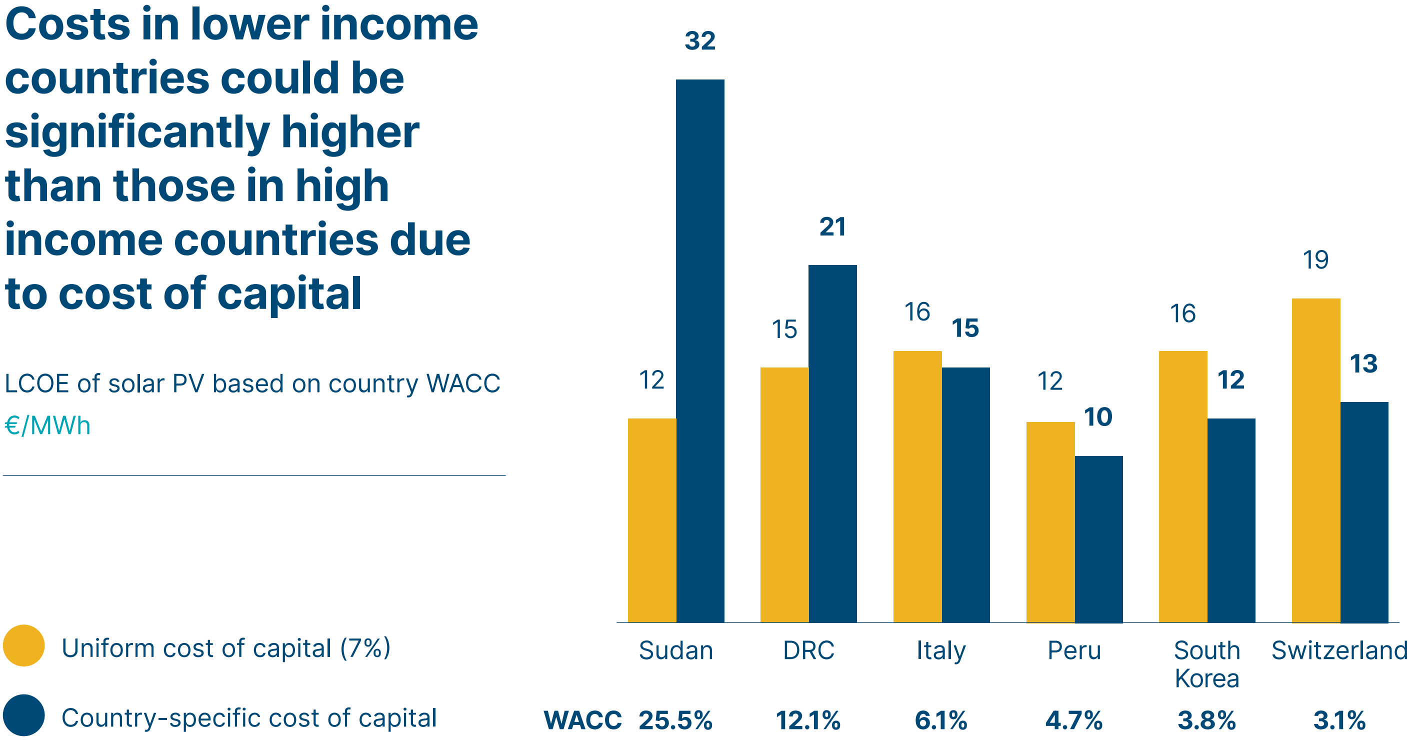


SOURCE: Systemiq analysis for the ETC (2023).

Exhibit 15

Costs in lower income countries could be significantly higher than those in high income countries due to cost of capital

LCOE of solar PV based on country WACC
€/MWh



SOURCE: Egli et al. (2019) *Bias in energy system models with uniform cost of capital assumption.*

In many middle- and low-income countries, these challenges have been exacerbated by additional challenges in today's macroeconomic environment, such as:

- Greater fiscal pressures following the COVID-19 pandemic, which saw tourism and other tax revenues collapse at the same time as health and welfare costs increased soared.
- Increased energy prices which create economic and fiscal stress in energy importing countries.
- Increased cost of foreign currency borrowing as a result of higher developed world interest rates.

Given these factors, adequate investment to achieve zero-carbon pathways across all middle and low-income countries will not occur without with much larger flows of external finance, and at a lower cost of capital than currently occur.

This capital mobilisation challenge has recently been analysed by the report of the Independent High-level Expert Group on climate finance chaired by Vera Songwe and Lord Nicholas Stern, which was published at COP27. This Songwe-Stern Report has a wider focus than this report, looking at the investments required to address adaptation, resilience and biodiversity issues, in addition to those needed to reduce emissions to net-zero. However, its key conclusion is highly relevant to our more specific focus – that adequate investment in middle and low-income countries will require a much more significant role for MDBs in providing external finance, which can in turn help mobilise increased private investment.[91]

Estimates of current climate mitigation investment in middle and low-income countries suggest that around $130bn per annum is provided by a combination of domestic public finance and private investment, including $25bn of MDB lending and $10bn of external private finance mobilised as a result of that MDB lending.[92,93] A dramatic increase will therefore be required to deliver the $900bn per annum of investment which the ETC estimates could be required in middle and low-income countries by the late 2020s.

Mobilising this investment at an affordable cost and in a catalytic way will require taking all of the following actions, which will be mutually reinforcing when implemented together:

- Increased mobilisation of domestic savings and private finance.
- Increased MDB and other external finance at a low enough cost of capital to be sustainable in macroeconomic terms.
- An expanded role for MDBs and national governments in defining the strategies within which investment can be effective, in addressing gaps in real economy policy to tackle the underlying causes of high cost of capital, and in catalysing private finance – this will, in turn, enable external finance to be provided at a lower cost, and for a better understanding of where to target concessional funds where market failures persist.
- Increased international private financial flows to lower-income countries, in line with financial institution's net-zero commitments and based on understanding of the risks and opportunities involved.

91 The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action.*
92 Systemiq analysis for ETC based on data from CPI (2021), *Global Landscape of Climate Finance; Joint Report on MDB's Climate Finance 2020.*
93 It is important to note the challenges in fully measuring and quantifying how much private finance has been mobilised by MDBs, for example the value of project preparation and policy support.

4.1 Mobilising domestic savings and private financial flows

The Songwe-Stern report estimates that around $2.4 trillion per annum of investment will be required by 2030 in middle and low-income countries (excluding China) to meet the wider set of needs analysed.[94] Of this, the authors estimate that slightly over half can and must come from domestic savings, mobilised by national governments, by national development banks, or by the domestic private sector.

This mobilisation of domestic savings in domestic currency is particularly important for power system investments where revenue streams naturally arise in local currencies, unlike in the case of export-oriented fossil fuel investments, where hard currency financing can be appropriate.

Achieving this domestic resource mobilisation requires action along several dimensions:

- Improve tax collection and reduce fossil fuel subsidies to increase fiscal resources.
- Carbon taxes or strong regulation to improve incentives for private investment.
- MDBs can play a role in fostering the growth of local currency capital markets.[95]
- And in some countries, such as India, large domestic companies which operate on a global scale, will play a major role in financing investment out of their retained earnings or from borrowings in local or global capital markets.

Despite significant potential from domestic resources, the Songwe-Stern report estimates that around $1trn per annum (or ~40% of the total investment need) will have to come from some form of external finance. Applying this share to the narrower set of climate mitigation investments on which this report focuses, this would imply a need for additional external finance of about $400bn.

94 The Stern-Songwe report estimates that $1.3-1.7 trillion a year by 2030 is needed for the energy transformation, $200-400bn to cope with loss and damage, $200-250bn for adaptation and resilience, $275bn-400bn to invest in natural capital, and $40-60bn for mitigating methane emissions.

95 For example, the European Bank for Reconstruction and Development's Local currency and Capital Markets Development Initiative, which aims to strengthen local capital markets and encourage the use of local currencies.

4.2 Multilateral development banks and other forms of official external finance

Role of MDBs

As outlined above, MDBs will need to play a critical role in financing the transition in middle and low income countres. Increasing the lending capacity of the MDBs is neither the only action required nor sufficient in itself to unleash the investment needed. Indeed, from a scale perspective, some experts within MDBs argue that they already have balance sheet resources in excess of the pipeline of "bankable projects". To increase this pipeline to the scale required, it is essential for lower-income countries to address the real economy barriers discussed in Chapter 2. MDBs themselves can help national governments identify how best to do this, as Section 3 below discusses. It is also vital to ensure that MDBs and other official financial institutions help mobilise private sector finance – as Section 3 and 4 below discuss. But increased MDB financing is undoubtedly a necessary and vitally important part of what needs to happen.

MDBs are a diverse group, differing in their mandates and the terms on which they provide finance. Some, such as the World Bank's International Financial Corporation and the European Bank for Reconstruction and Development, have mandates to provide finance at market rates in order to prevent market distortion; others, such as the African Development Bank and the World Bank's International Development Association, offer finance at concessional rates which provide an explicit subsidy.

Yet even MDBs which offer finance at supposedly market rates are able to take on more risk than the private sector is prepared to, due to their capacity to accept certain risks (e.g., MDBs are able to absorb political risks to a much greater extent than the private sector because of their government shareholders), which allows them to mobilise finance from commercial banks. Additionally, all MDBs are able to mobilise credit at a lower cost than the private sector because their government shareholders provide equity capital without receiving a return and implicitly stand ready to absorb any future losses (for instance via the commitment of "callable capital", which is capital pledged by shareholders to be used in the event that the MDB cannot meet its obligations).[96]

This lower cost of capital is vital at both the micro and macro level:

- At the micro level, it means that MDBs and other official financial institutions can provide finance at rates which makes zero-carbon projects economic versus fossil fuel projects despite higher upfront capital expenditure requirements.
- At the macro level, they make large-scale external debt finance more sustainable. Exhibit 16 taken from the Songwe-Stern report shows the World Bank lending rate compared with market bond yields for a range of lower-income countries. Exhibit 17 shows estimates from the Songwe-Stern report of the debt-to-GDP ratios which would result if their proposed scale up of external finance were provided at market rates compared to World Bank rates. In the former case, debt ratios would rise to levels which might well prove unsustainable, whereas at World Bank rates, the proposed scale up in external finance has a far more muted impact on debt-to-GDP ratios.

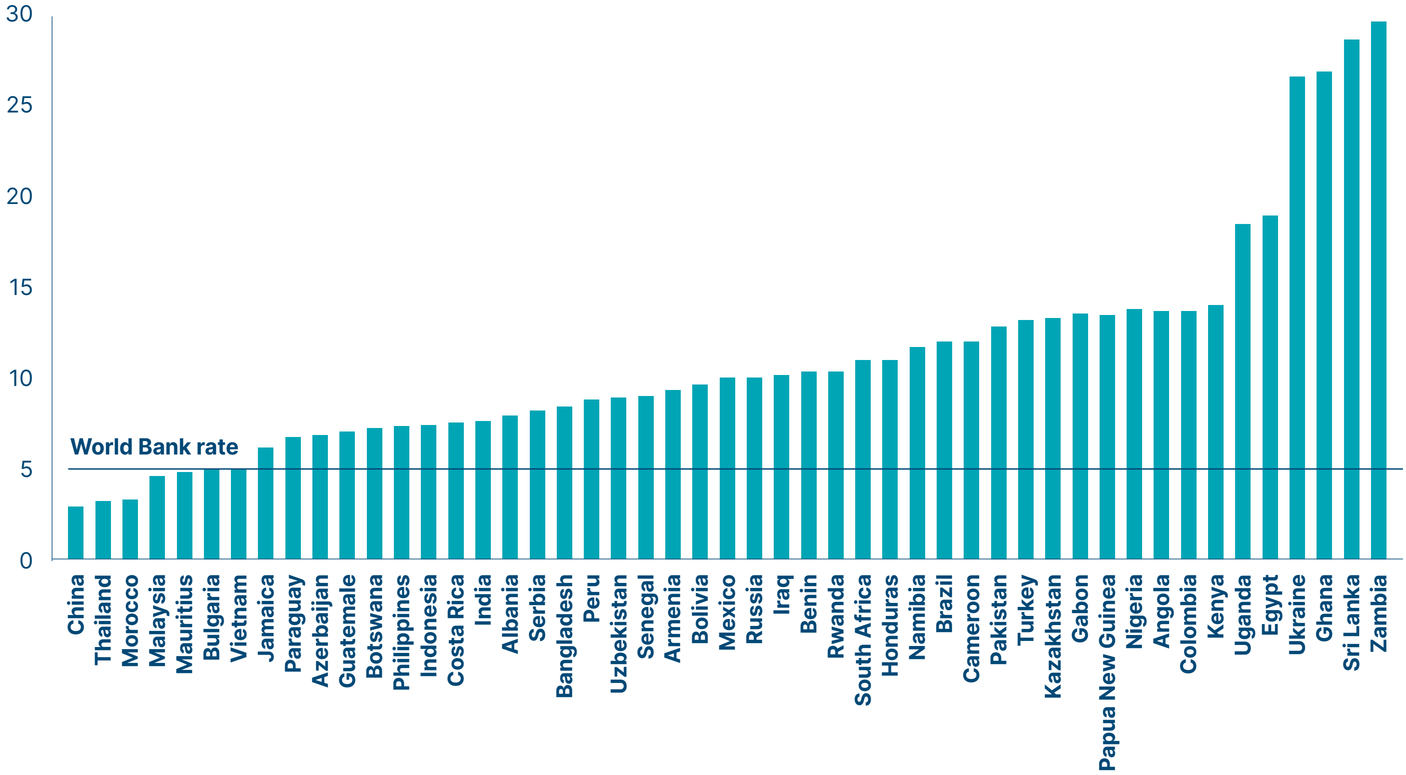
96 To date, no MBD has even had to call on its callable capital.

Exhibit 16

The World Bank's average lending rate is significantly lower than the market cost of borrowing for most lower income countries

10-year bond yields in low income countries

%



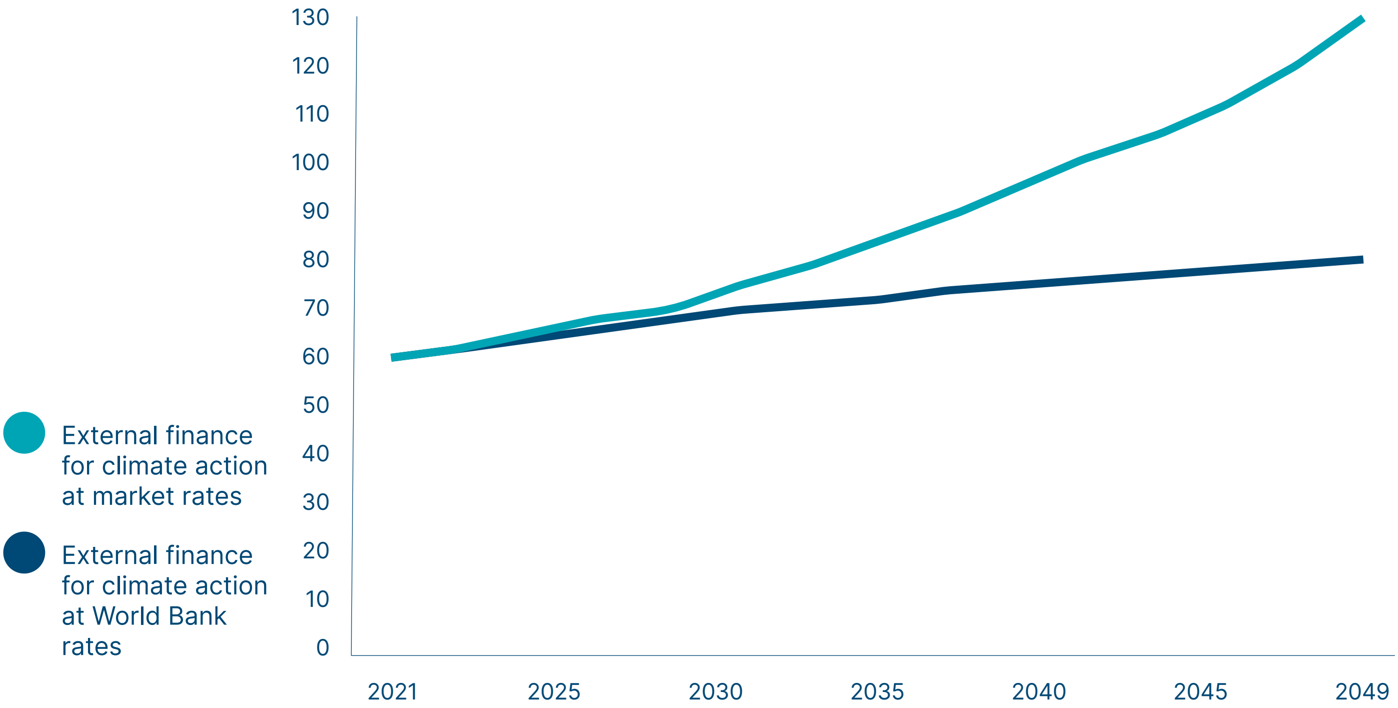
SOURCE: The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action.*

Exhibit 17

A significant scale up in external finance for climate action at market rates would lead to much higher debt to GDP ratios compared to World Bank rates

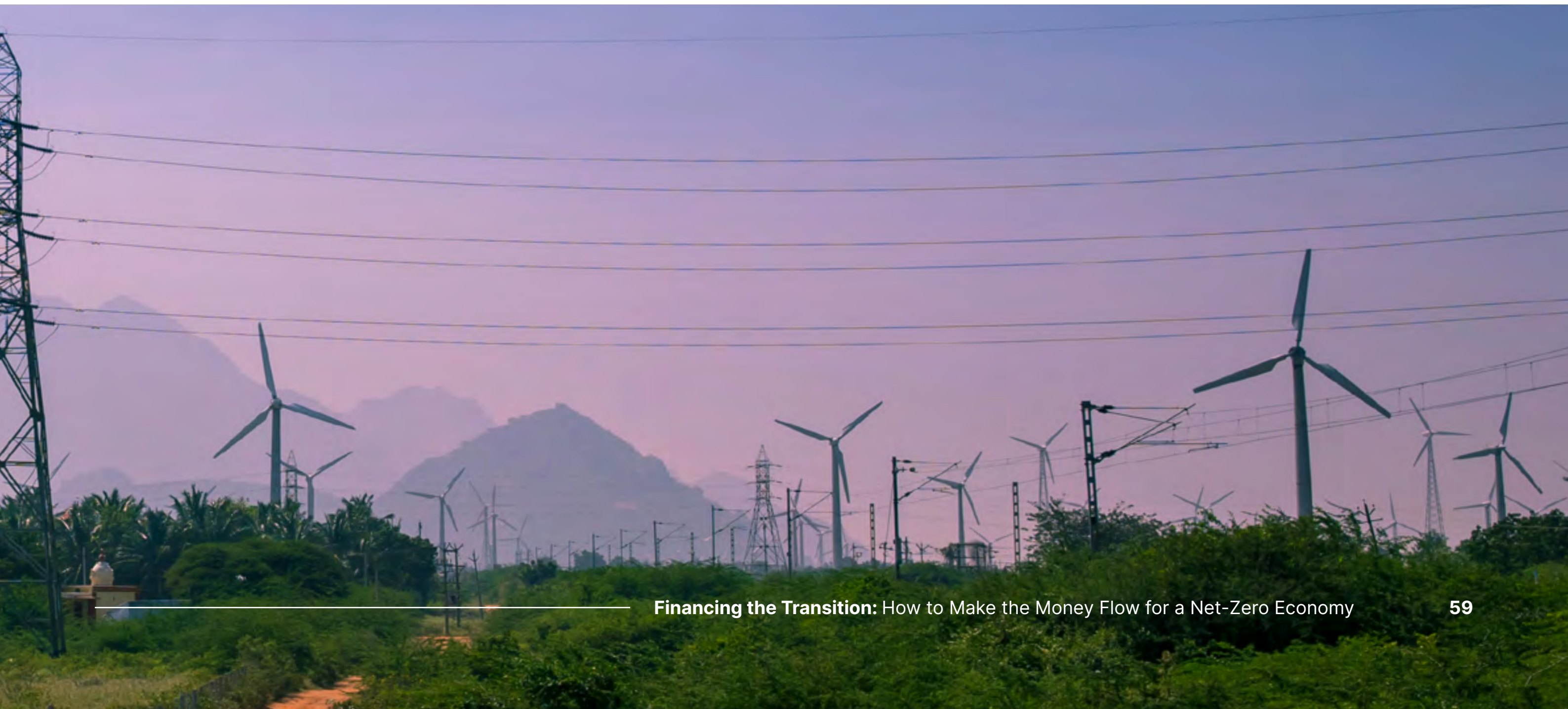
Average low income country debt projections from 2019-49

Debt to GDP ratio (%)



SOURCE: The Independent High-Level Expert Group on Climate Finance (2022), *Finance for Climate Action*.

NOTE: Illustrates the impact of the investment strategy advocated by the Independent High-Level Expert Group on Climate Finance at different rates. The Group's estimates of investment for the energy transition are closely aligned to the ETC's, but it also has broader focus, including loss and damage, adaptation and nature-based solutions.



Recommendations for MDBs

The rise in debt ratios shown on Exhibit 17 illustrates a potential constraint on the role of external debt finance (whether provided by MDBs or the private sector). It is therefore essential to create environments conducive as much as possible to both domestic finance mobilisation (as discussed in Section 1) and external equity finance (touched on in Sections 3 and 4 below). In some cases, restructuring or write-down of debt may also be required to make even existing debt burdens sustainable; this was raised at COP27 within the context of assisting countries deal with the loss and damage costs associated with climate change.

But a significant increase in MDB financial capacity is certainly required. Specific recommendations to modernise the development finance system – especially to unlock additional private capital – have been developed by many organisations over the past decade.[97] In 2022, MDB reform has become a public priority for the United States[98] (which is critical as it is the largest shareholder in the MDBs), the private sector,[99] and for the G20, which published a comprehensive paper on how to boost MDBs' investing capacity.[100] This and the following section summarise the key recommendations from this body of research.

In terms of expanding financial capacity, the potential levers for MDBs include:

- New capital subscriptions from shareholders to increase paid-in capital, and thus lending capacity, at any given leveraged level.
- Willingness to treat "callable capital" as available to support leverage and increased lending.[101]
- Accepting a higher leverage level, which may well be compatible with only marginally higher borrowing costs.

In addition, MDBs should:

- Increase the proportion of their lending which is directed to climate mitigation investments.
- Scale-up the targeted use of concessional funds and catalytic instruments (including grants and guarantees) to address financing barriers and increase the ratio of private finance which can be mobilised per $ of MDB lending.[102]

The precise mix of these different actions needs to be decided by MDB shareholders and management. But the crucial starting point is a commitment by MDB shareholders and management to play a greatly increased role in financing the energy transition in lower-income countries. Multiple reports have estimated the potential capital headroom in MDB balance sheets and the potential for more mobilisation of private capital.[103] Drawing on these, Exhibit 18 suggests a credible but ambitious scenario – conditional on the real economy policies and financial sector actions discussed in Chapter 2 and 3 being implemented – in which MDB lending to finance the energy transition increases from $25 billion to $140bn per annum[104], and in which the ratio of private capital mobilisation for each dollar of MDB lending rises from less than 0.5 to 2. In total, this would result in external finance to developing countries rising by $385bn. However, we note the challenges in maximising both the increase in MDB financing and private sector mobilisation, for example, due to the risk of conflicting incentives.

97 This includes the OECD, the Blended Finance Taskforce, the Centre for Global Development, the Overseas Development Institute, Convergence, the IMF, and various COP and UN High Level Expert Advisory Groups. For example, see ODI (2021), *Development Finance Institutions: the need for bold action to invest better*; Report of the G20 Eminent Persons Group on Global Financial Governance (2018), *Making the Global Financial System Work for All*; Centre for Global Development (2022), *Reforming the World Bank and MDBs to Meet Shared Global Challenges.*

98 See Remarks by Secretary of the Treasury Janet L. Yellen at the Centre for Global Development – October 6, 2022.

99 For example, see Larry Fink (2021), *Moving from Ambition to Action.*

100 An Independent Review of Multilateral Development Banks' Capital Adequacy Frameworks (2022), *Boosting MDB's Investing Capacity.*

101 ibid

102 IMF (2022), *Global Financial Stability Report October 2022 – Navigating the High-Inflation Environment.*

103 For example, Blended Finance Taskforce (2018), *Better Finance, Better World*; An Independent Review of Multilateral Development Banks' Capital Adequacy Frameworks (2022), *Boosting MDB's Investing Capacity*; Grantham Research Institute on Climate Change and the Environment and Brookings Institution (2022), *Financing a Big Investment Push in Emerging Markets and Developing Countries for Sustainable, Resilient and Inclusive Recovery and Growth.*

104 Estimates of how much MDBs could expand their lending by while maintaining a AAA credit rating are an average of those from: An Independent Review of Multilateral Development Banks' Capital Adequacy Frameworks (2022), *Boosting MDBs' investing capacity*; Nick Stern (2021), *Beyond the $100bn: financing a sustainable and resilient future*; S&P (2016), *How Much Can Multilateral Institutions Up The Ante?*; Rockefeller Foundation (2021), *Reimagining the Role of MDBs.*

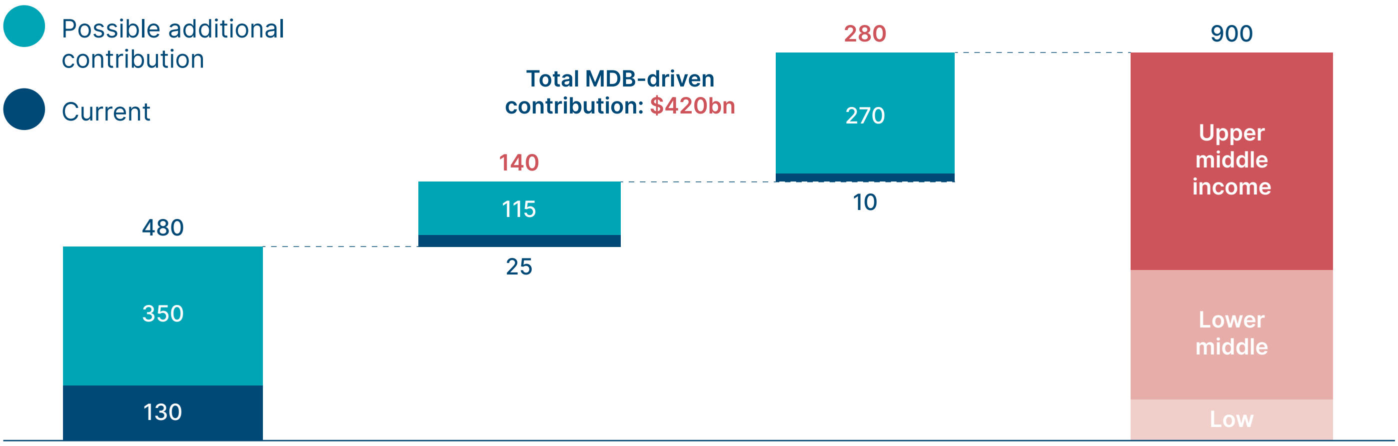
Exhibit 18

MDBs could realise half of the investment need through scaling up lending, policy and capacity building, and de-risking of private capital

Illustrative scenario for financing climate mitigation in middle and low income countries by 2030[1]

$ billion p.a.

ILLUSTRATIVE SCENARIO



Domestic public and private finance

At least half of the investment should come from:[2]

- Domestic savings + private finance driven by real economy policy + private finance actions
- Public finance

MDB lending

Increase in total MDB lending by $600bn (from $230bn)[3]:

- $350bn directed to climate
- Of which $275bn to low/middle income countries
- Of which $140bn to climate mitigation[4]

External private finance mobilised by MDBs

MDB policy and capacity support + de-risking mobilises at least $2 of private capital for every $1 of MDB capital

Annual investment need 2026-30

SOURCE: Systemiq analysis for the ETC (2023); Climate Policy Initiative (2021), *Global Landscape of Climate Finance 2021; Joint Report on MDB's Climate Finance 2020.*

NOTE: (1) Excludes China; (2) Estimates of current public and private investment cover regions dominated by middle and low income countries but likely overstate the true current amount invested as they do include some high income countries, but exclude China; (3) Literature review of estimates of feasible increases in MDB lending while maintaining a AAA rating; (4) Of total MDB finance, 50% used for climate, 2/3 directed to middle and low income countries, 50% used for mitigation (50% for adaptation).

Other external finance action beyond MDBs

MDBs are likely to play the biggest publicly sponsored role in the provision of the required increase in external finance. But additional resources can also be provided through country specific development financial institutions.

In addition, resources could be made available to national governments via greater availability of IMF Special Drawing Rights (SDR). These currently provide external finance to governments at an interest rate in line with risk-free short-term rates in the developed world.[105] This greater SDR availability could be achieved either via enhancement of mechanisms to redirect the existing underutilised SDRs of high-income countries, or via regular issues of new SDRs; this could be used either to support increased investment or to provide emergency liquidity to deal with climate change induced disasters in line with the proposals of the Bridgeton Initiative [Box 6].

105 IMF (2023), *Special Drawing Rights.*

Box 6

Special Drawing Rights and the Bridgetown Initiative

Additional resources could be made available to national governments in lower-income countries by increasing access to IMF Special Drawing Rights (SDRs), which enable governments to borrow money from the IMF at interest rates linked to short-term risk free rates in higher-income economies.

Allocations of SDRs are made in proportion to shareholder contributions into the IMF and as result the vast majority of SDRs are allocated to high-income countries. SDRs available for use by or in lower-income countries could therefore be increased by:

- Forms of "rechannelling" by which higher income countries make their SDRs available to middle/low-income countries. In response to the COVID-19 pandemic, for instance, the G20 countries committed to recycling $100bn of their SDRs through the IMF's Poverty Reduction and Growth Trust and the Resilience and Sustainability Trust. In addition, proposals have been made for high-income countries to channel their SDRs through MDBs and other multilateral climate funds.[106]

- The regular issue of new SDR tranches.

Innovative ways of using SDRs are among the proposals of the Bridgetown Initiative, developed by Barbadian PM, Mia Mottley, and her economic advisor, Avinash Persaud. This sets out a plan for wide-reaching financial reform of the international financial system to support lower-income countries.[107] It proposes measures to:

1. **Provide emergency liquidity** – in order to address the debt crisis, the initiative calls upon the IMF to return access to its unconditional rapid credit and financing facilities to pre-crisis levels, to temporarily suspend interest surcharges, and to re-channel at least $100bn of SDRs to low-income countries. In addition, all major issuers of debt should introduce clauses that temporarily suspend debt repayments in the aftermath of natural disasters.

2. **Expand MDB lending by $1trn** – the initiative recommends implementing all of the recommendations of the independent G20 Capital Adequacy Framework review to utilise capital headroom in MDBs. It also recommends increasing risk appetite, use of guarantees to mobilise more private capital, and to provide a mechanism for re-channelling the SDRs.

3. **Activate private sector savings for climate mitigation** – the initiative proposes a new issuance of $650bn SDRs into a new multilateral Climate Mitigation Fund, which can invest in low-carbon projects and mobilise private capital.

106 Centre for Global Development (2022), *How we can put SDRs to work in the fight against climate change – the MDB option.*
107 Ministry of Foreign Affairs and Foreign Trade (2022), *The 2022 Bridgetown Initiative.*

4.3 Creating the conditions for profitable MDB investment and increased private finance

In addition to making more MDB finance available at a reasonable cost of capital, it is important to ensure that this money can be invested in bankable projects within the context of clear national mitigation strategies. Crucially, private finance must be mobilised alongside MDB lending.

The fact that MDBs have equity shareholders who do not require a rate of return enables them to deploy skilled human resources to technical assistance and to project development and assessment on a scale unavailable to private financial institutions. This resource needs to be used for:

- **Policies:** Help countries develop energy transition strategies and supporting policies.
- **Pipeline:** Proactively develop bankable projects.
- **Private sector:** Work with the private sector to catalyse private finance, including in the form of blended finance.

National strategies and policies

To create a context within which investment can flow most effectively, governments need to build on their NDCs to define clear strategies for the energy transition, outlining the overall shape of power system and other capacity growth over time, and implementing policies (e.g., carbon pricing and regulation) which will ensure that zero-carbon investment is profitable.

MDBs are well-placed to provide policy advice, knowledge transfer and capacity building, for instance in relation to electricity market design and system operation. MDBs could effectively deliver this support through “country platforms” like the South Africa and Indonesia JET-Ps.

Developing bankable projects

Rather than waiting for bankable projects to be proposed to them, MDBs should be proactive in identifying which projects are likely to be profitable within national transition strategies and in shaping projects into specific investment propositions which can be financed either by themselves or by the private sector.

Catalysing private and blended finance

MDBs should see mobilising private financing through blended finance as an explicit key strategic objective, and should deploy both the human and balance sheet resources to achieve this. As described in several recent reports, this will require:

- Setting explicit and ambitious targets for private capital mobilisation, with changed internal incentive structures to reflect this priority.[108]
- Increase the use of a pooled portfolio approach, where multiple investments are bundled into a portfolio to mitigate risks, (alongside individual investments) which makes low-carbon investments in lower-income countries more accessible to institutional investors.[109]
- Expanding the use of catalytic instruments, including guarantees and first loss equity where a development finance institution agrees to bear the first losses in an investment in order to catalyse the participation of private investors who would otherwise not have invested.[110] Currently these account for only round 5% and 2% respectively of MDB climate financing.[111]
- Applying successful “country platform” models of coordinated development (e.g., the South Africa Just Energy Transition Partnership) across multiple countries. Such platforms can play an important role in clustering capital (from both the public and private sector), capabilities and expertise.
- Addressing high transaction costs in blended finance via product standardisation, asset pooling and information sharing across blended finance intermediaries.[112]

108 Blended Finance Taskforce (2018), *Better Finance Better World.*
109 ODI (2021), *Development Finance Institutions: the need for bold action to invest better.*
110 Blended Finance Taskforce (2018), *Blended Finance Taskforce calls to scale up the issuance of development guarantees.*
111 IMF (2022), *Global Financial Stability Report October 2022 – Navigating the High-Inflation Environment.*
112 Blended Finance Taskforce (2018), *Better Finance Better World.*

4.4 Private sector commitments and enhanced capability

If MDBs and other development finance institutions, together with national governments, take the actions described in Sections 1 to 3, this will in itself help unleash increased private finance.

But the scale of this effect will be magnified if major asset managers and banks actively seek to increase their role in financing the energy transition in middle and low-income countries. Net-zero and other climate change commitments, made by financial institutions which have global capability, should therefore describe how they will seek to increase their impact in lower-income countries.

Implementing such commitments in a profitable way will in turn require financial institutions to invest to better understand opportunities and risks. This will require developing the skills and in-country resources required to:

- Understand the scale and nature of the energy transition opportunity in different groups of lower-income economies.
- Actively develop project pipelines in specific chosen areas of technology or sector focus.
- Identify where they can profitably invest on a standalone basis and where they should build relationships with MDBs to help design and implement blended finance approaches.

One way financial institutions can develop such skills and country-specific expertise is by engaging with country platforms, such as the JET-Ps, and working with broader stakeholders to understand and support the transition in lower-income countries.

Financing concessional/grant payments

Chapter 1 set out that in addition to capital investment, there is a second distinct component to financing the transition – concessional/grant payments required to pay for decarbonisation activities which will not occur fast enough unless economic actors are compensated in some way.

Phasing out coal earlier than would naturally occur, ending deforestation and removing carbon dioxide from the atmosphere are critical to remaining on a 1.5°C pathway. As with capital investment, concerted and well-designed policy and regulatory action needs to lead the way in accelerating the competitiveness of renewables relative to coal, and reducing demand for products produced on deforested land.

But these policies are not being implemented fast enough. In their absence, finance can be an effective short-term lever to accelerate progress. Chapter 1 set out that if these three decarbonisation activities were to be achieved by financial mechanisms alone, at least $300bn could be required in 2030 in middle and low-income countries (although there is significant uncertainty on the exact amount required and the true cost is likely to be much higher without concerted action to end deforestation):

- Around $25-50bn to phase out coal early – these payments would then decline over time to 2040.
- At least $130bn to support an end to deforestation by 2030.
- Around $100bn a year to fund carbon dioxide removals from natural climate solutions – these payments would increase gradually to 2050.

Beyond 2030, payments for coal phase-out should decline rapidly, but might be required for a further 5-10 years in select instances where long-term purchasing agreements for coal power are in places. On the other hand, payments for carbon dioxide removals from natural climate solutions will scale up beyond 2030 and could reach around $200bn by 2050.

This chapter explores how these could be funded, presenting an illustrative financing strategy of how corporates, philanthropists and governments could achieve these three decarbonisation objectives through finance alone. The key conclusion from this chapter is that mobilising sufficient finance for these payments will be incredibly challenging, but the need to do so can be mitigated by concerted policy action.

5.1 Who pays and how?

The financing of concessional/grant payments will not be associated with any economic returns and must be largely borne by high-income countries. There are three ways in which these can be funded:

1. **Companies/financial institutions** could finance concessional/grant payments via the purchase of carbon credits in either:
   - *Voluntary markets* where companies have no legal obligations, but choose to purchase carbon credits (e.g., in line with net-zero strategies or to offset legacy emissions). In addition, where companies have value chains that involve direct involvement in land use (e.g., food and fibre-related companies) may be more likely to get directly involved in actions which drive removals rather than paying somebody else to do it.
   - *Compliance markets* where companies are obliged to purchase carbon credits in certain carbon markets such as the EU Emissions Trading Scheme (ETS), CORSIA or equivalent mechanisms. Today carbon dioxide removals are either excluded from these markets or very limited in scale. Over time, a greater role for removal credits should be introduced into these markets while maintaining pressure for rapid gross emission reductions.[113]
2. **Philanthropic finance is around $75bn per year, though just 2% of this is directed to climate mitigation.** More could be directed towards achieving climate mitigation objectives and specifically to concessional/grant payments, given the objective of philanthropic finance is to achieve social impact with no expectation of financial return.
3. **Intergovernmental transfers of climate-related funding.** Governments in high-income countries already make income transfers to lower-income countries in the form of overseas development assistance. This currently amounts to $160bn per annum, of which around 30% ($45bn) supported climate (mitigation and adaptation) objectives.[114] In addition, development financial institutions also provide around $30bn of bilateral climate finance.

113 Due to the complexity and time required to reform compliance carbon markets it is unlikely that credits for phasing out coal or ending deforestation would be linked into these markets, given that we suggest that any credits for limiting these activities would need to be time limited.
114 OECD – Climate Change: OECD DAC External Development Finance Statistics [Accessed December 2022].

- Provisions for intergovernmental transfers of funding towards emissions reductions have been established via Article 6 of the Paris Agreement, however, given that nearly all countries now have the ambition to reduce emissions to net-zero, any crediting of transfer payments should be in addition to the purchasing countries NDC as set out in the ETC's *Mind the Gap* report.[115]

The optimal financing strategy for phasing out coal, ending deforestation, and carbon dioxide removals will differ and require a different mix of these sources of finance.

Phasing out coal early

This report focuses on payments for coal power, where real economy policies are expected to be insufficient to phase out coal fast enough this decade. Our current working assumption is that significant concessional/grant payments will not be required for oil and gas as well-designed real economy policy can achieve a substantial reduction in the emissions associated with using these fuels. We will explore this hypothesis in our forthcoming report on *Fossil Fuels in Transition*.

In Chapter 1, we set out a tentative estimate that phasing out coal, where it remains competitive with renewables, could cost around $45-100bn a year to 2030, with payments declining to 2040, but note the uncertainty surrounding this.

Of this global sum, around $25-50bn per annum could occur in middle and low-income countries, excluding China, requiring a transfer of finance from the developed world. While there will be significant costs of phasing out coal in China, the finance can be sufficiently mobilised without international financial support.

Some of this early phase-out will occur without concessional finance or grants:

- Various mechanisms are being developed which seek to incentivise existing owners to phase out coal operations in return for finance to develop replacement low-carbon capacity.[116]

- And voluntary net-zero commitments, whether made by existing coal operators or by the investors and financial institutions which finance them, can motivate early action.

But it is clear that earlier than economic coal phaseout will not occur at scale globally without some degree of concessional/grant payments.

These payments will not solely be used to directly compensate coal plant owners, but rather can be used to unlock various financial solutions to deliver a managed phase-out that at the same time drives investment in clean energy. The suitability of such solutions will depend on factors such as coal plant types and ages, and the energy market structures in which they operate, requiring local tailoring to be effective. Solutions could include:[117]

- The provision of concessional finance to compensate asset owners for early retirement, for example, through auctions in which asset owners submit bids to government-run funds.

- The refinance of existing coal operator loans at lower rates of interest in return for commitments to phase out coal operations faster than previously planned; these refinancing terms can also be linked to investment in investments in renewables to replace coal assets.

- Direct one-off payments to buy out existing Power Purchase Agreement (PPA) contracts.

- Annual payments to cover the difference between the cost of new renewable generation and the marginal cost of running coal.

- Direct government-to-government development aid assistance to help manage adverse impacts, for example on employment.

- Payment models such as the Energy Transition Mechanism, currently being developed by the Asian Development Bank - described in Box 8.

The optimal way forward may be via mechanisms, such as country platforms like the South Africa JET-P, which combine different public and private funding streams and subsidised phase out in multiple self-reinforcing ways [Box 7]. These

115 ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*
116 For example, see RMI (2023) *Financing Mechanisms to Accelerate Managed Coal Power Phaseout.*
117 Forthcoming World Bank White Paper (2023), *Scaling up to Phase down: Financing Energy Transitions in the Power Sector.*

partnerships could also be more effective at allocating funding in an additional way (i.e. to coal asset owners who could not have otherwise retired their assets early), preventing risks of moral hazard. Rapid scale-up of mechanisms of this sort is now essential if coal use is to be phased out fast enough to limit global warming to 1.5°C.

Indeed, as the RMI concludes, the coal transition needs to be driven from both the bottom up and top down:[118]

- Asset-level locally developed and led solutions are important to drive early on-the-ground progress and pilot solutions to be scaled up.

- Country-level programmes are required to coordinate planning, financiers and financing, delivering system-wide phase-out.

Financial institutions, supported by guidance from GFANZ, need to develop consensus on credible financing mechanisms and understanding of the circumstances in which different approaches should be used (e.g., in certain market structures, remaining years of technical life). Standardisation of best practice approaches cam help to catalyse finance action, as it has with renewable energy financing.[119]

In addition, funding from corporates via carbon markets can be an important source of finance to accelerate coal phase-out this decade, as proposed by John Kerry at COP27.[120] As discussed in the ETC's *Mind the Gap* report, carbon markets can play a useful role in financing the early phase-out of coal (e.g., by bringing forward the closure of an existing coal plant to 2030 or earlier), provided:

- Company purchase of credits is in addition to strong internal action.

- The use of credits for coal phase-out is targeted towards coal plants which would not otherwise be retired early (i.e. the funding must deliver *additional* emission reductions).

- The use of credits is time limited.

Box 7

South Africa Just Energy Transition Partnership (JET-P)

At COP26 in 2021, a first-of-a-kind approach was launched to accelerate national decarbonisation efforts while ensuring a just transition. South Africa's Just Energy Transition Partnerships is a joint initiative between the governments of South Africa, France, Germany, the UK, the US, and the EU.

The JET-P aims to accelerate the decarbonisation of South Africa's energy sector, protect vulnerable workers and communities affected by the transition away from coal, and support new opportunities within a low-carbon economy (e.g., renewables).

The partnership aims to develop a country-led and country-specific investment plan, including policy reforms to build capacity and the enabling environment for investments. The JET-P brings public and private finance together to deploy different sources of finance and concessional funds in a coordinated and well-targeting way. An initial $8.5bn has been committed by participating governments but estimates suggest at least $250bn will be needed by 2050.

The ambition is for the JET-P to pave the way for further country platforms to be developed in a replicable approach, but with tailored investment and decarbonisation strategies. JET-Ps have since been agreed for Indonesia and Vietnam, with Senegal also being considered.

118 RMI (2022), *Unwrapping Coal in 2022: A look back at coal transition finance this year.*

119 GFANZ (2022), *The Managed Phaseout of High-emitting Assets.*

120 Climate Advisors (2022) *Estimating the Impact of the Energy Transition Accelerator.*

Box 8

Energy Transition Mechanism (ETM)

Developed by the Asian Development Bank (ADB), the ETM aims to combine concessional and market-based funds to accelerate the retirement of coal-fired power plants while at the same time mobilising capital to clean energy. Since COP26, the ADB has been piloting the public-private partnership in Indonesia and the Philippines, with the aim of scaling the solution across the Asia and Pacific region.[121]

The concept for the ETM is as follows:[122]

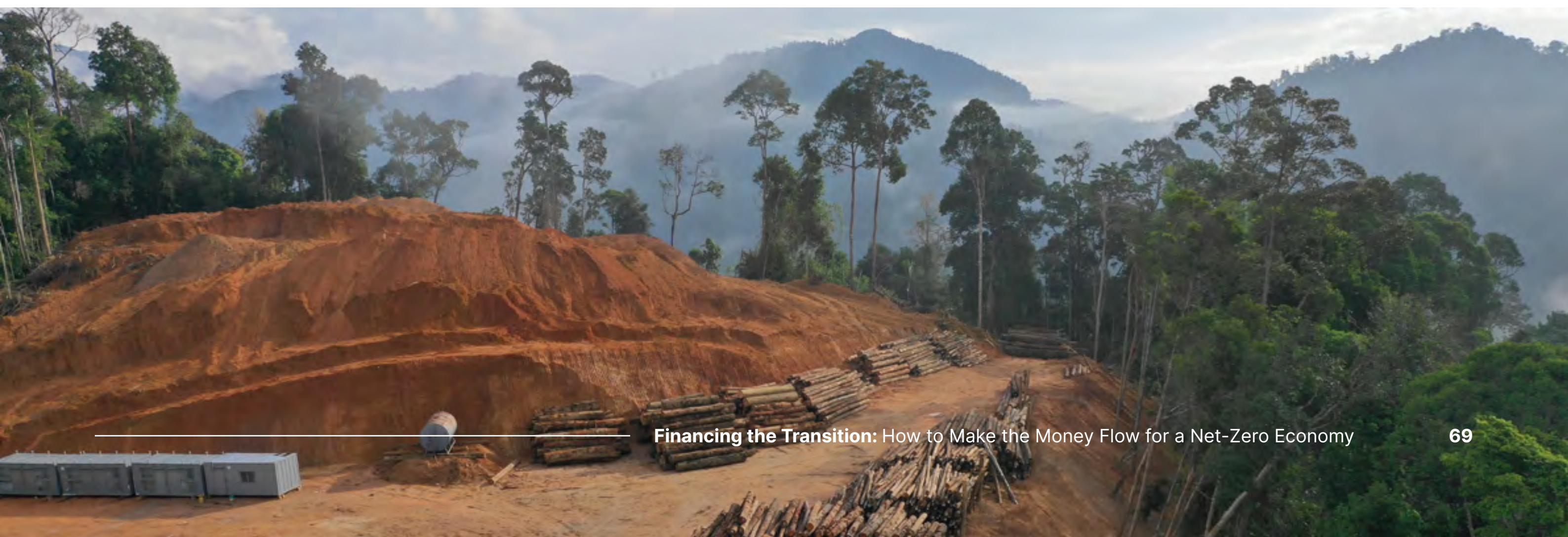
1. ETM is set up by government and is overseen by a multilateral bank.
2. Long-term investors (e.g., governments, MDBs, DFIs) invest in the ETM with a lower rate of return.
3. Coal asset owners transfer ownership of assets to ETM in return for capital, which must be used to invest in clean energy.
4. A Carbon Reduction Facility (CRF) owns the coal assets, operates them until the agreed decommissioned date, and uses profits to repay investors.
5. A Clean Energy Facility (CEF) provides finance, technology assistance and know-how to accelerate clean energy investments and supporting infrastructure.
6. Investors receive returns from both the CRF and CEF.

Progress and next steps: At the end of 2022, the ADB announced that the ETM has moved from a concept to an operational program, achieving several milestones including:[123]

- Signing of a memorandum of understanding at the G20 to explore the accelerated retirement of the first privately owned coal power plant under the ETM in Java, Indonesia.
- Launch of the Indonesia ETM Country Platform, led by the Government of Indonesia, to act as the central coordination platform of the partnership.
- Establishment of the ETM Partnership Trust which will provide concessional funding.

ADB recently completed a pre-feasibility study that included financial and technical analysis in three pilot countries—Indonesia, the Philippines, and Viet Nam—as well as regulatory and institutional assessments to validate the ETM concept. They have now launched a full feasibility study to conduct additional system-level analysis as well as detail the valuation of initial target coal plants, structure the country funds, and prepare the Southeast Asian regional partnership platform for a potential pilot program.

121 Asian Development Bank (2021), *Energy Transition Mechanism Explainer: How ETM Will Support Climate Action in Southeast Asia.*
122 World Economic Forum (2021), *How to accelerate the energy transition in developing economies.*
123 Asian Development Bank (2022), *ADB Energy Transition Mechanism Marks Significant Milestones.*



Ending deforestation

As set out in Chapter 1 and in more detail in *Financing the Transition: Supplementary report on the costs of avoiding deforestation*[124], the range of potential concessional/grant payments to end deforestation is extremely wide:

- The IPCC cost curve suggests that payments of about $130bn could be required perpetually to reduce deforestation-related emissions by around 4 $GtCO_2$ a year and much higher to stop deforestation entirely.
- And the estimated cost to fully protect the forest frontier by 2030 by offsetting the economic incentive to deforest is at the very least $130bn per annum from now to 2030, and potentially much higher to truly reflect the opportunity cost of cutting down forest for profit.

These estimates of required payments are hugely higher than the amounts currently flowing or promised:

- To date, governments and corporates of high-income countries have pledged $19.2bn to end deforestation but these commitments are spread over several years.
- Financing via REDD+ credits in voluntary carbon markets was around $500m in 2022, up from $50m in 2018, but with further growth facing important challenges (see the supplementary report on deforestation).[125]
- Total domestic and international mitigation finance for forests in recent years from all sources has been estimated at $2.3bn a year.[126]

The scale of payments required to offset the economic incentive to deforest is so large that they cannot be the sole, or even the primary means, to end deforestation. Deforestation will continue unless, in addition:

- Tropical forest countries are willing to ban or severely restrict deforestation without receiving payments equal to the economic opportunity foregone and are able to enforce these bans.
- Alternative business models are developed to derive significant employment and revenue from standing forests.
- Consumer demand for products directly sourced from deforested land is dramatically reduced. This requires changes in consumer and company behaviour informed by greater transparency, improved traceability and better labelling.
- Consumer demand for the products which drive deforestation, in particular animal meat, and especially beef, is significantly reduced. This might be achieved via consumer shifts to plant-based diets, plant-based meat alternatives or the development of synthetic meats.

But implementing[124] these actions will take time and their impact will likely be inadequate for many years. Some level of concessionary/grant payments to offset the incentive to deforest will therefore be essential.

We recommend that at least $130bn a year of finance could make an important contribution to avoiding deforestation. However, the scale of these payments raises the question of whether available money would be better spent in other ways than via concessional/grant payments e.g., directly supporting governments which are willing and able to impose deforestation bans. Regardless of their exact role, they will, however, need to play an important role this decade to avoid deforestation, as part of a suite of actions, while more fundamental policy changes can be put in place. This is explored in more detail in our *Supplementary report on the costs of avoiding deforestation*.

Carbon dioxide removals

As set out in the ETC's *Mind the Gap* report, at least 70-225 $GtCO_2$ of cumulative removals between now and 2050 could be required to neutralize the impact of the likely carbon budget overshoot ahead of mid-century. Companies and financial institutions could play a significant role in financing carbon dioxide removals, but governments will also have to play a very major role.[127]

Companies – Currently, compliance markets cover just 10% of total global emissions and purchases of removal credits in voluntary carbon markets are equal to only 0.1%, of which only a small share is funding actual removals. Several actions can and should be undertaken to increase volumes in these markets, as set out in the ETC's *Mind the Gap*. But even with very ambitious assumptions, private purchases alone will be insufficient.

124 ETC (2023), *Financing the Transition: Supplementary Report on the Costs of Avoiding Deforestation.*
125 Trove Research (2022), *Voluntary carbon Market 2022 in Review.*
126 Forest Declaration Assessment (2022), *Are we on track for 2030?*
127 ETC (2022), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation.*

Governments – Even when companies are making the payments, governments will play a crucial role in setting the rules and motivations. For example:

- Setting the rules for compliance markets – including the types of sectors and companies that are obliged to purchase credits, the total quantities of credits and whether or not removals are allowed (and whether these removals need to occur within the geographic coverage of the scheme).
- Creating reporting requirements for companies and other forms of encouragement which stimulate voluntary markets.
- Applying regulations to supply chains could encourage/force major companies to take direct actions: for example, changes to agricultural policy could have an impact on forest management, or soil carbon sequestration.

But governments can also be buyers of removals themselves in a number of ways, internationally and/or domestically:

- **Internationally:** this could be within the context of the carbon trading arrangements being established under Article 6 of the Paris Agreement. However, as set out in the ETC's *Mind the Gap* report any use of credits to meet domestic targets should be very limited. Governments can and should simply make payments to support removals without any implications for the domestic carbon account and may wish to do so for good reasons including accounting for historical emissions, so-called consumption emissions or as a means to accelerate the global transition to net-zero.
- **Domestically:** Governments could also make payments or directly fund projects to deliver removals within their own country.

Section 5.2 considers how funding from these, and other sources can be scaled up to 2030.

5.2 Achieving adequate concessional/grant payments in middle and low-income countries

If these critical emission reductions and removals were to be achieved through financial mechanisms alone, financing at least $300bn a year of concessional/grant payments in middle and low-income countries by 2030 would require action from corporates, philanthropy, and governments.

An illustrative scenario is set out in Exhibit 19:

1. The participation of **corporates in voluntary carbon markets** should be maximised. Estimates suggest this could reach 1–1.7 Gt of emissions by 2030.[128] At an average cost of $45-50/tCO$_2$, this could raise $45-80bn for these payments. Other estimates suggest participation could be even higher, raising up to $190bn per year by 2030.[129]
2. More action from **philanthropists** within climate should be mobilised. If 10% (up from 2% currently) of global philanthropic finance could be devoted to climate mitigation, around $75bn could be raised.[130]
3. In coal close-down in particular, there is an opportunity for **hybrid payment and investment instruments** which seek simultaneously to close down high-carbon assets and investing in new lower-carbon assets.[131]

- **However, despite these, intergovernmental transfers of climate related funding** must be significantly scaled up to fill any gap in funding, in particular to finance avoided deforestation and carbon dioxide removals. As an example, if high-income countries met the UN's target for official development assistance (ODA) at 0.7% of gross national income (GNI), devoted half of this to climate-related objectives, and three-quarters of this amount to climate mitigation, this would deliver $200bn per annum.[132] Given the need for all countries to reduce emissions to net-zero by mid-century, these payments must deliver emissions reductions in addition to those to which the purchasing country is already committed to meet its NDC, rather than being presented as a means to deliver the NDC.[133]

128 BNEF (2022), *Long-term Carbon Offsets Outlook*.
129 FOLU (2022), *Prosperous land, prosperous people: a story of scaling finance for nature-based solutions in Kenya*.
130 Climate Works Foundation (2021), *Funding Trends 2021: Climate Change Mitigation Philanthropy*.
131 See, for example, Asian Development Bank (2021), *Energy Transition Mechanism*.
132 The remaining 25% is assumed for climate adaptation, noting that around 25% of current climate-focused ODA has both a climate mitigation and adaptation objective.
133 ETC (2022) *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation*.

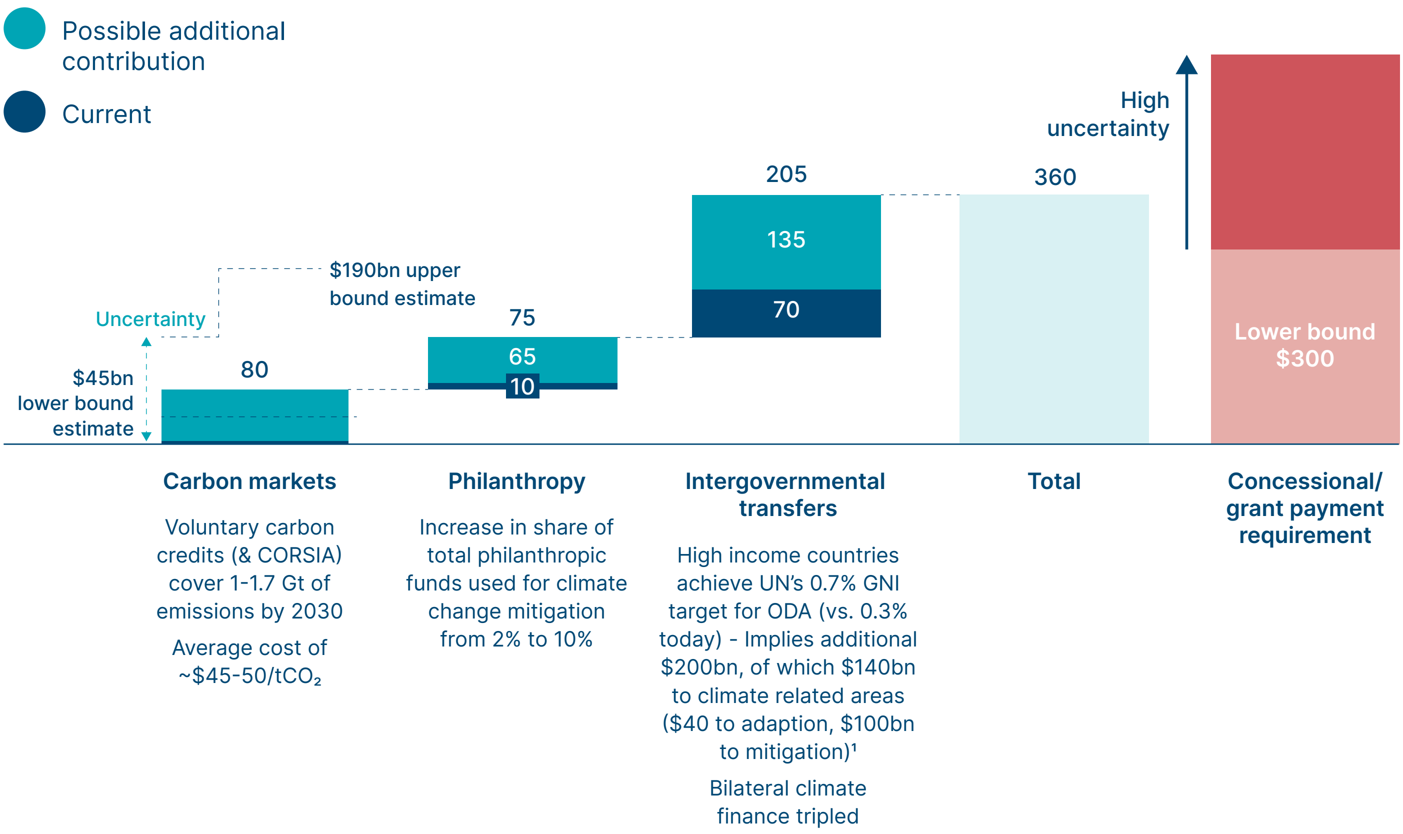
Exhibit 19

Three key sources of finance to scale concessional/grant payments to prevent deforestation, phase out coal power early, and scale carbon removals

Illustrative scenario for financing concessional/grant payments in middle and low income countries by 2030

$ billion p.a.

ILLUSTRATIVE SCENARIO



SOURCE: Systemiq analysis for the ETC (2023); ETC (2022), *Mind the Gap*; Bhattacharya, A. and Stern, N. (2021), *Beyond the $100bn*; OECD (2021), *ODA Data and Trends*; Climateworks Global Intelligence (2021), *Climate change mitigation philanthropy*; BNEF (2022), *Long-term carbon offsets outlook*; FOLU (2022), *Prosperous land, prosperous people: a story of scaling finance for nature-based solutions in Kenya*.

NOTE: (1) 50% of total Official Development Assistance (ODA) to climate related projects, and 75% to climate mitigation; (2) Current voluntary carbon market funding is estimated at ~$1bn.

The challenges of maximising each of these contributions – especially of intergovernmental transfers in today's current economic and political climate – further underscores the critical importance of policy and regulatory action to ensure that financial mechanisms are a backstop solution.

Any financing strategy of concessional/grant payments must be accompanied by concerted policy action which:

- Reduces demand for products produced on deforested land, namely incentivising shifts to plant-based diets and including a focus on developing and reducing the cost of plant-based meat alternatives.
- Increases the pace at which coal becomes uncompetitive compared to renewables, namely by removing fossil fuel subsidies and appropriate power market design (e.g., long-term contracts for difference).
- Supports deep economy-wide decarbonisation which reduces the likelihood of a carbon budget overshoot and the need for carbon dioxide removals.

In the absence of significant finance and associated policy interventions, progress in these key emitting areas may be limited, ultimately challenging the feasibility of the world's agreed climate objectives.

Chapter 6

Critical actions needed in the 2020s

Energy Transitions Commission

FINANCING THE TRANSITION IN THE 2020s

2030 TARGETS

CAPITAL INVESTMENT — **$3 trillion** a year by 2030 globally, including:

- **$2000bn Power**: 1.5x increase in global electricity use; Wind and solar ~40% global generation; Scaling storage and flexibility deployment
- **$550bn Buildings**: Heating increasingly electrified; Building retrofits significantly under way
- **$200bn Transport**: EVs near 100% of new car sales in high income countries, 50%+ in lower income countries

CONCESSIONAL/ GRANT PAYMENTS — **>$300 billion** a year by 2030 in middle and low income countries, including:

- **$25-50bn Early coal phase out**: 2 $GtCO_2$ avoided p.a. by 2030
- **>$130bn End deforestation**: 4.6 $GtCO_2$ avoided p.a. by 2030
- **$100bn Natural climate CDR solutions**: 3.6 $GtCO_2$ avoided p.a. by 2030

Critical priorities to scale up capital investment

EIGHT ACTIONS FOR THE 2020s

REQUIRED IN ALL COUNTRIES

Critical action

1. **Well designed real economy policy**
   - Establish a clear strategic vision
   - Reduce downside risks
   - Bridge green premiums
   - Remove supply-side bottlenecks
2. **Targeted role for public finance**
   - Residential building retrofits
   - First of a kind technologies
   - Scale up key infrastructure
3. **Net-zero commitments of financial institutions**
   - Targets for the net-zero transition (e.g. investment ratios)
   - Innovation in financial products
   - Investment strategies in key sectors + lower income countries
4. **Supporting role for financial regulators**
   - Disclosure of climate risks and strategies
   - Management of climate risks

REQUIRED IN MIDDLE AND LOW INCOME COUNTRIES

5. **Increased mobilisation of domestic savings**
   - Improve tax collection + reduce fossil fuel subsidies
   - Growth of local currency capital markets
   - Financing from retained earnings
6. **Significant scale up in Multilateral Development Banks (MDBs) and external finance**
   - Expand financial capacity
   - Targeted use of catalytic instruments
   - Increase share of lending to climate mitigation
7. **Expanded role for MDBs**
   - Help countries develop supporting policies
   - Proactively develop bankable projects
   - Mobilise private finance
8. **Private sector commitments**
   - Develop relationships with MDBs
   - Understand scale of opportunities + develop project pipelines

ACTORS

Leading actors / Supporting actors

Action	POLICY-MAKERS/ REGULATORS	PRIVATE SECTOR	FINANCIAL INSTITUTIONS	DEVELOPMENT FINANCE INSTITUTIONS (e.g. MBDs)
1	Leading			Supporting
2	Leading			
3		Supporting	Leading	
4	Leading		Supporting	
5	Leading	Supporting	Supporting	Supporting
6	Supporting			Leading
7	Supporting			Leading
8		Supporting	Leading	

This chapter suggests plausible targets for scaling low-carbon finance by 2030, and actions that must be undertaken in order to achieve this.

6.1 The scale of the challenge to 2030

Achieving a global net-zero economy fast enough to avoid severely harmful climate change will require two conceptionally-distinct forms of financial flow:

- Capital investment in the low-carbon assets and technologies required for the energy transition and which are increasingly offering attractive and bankable opportunities for investors.

- Concessional/grant payments to accelerate action in stopping the most harmful activities (e.g., burning coal for power generation, and deforestation), which would not occur fast enough unless economic actors are compensated in some way. Additionally, these payments will be required to scale carbon dioxide removals and to support a just transition.

Capital investment – the global investment opportunity:

- Low-carbon investment was around $800–1,200bn in 2021. Investment will need to double by 2025 ($2trn per year) and triple by 2030 ($3trn per year). Within this:

  - Almost 70% of the investment needed ($2trn per year) is in the power sector to develop zero-carbon power generation capacity, extend and upgrade transition and distribution networks, and build storage capacity – this investment will underpin decarbonisation in almost every other sector.

  - A further 15%, or $550bn each year needs to be focused in the buildings sector, retrofitting buildings to improve insulation and energy efficiency and decarbonising heating.

  - The remaining 15% will be needed to decarbonise the transport and hard to abate industrial sectors and develop the hydrogen sector.

- Investment in middle and low-income countries (excl. China) should increase four-fold, to $900bn per year by 2030. This could be achieved through:

  - 2-3 times increase in domestic private and public finance.

  - At least a 10-fold increase in MDB lending and external private finance mobilised by MDBs.

- Investment in high-income countries and China will need to double by 2030.

Concessional/grant payments – accelerating decarbonisation efforts:

- In the absence of concerted policy action, these payments could average *at least* $0.3trn a year in middle and low-income countries, increasing from less than $20bn today:

  - Around $25–50bn to phase out coal early – these payments would then decline over time to 2040.

  - At least $130bn to end deforestation by 2030.

  - Around $100bn a year to fund carbon dioxide removals from natural climate solutions – these payments would increase gradually to 2050.

In addition to concessional/grant payments in middle and low-income countries, there will also be a need for similar levels of funding and/or investment to:

- Phase out coal in China, which could cost around $20–50bn a year over the next 10-15 years, though given China's relative wealth it is not suggested that these payments are from external concessional/grant funding.

- Scale carbon dioxide removals from engineered and hybrid solutions (e.g., direct air capture), which could require payments of around $50bn by 2030, increasing to many multiples of this by mid-century as these technologies are scaled up and used to avoid any overshoot of a 1.5°C carbon budget.

6.2 Actions needed to scale up capital investment

Exhibit 20

There are 8 critical priorities for the 2020s to scale up capital investment

Actions required in all countries

1. **Well-designed real economy policy action which unleashes investment**
   Critical action
2. **Targeted role for public finance where there are material barriers to finance**
3. **Net-zero commitments of financial institutions to accelerate capital reallocation**
4. **Supporting role for financial regulation to drive informed and efficient capital reallocation**

Additional actions required in middle and low income countries

5. **Increased mobilisation of domestic savings and private financial flows**
6. **Significant scale up in MDB and other external finance**
7. **Expanded role for MDBs and national governments in creating the conditions for profitable investments**
8. **Private sector commitments and enhanced capability to invest in lower income countries**

① Well-designed real economy policy which unleashes investment

●◕ Key responsible actors
◑◔ Supporting actor
○ NA

Policymakers/ regulators	Private sector	Financial institutions	International financial institutions (e.g. MDBs)
●	◑	◑	◑

Policymakers and regulations must lead the way in directing action and creating incentives for the non-financial sector to invest through well-designed real economy policy. Done well, this can unleash private sector investment, achieved through:

a. **Establishing a clear strategic vision** to offer certainty to investors – clear medium-term targets, ambitious standards and regulations (e.g., a ban on the sales of ICE vehicles by 2035).

b. **Addressing the green premium challenge** through carbon pricing, contracts for difference, quantitative mandates, direct consumer subsidies, and public procurement which creates demand for low-carbon alternatives.

c. **Reducing downside risks** by de-risking investment in early stage technologies, implementing credible and consistent policymaking, and strategic planning.

d. **Removing supply side bottlenecks** to the pace of transition – streamlining planning and permitting, prioritising infrastructure development (e.g., grid expansion, EV charging, hydrogen and CO_2 networks), supporting supply chain development, especially for critical raw materials.

Developing the suite of policies requires a strong dialogue between policymakers and the private sector and financial institutions to provide policymakers with a rich understanding of the business case and barriers for investment. In middle and low-income countries, development finance institutions (e.g., the MDBs) must play an important role in providing technical assistance and policy support to policymakers in developing the real economy policies which will create a strong pipeline of bankable investments.

② Targeted role for public finance where there are material barriers to finance

Policymakers/ regulators	Private sector	Financial institutions	International financial institutions (e.g. MDBs)
●	◔	◔	○

In some cases, even with well-designed real economy policy, investments in certain sectors will face additional barriers to sufficient finance being mobilised. In these cases, public finance should play a critical role to supplement or to ensure adequate private finance. The three priorities for public finance support are:

- **Residential building retrofits:** financing barriers include the high upfront costs required for households and large differences in the cost of capital faced by households of different economic circumstances. Public finance can overcome these barriers through:

  → Targeted financial support to households (e.g., low-cost loans or grants to low-income households).

→ Public investment banks which can effectively pool investments (e.g., on a local basis) to overcome high transaction costs and de-risk investments for low-cost households.

- **First-of-a-kind technologies and business models:** financing barriers exist due to the high risks and uncertainties of unproven low-carbon solutions (e.g., low-carbon steel plants, sustainable aviation fuel). Public finance can incentivise investments through:

  → Sector-specific loans and tax incentives.

  → Public investment banks developing strategies for investing in new technologies and sectors and deploying de-risking mechanisms (e.g., guarantees, offtake agreements, contracts for difference).

- **Scale up of key infrastructure:** financing is held back by the 'chicken and egg' situation of investment in low-carbon assets depending on sufficient infrastructure being in place, but investment in such infrastructure requires certainty of, and sufficient, demand. Public finance can accelerate the roll-out of infrastructure through:

  → Direct public financing of key infrastructure, or via public investment banks which also mobilise private finance.

  → Sector-specific loans and tax incentives.

Additional public support may be required where large shared infrastructure has few initial users to ensure these early users face the average asset opex cost over its lifetime.

3 Net-zero commitments of financial institutions to accelerate capital reallocation

Policymakers/ regulators	Private sector	Financial institutions	International financial institutions (e.g. MDBs)
○	◔	●	○

Many financial institutions are now making commitments to align their capital allocation with pathways to net-zero emissions. These voluntary commitments cannot replace the need for strong public policy, but they can play a useful ancillary role in driving an allocation of capital favourable to the energy transition if they deliver these interdependent objectives:

- An end to investment in activities which are incompatible with achieving the required energy transition (e.g., new coal mines or power plants).
- Increased investment in the technologies and assets required to deliver a prosperous net-zero economy – this in turn will drive a fall in demand in fossil fuel use and support reduced investment in fossil fuel supply (as per the next point).
- A gradual reduction of high-carbon investments (e.g., oil and gas production or use), in line with feasible and necessary declines in demand.

Key actions from financial institutions to make these net-zero commitments as effective as possible:

- Develop net-zero transition plans, in line with guidance from GFANZ, including detail on implementation strategy, engagement strategy, and governance.
- Develop a suite of metrics and targets to drive transition planning and assess progress, including financed emissions and the balance between investments in new clean technologies and fossil fuels
- Identify what role they will play in financing the huge scale of investment in zero-carbon power capacity.

- Set out clearly their approach to the funding of building construction and retrofits, including innovation in financial products (e.g., mortgage top-ups to pay for energy efficiency improvements).
- Identify how to support decarbonisation efforts in lower income countries, whether through financing new capital investment or through engagement in plans to phase out existing coal plants.

The private sector should engage with financial institutions to support the translation of their net-zero transition plans into new investment and phase-out strategies.

While useful supporting actions, these should be in addition to making sure that real economy policy is well-designed and leads the way in mobilising capital for the transition.

4 Supporting role for financial regulation to drive informed and efficient capital reallocation

Policymakers/ regulators	Private sector	Financial institutions	International financial institutions (e.g. MDBs)
●	○	◐	○

Financial regulation should support and encourage action by private financial institutions to reallocate capital to achieve the energy transition. This should entail:

- Ensuring transparent disclosure of climate risks and strategies through financial disclosures.
- Ensuring that financial institutions assess and manage climate-related risks through scenario analysis and stress tests.

⑤ Increased mobilisation of domestic savings and private financial flows

Around half of the financing need in middle and low income countries must come from domestic savings, mobilised by national governments, by national development banks, or by the domestic private sector. Achieving this domestic resource mobilisation requires action along several dimensions:

- National governments can improve tax collection and reduce fossil fuel subsidies, which increases fiscal resources.
- National governments and regulators can introduce carbon taxes or strong regulation which improves incentives for private investment.
- MDBs can play a role in fostering the growth of local currency capital markets.[134]
- And in some countries, such as India, large domestic companies which operate on a global scale, will play a major role in financing investment out of their retained earnings or from borrowings in local or global capital markets.

⑥ Significant scale up in MDB and other external finance

Increasing the lending capacity of the MDBs is neither the only action required, nor sufficient in itself to unleash the investment needed. But increased MDB financing is undoubtedly a necessary and vitally important part of what needs to happen.

MDBs can mobilise credit at a lower cost than the private sector – this lower cost of capital is vital to make zero-carbon projects economic versus fossil fuel projects and to prevent a build-up of unsustainable debt levels.

The precise mix of different actions needs to be decided by MDB shareholders (e.g., Finance Ministers and management), but should include:

- Exploring different levers to expanding financial capacity, including new capital subscriptions and treating "callable capital" as available to support leverage.
- Increasing the proportion of their lending which is directed to climate mitigation investments.
- Scaling-up the targeted use of concessional funds and catalytic instruments (including grants and guarantees) to address financing barriers and increase the ratio of private finance which can be mobilised per $ of MDB lending.

The crucial starting point is a commitment by MDB shareholders and management to play a greatly increased role in financing the energy transition in lower income countries.

In addition, resources could be made available to national governments via greater availability of IMF Special Drawing Rights, which provide external finance to governments at an interest rate in line with risk-free short-term rates in the developed world. Policymakers in both higher and income countries, in conjunction with the MDBs, should develop strategies and mechanisms for such reallocations.

⑦ Expanded role for MDBs and national governments in creating the conditions for profitable investments

In addition to making more MDB finance available at a reasonable cost of capital, it is important to ensure that this money

134 For example, the European Bank for Reconstruction and Development's work to develop mechanisms for local currency lending in Uzbekistan to strengthen the private sector's role in the economy. See EBRD (2018) *Uzbekistan Country Strategy 2018-23.*

can be invested in bankable projects within the context of clear national mitigation strategies and that private finance is mobilised alongside MDB lending.

The provision of technical assistance and project development and assessment by MDBs needs to be expanded:

- **Policies:** Help countries develop energy transition strategies and supporting policies.
- **Pipeline:** Proactively develop bankable projects.
- **Private sector:** Work with the private sector to catalyse private finance, including in the form of blended finance.

8 Private sector commitments and enhanced capability to invest in lower income countries

Private sector asset managers and banks should actively seek to increase their role in financing the energy transition in middle and low income countries. Investing in such countries will require financial institutions to invest in better understanding the opportunities and risks.

This will require developing the skills and in country resources required to:

- Understand the scale and nature of the energy transition opportunity in different groups of lower income economies.
- Actively develop project pipelines in specific chosen areas of technology or sector focus.
- Identify where they can profitably invest on a standalone basis and where they should build relationships with MDBs to help design and implement blended finance approaches.

One way financial institutions can develop such skills and country-specific expertise is by engaging with country platforms, such as the JETPs, and working with broader stakeholders to understand and support the transition in lower income countries.

Exhibit 21

There are 5 critical priorities for the 2020s to scale up concessional/grant payments

1

Well-designed real economy policy action which:

Accelerates pace at which coal is uncompetitive with renewables

Reduces short-term incentives to deforest

Reduces need for carbon dioxide removals

Critical action

2

Development of innovative funding mechanisms to accelerate progress and mobilise private finance, for example through country platforms

For the additional concessional/grant payments that are required...

3

Maximise participation of corporates in voluntary carbon markets + standards and regulations to improve quality and additionality of credits

4

Maximise finance from philanthropists to fund concessional/grant payments

5

Scale up intergovernmental transfers of concessional/grant payments

6.3 Actions needed to fund concessional/grant payments to stop the most harmful activities

Phasing out coal earlier than would naturally occur, ending deforestation and removing carbon dioxide from the atmosphere are critical to remaining on a 1.5°C pathway. But the policies and actions set out are not being implemented fast enough. In their absence, concessional/grant payments can be an effective short-term lever to accelerate progress.

If these three decarbonisation activities were to be achieved by financial mechanisms alone, at least $300bn could be required every year to 2030 in middle and low income countries.

1 Well-designed real economy policy action which reduces the need for concessional/grant payments as a solution

Policymakers/ regulators	Real economy ' actors	Financial institutions	International Financial institutions (e.g. MDBs)

Policymakers must step up action to design and implement well-designed policies which tackle the most harmful activities. The ETC's *Degree of Urgency* report details the critical policies required this decade to keep 1.5°C on the table, including those required to:

- Accelerate the pace at which coal becomes uncompetitive with renewables, for example through appropriate power market design (e.g., contracts for difference) and removing fossil fuel subsidies.
- Reduce short-term incentives to deforest, for example through incentivising behaviour change towards plant-based diets and investment in synthetic meat alternatives, and increases the value of standing forests, combined with government action to make deforestation illegal and effective enforcement.
- Reduce the need for carbon dioxide removals by accelerating the pace of economy-wide decarbonisation, which reduces the likelihood of a carbon budget overshoot by mid-century.

With concerted policy action, the private sector will mobilise finance to address the most harmful activities, reducing the need for concessional/grant payments to fill the gaps. Concessional/grant payments, which will draw on scarce pools of public and private funds, should be targeted towards cases where they can deliver *additional* impact (e.g., the coal plant would not have been retired early without payments).

2 Development of innovative funding mechanisms to accelerate progress and mobilise private finance, for example through country platforms

Policymakers/ regulators	Real economy ' actors	Financial institutions	International Financial institutions (e.g. MDBs)

In addition to policy, there are two other forces that are incentivising the private sector to phase out coal early without the need for concessional/grant payments:

- Voluntary net-zero commitments, whether made by existing coal operators or by the investors and financial institutions which finance them, can motivate early action – as discussed in Section 6.2.
- Various mechanisms are being developed which seek to incentivise existing owners to phase out coal operations in return for finance to develop replacement low carbon capacity.

These mechanisms can deploy concessional/grant payments in the most effective and targeted way, mobilising private finance and at the same time delivering a coordinated push for capital investment in renewables. Country platforms, such as the South African Just Energy Transition Partnership, are now a proven concept, with further deals agreed for Indonesia and Vietnam.

Key actions required include:

- As more JET-Ps are launched, MDBs are uniquely positioned to lead the development of these country platforms and should define their role in scaling up such partnerships in other countries.
- Policymakers in high income countries should maintain momentum, commitment and engagement for such partnerships, in addition to financial commitments.
- Policymakers in key middle/low income countries should develop clear plans and assessments of financial needs which can be translated into similar partnerships.
- Financial institutions and coal plant owners need to develop consensus on credible financing mechanisms and drive a standardisation of best practice approaches.

For the additional concessional/grant payments that are required...

3 **Maximise participation of corporates in voluntary carbon markets, with credits focused on removals not reductions** – estimates suggest this could reach 1–1.7 Gt of emissions by 2030.[135] At an average cost of $45-50/ tCO_2, this could raise $45-80bn for these payments. Other estimates suggest participation could be even higher, raising up to $190bn per year by 2030.

4 **Maximise finance from philanthropists to fund concessional/grant payments** – If 10% (up from 2% currently) of philanthropic finance could be devoted to climate mitigation, around $75bn could be raised.[136]

5 **Scale up intergovernmental transfers of concessional/grant payments** – to fill any gap in funding, in particular to finance avoided deforestation and carbon dioxide removals. As an example, if high income countries met the UN's target of international aid at 0.7% of GNI and devoted half of this to climate-focused areas, this could realise around $200bn of finance for these payments.

135 BNEF (2022), *Long-term Carbon Offsets Outlook 2022.*
136 FOLU (2022), *Prosperous land, prosperous people: a story of scaling finance for nature-based solutions in Kenya.*

Annex 1:

Sector investment estimates

This Annex sets out estimates of investment needed by sector, on average over the next 30 years, and indicates the likely profile of annual investments over time. For each sector we also comment briefly on the current economics of investment in low carbon technology and the key policies required to support adequate early investment. The table below summarises the sources of our approach and data.

Exhibit 22

Summary of sources for investment estimates

Type	Sources
Power generation	Systemiq analysis for ETC (2022); BloombergNEF data; IRENA data
Power T&D	Systemiq analysis for ETC (2022); BloombergNEF data
Power storage and flexibility	Systemiq analysis for ETC (2022); BloombergNEF data
Hydrogen	ETC (2020), *Making the Clean Hydrogen Economy Possible*
Buildings	IIGCC (2022), *Climate Investment Roadmap 2022*
Road transport	Light duty vehicles: Systemiq analysis for ETC (2022); BloombergNEF data Medium duty vehicles: Systemiq analysis for ETC (2022); BloombergNEF data Heavy duty vehicles: Systemiq analysis for ETC (2022); MPP (2022), *Making Zero Emissions Trucking Possible*
Shipping	UMAS (2020), *Aggregate investment for the decarbonisation of the shipping industry (for GMF)*
Aviation	MPP (2022), *Making Net-Zero Aviation Possible*
Steel	MPP (2022), *Making Net-Zero Steel Possible*
Chemicals	Systemiq analysis for ETC (2022); Material Economics (2019), *Industrial Transformation 2050*
Cement	Systemiq analysis for ETC (2022); ETC (2022), *Carbon Capture, Utilisation and Storage: Vital but Limited*
Aluminium	MPP (2022), *Making Net-Zero Aluminium Possible*
Removals	ETC (2021), *Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive*

A1.1 Power

As described in the ETC's 2021 report on *Making Clean Electrification Possible*, electricity production to support a global net-zero economy could require a 4 fold increase – from 27,000 TWh per annum today, to between 90,000 – 120,000 TWh by 2050.[137] As a result, gross investments in the power system account for around 70% of all the investment required across the world to build a net-zero economy.

This investment in the power system underpins the decarbonisation of all other sectors of the economy, either directly or through the production of green hydrogen. Thus as Exhibit 23 illustrates:

- Total power generation investment of ~$1300bn per annum, on average to 2050, supports both direct electrification (~$900bn per annum) and hydrogen production (~$400bn per annum).

137 ETC (2021), *Making Clean Electrification Possible.*

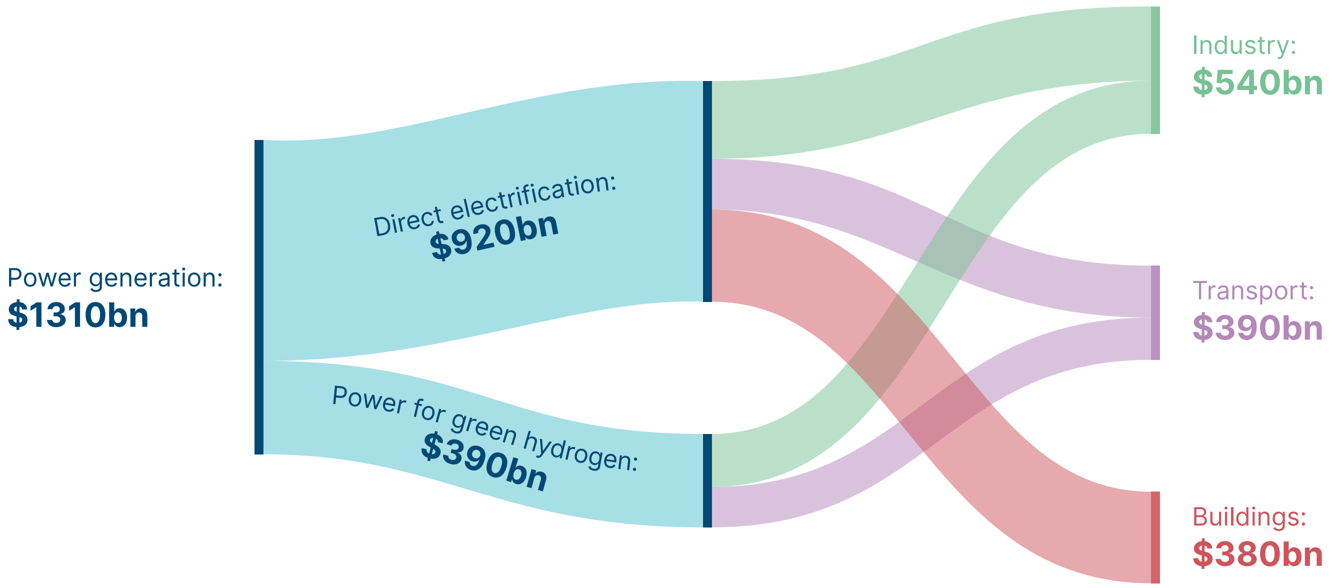
- Direct electrification is in turn the primary route to the decarbonisation of residential and commercial buildings, and also plays a vital role in the industry and transport sectors.

- The total investment to deliver zero-carbon hydrogen of $470bn a year ($390bn to provide the electricity and $80bn to build hydrogen production facilities and distribution networks), supports both the decarbonisation of the transport and industrial sectors.

Exhibit 23

Electrification underpins the decarbonisation of other sectors — industry accounts for the biggest share of power investments

Electricity production investments between 2021-2050, allocated to end-sector based on relative consumption
$ billion, annual capital expenditure



The key required investments by specific category and over time are illustrated in Exhibit 24:

- **$1300bn per year in zero-carbon generation:** Installed wind capacity needs to grow from today's 850 GW to between 13,000 and 15,000 GW by 2050, while solar capacity needs to increase from today's 970 GW to between 29,000 and 30,000 GW.[138,139] Achieving this will require a rapid ramp up in annual installations by around 3 times a year by 2030.

- **$900bn per year in transmission and distribution networks:** Investment in networks will be required to underpin significant increases in electricity demand and enable the integration of variable renewable generation.

- **$200bn per year in storage and flexibility:** An increase in the capacity of battery, hydrogen or other storage plus zero-carbon dispatchable generation is required to provide solutions to daily and longer-term balancing challenges. Stationary battery generation is expected to increase from less than 0.1 TWh today to around 11 TWh by 2050 for daily and weekly balancing. For seasonal variation of demand, around 1000 GW of installed hydrogen turbine capacity could be required, alongside a limited role for natural gas turbines equipped with CCS.

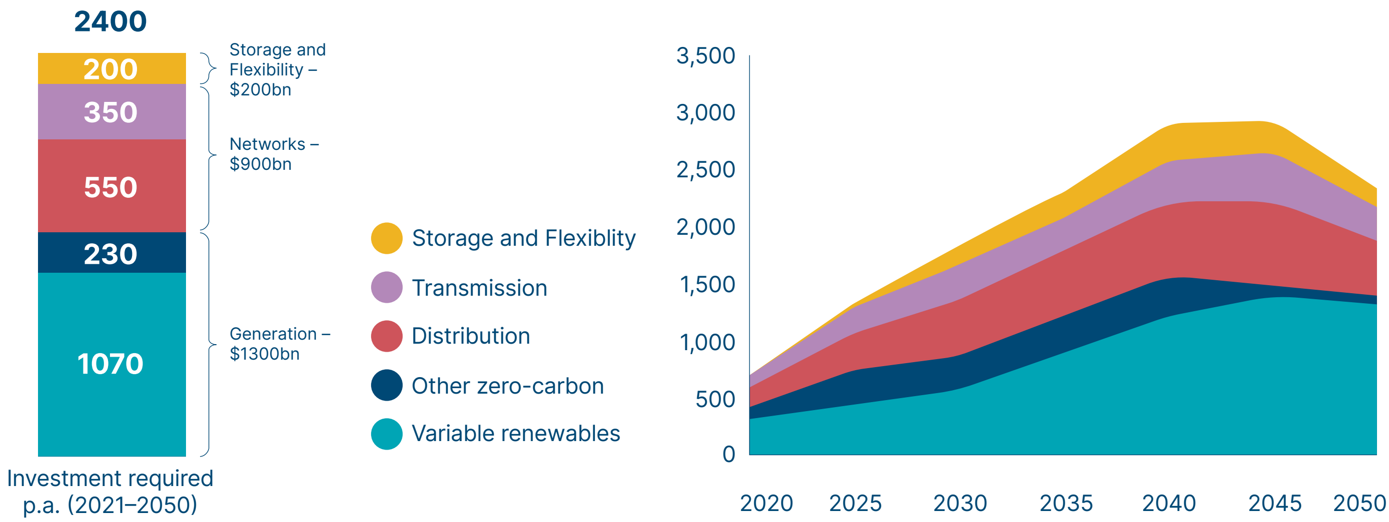
138 ETC (2021), *Making Clean Electrification Possible*.
139 Current data from BloombergNEF (2021), *New Energy Outlook*.

Exhibit 24

Investments in power need to triple by 2030 to rapidly increase wind and solar installations by 5-7 times

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); BNEF (2022), *Energy Investment Trends*.

NOTE: Includes investment in clean electricity generation required to produce green hydrogen.

Investment in renewable electricity generation has already increased dramatically, with renewables now accounting for an estimated 70% of investment in power generation.[140] But total global power sector investment – estimated at around $930bn in 2021 – still falls far short of the $2,400bn required every year on average over the next 30 years.

Maximum rates of power sector investment will likely be achieved in the 2030s and early 2040s, with a tail-off in the late 2040s – but it is essential to achieve a rapid ramp up in the 2020s if subsequent pathways to decarbonisation are to be achievable:

- Many high income countries have made commitments to achieve near total decarbonisation of their power systems by 2035 and need to do so to ensure that wider electrification delivers maximum possible emissions reduction. Achieving these commitments will require a dramatic acceleration of renewable capacity growth. Middle and low income countries, some of which will need to grow electricity supply 5-10 times by 2050, must start the growth path early to make that achievable.

- In all countries it is essential to invest in transmission and distribution capacity ahead of demand growth. Distribution network investments are typically required around 5 years ahead of need (e.g., to support new use cases such as EV charging infrastructure), and transmission investments are required around 3-5 years ahead of need to connect remote wind and solar resources and strengthen key connections between renewable generation and load centres.

Current costs and required policies

Wind and solar electricity production are now cost-competitive against new and existing fossil for bulk electricity provision in countries representing 90% and 66%, respectively, of global electricity generation.[141] As a result, investments in renewables, grids and storage are already attractive to private investors today provided real economy policies (e.g., power market design, planning and permitting rules, and the regulation of network providers) are well designed and implemented (see Chapter 2).

But in some lower income countries, higher costs of capital currently impede the required pace of investment, and action is needed to increase the quantity and reduce the cost of finance available (see Chapter 4).

140 IEA (2022), *World Energy Investment 2022*.
141 BloombergNEF (2022), 1H2022 LCOE Update.

A1.2 Hydrogen

Hydrogen will play a major role in the future low-carbon economy, helping to achieve decarbonisation in multiple sectors including shipping, steel and chemicals, and playing a key storage role within the power system. The ETC's report on *Making the Hydrogen Economy Possible* estimates that total hydrogen production could rise 5-7 times from today's 120 million tonnes per annum to reach 500-800 million tonnes by 2050. The greater part (e.g., 85%) will likely be produced via electrolysis of water ("green hydrogen"), but with a significant transitional role also for blue hydrogen (via methane reformation plus CCS). Other published estimates also suggest dramatic growth.[142]

Between 2021 and 2050, required average annual investments in hydrogen infrastructure are estimated at $80bn a year:

- **$40bn per year in hydrogen production** to drive a massive increase in green hydrogen supply, produce greenfield blue hydrogen and retrofit grey hydrogen facilities.

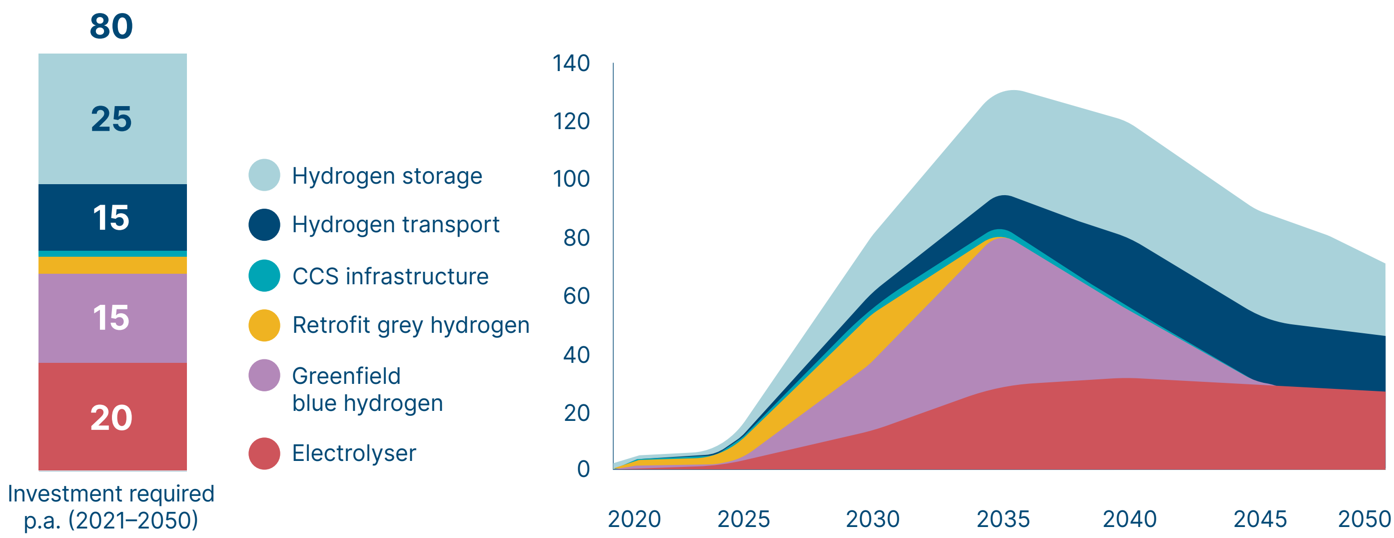
- **$40bn per year in transport and storage** to build refuelling stations, pipelines, import and export terminals, and storage capacities.

Exhibit 25

Investments in hydrogen infrastructure need to ramp up from $2bn to $80bn by 2030, peaking in 2035 as blue hydrogen investments then phase out

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023).

NOTE: Excludes investment in clean electricity generation required to produce green hydrogen

These investments in hydrogen infrastructure will, however, be dwarfed by the investments required to produce the zero-carbon electricity to produce green hydrogen. If total hydrogen production reached 650 million tonnes per annum in 2050, and if 85% of this (520 million tonnes) were produced in the green fashion via electrolysis, this would require about 23,000 TWh of electricity, and the investment required to produce this would be around $400bn per annum. This requirement, and its likely profile over time, is included within Exhibit 23.

142 See Chapter 1 of ETC (2021), *Making the Hydrogen Economy Possible.*

Additional investments will also be required for sectors where hydrogen is used as feedstock to produce hydrogen-derived fuels, for example, to build Haber-Bosch plants for ammonia production for shipping, or plants to produce synthetic fuels for aviation. Where these investments might be higher-cost than the fossil fuels-based alternatives in the early stages of the transition or need to happen at a faster pace than business-as-usual stock turnover, they are captured in our estimates for transport and industry – see Annex 1.4 and 1.5.[143]

Current costs and required policies

As natural gas prices have increased, green hydrogen has become more cost-competitive with its fossil alternative, making investments in green hydrogen production increasingly attractive.[144] Many projects for green hydrogen production are therefore in development, supported by significant government subsidies. But there remain uncertainties about the pace at which end-use application of hydrogen (whether green or blue) will grow in the 2020s. Government policies to support initial demand growth are therefore vital.

143 Costs for ammonia production are included in the hydrogen sector, whereas costs for other fuels are included in the end use sector.
144 In particular when complemented by the $3/kg tax credits introduced under the US IRA.

A1.3 Buildings

Of our estimated $3.5trn per annum of required investment for decarbonisation, $500bn annually – 15% of total – lies in the buildings sector. This large investment equates however to just 4% of the $12trn currently invested in the global buildings sector every year, by far the largest category of investment in the global economy.[145] Population growth and urbanisation in middle and lower income countries will drive further increases in this expenditure, independent of climate change considerations. The IEA estimates that total building floor area could grow by 80% between 2021 and 2050 in middle and lower income countries.[146]

Estimating the incremental investment required to achieve decarbonisation in buildings is inherently difficult and the estimates are more uncertain than for other sectors. This is for two reasons:

- First, whereas in some other sectors it is possible to define the physical investment need in terms of specific units such as gigawatts of wind, solar or electrolyser capacity, investment in the building sector entails multiple small-scale investments in multiple specific variants of technology, across hundreds of millions of buildings across the world.

- Second, it is inherently difficult to estimate the incremental cost of constructing a *new* building in a more energy efficient fashion, versus the business as usual option. While retrofit investment (e.g., to improve heat insulation in existing buildings) is clearly incremental to business as usual, truly incremental investment within new-builds (concentrated in lower income countries) is more difficult to determine, especially given there is no universally agreed definition of a low-carbon building standard. Another consideration is that a large part of decarbonising buildings will be achieved through decarbonising the power system; investing heavily in low-carbon construction would therefore be somewhat offset by a lower investment need in the power sector due to lower energy demand. The ETC will be doing further work on this within a forthcoming workstream on energy productivity in 2023. At this stage, therefore, our estimates exclude new-build costs other than those arising from specific forms of low-carbon heat technology.

Another complexity in the building sector is that additional investment will also be required to ensure adaptation to climate change, and that adaptation investment will sometimes be made in combination with mitigation investment, for instance retrofitting houses to both improve insulation and increase resilience to higher rainfall.

In addition, the emissions intensity of building construction will be reduced via the investments required to decarbonise cement, steel and plastics, which are included in the industry sectors below.

Our estimates of the incremental investment required within the building sector itself to achieve emission reductions (rather than for adaptation or to support economic growth) are:[147]

- **$230bn per year on retrofits of existing buildings** including physical upgrades (e.g., insultation and double glazing) and digital upgrades (e.g., smart controls) – this investment will be concentrated in the developed world.

- **$140bn per year in heat pumps in both new and existing buildings:** Investment is required to install heat pumps in around 55% of houses across the world by 2050, decarbonising heating when powered with clean electricity and improving energy efficiency.

- **$130bn per year in other renewable heating and cooking technologies in both new and existing buildings:** Investment in various solutions such as boilers and stoves relying on 'modern' solid biomass (e.g., pellets), or solar thermal water heating.

145 Penn World Tables (2019) - Capital detail database (investment in residential and non-residential structures).

146 IEA (2021), *Net Zero by 2050: A Roadmap for the Global Energy Sector.*

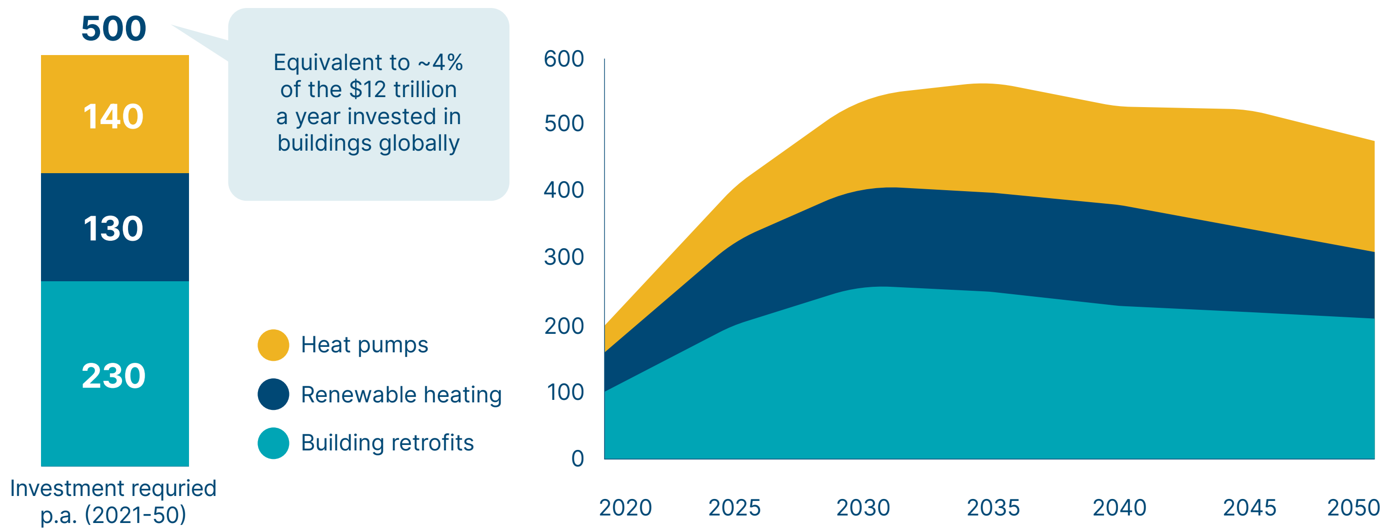
147 Source: IIGCC (2022), *Climate Investment Roadmap* – estimates based on IEA data.
Note: the ETC excludes energy-efficient appliances from total investment needs, as these expenditures are made consumers and simply replace investments in appliances otherwise made.

Exhibit 26

Capital investments to decarbonise buildings need to average $500bn a year, driven by retrofits of the existing building stock in high income countries

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); IIGCC (2022), *Climate Investment Roadmap 2022*; Penn World Tables (2019), *Capital detail database*.

Current costs and required policies

Retrofitting existing residential homes to achieve emissions reductions will in some cases involve investments that do not earn an attractive rate of return. Real economy policies, such as subsidies for heat pumps and insulation, will therefore be required (see Chapter 2) and optimal policy may also entail a role for public investment banks, or for innovative combinations of public and private finance, as discussed in Chapter 3.

In lower income countries meanwhile, the key challenge is to ensure that policies for urban design and building regulation support low-carbon urbanisation, as well as the deployment of specific low-carbon heating technologies. Global and national policies to drive technological progress in, for instance heat pump/air conditioner performance can also play a major role. During 2023, the ETC will do a deep dive into opportunities to improve energy productivity with a particular focus on the building sector.

In all countries, it is vital that financial institutions making the sort of net-zero commitments discussed in Chapter 3, focus as much on buildings as on the power, transport and industry sectors. For many banks, lending against property accounts for a high percentage of total loan portfolios; commitments to favour lower carbon construction could have a significant impact.

A1.4 Transport

Current global investment in transport infrastructure (e.g., to build roads, airports, ports and railways) amounts to around $2trn a year.[148] In addition, almost $2bn is spent to purchase around 70 million passenger vehicles every year.[149] But most of this expenditure will be largely unaffected by the energy transition and is excluded from our estimates of incremental investment. In particular:

- The scale of future transport infrastructure investment will be broadly unchanged as the cost of building roads is unaffected by whether the vehicles using the roads are ICEs or EVs.

- The purchase price of passenger EVs is likely to reach parity with ICEs sometime during the 2020s, eliminating the need for incremental consumer expenditure.[150]

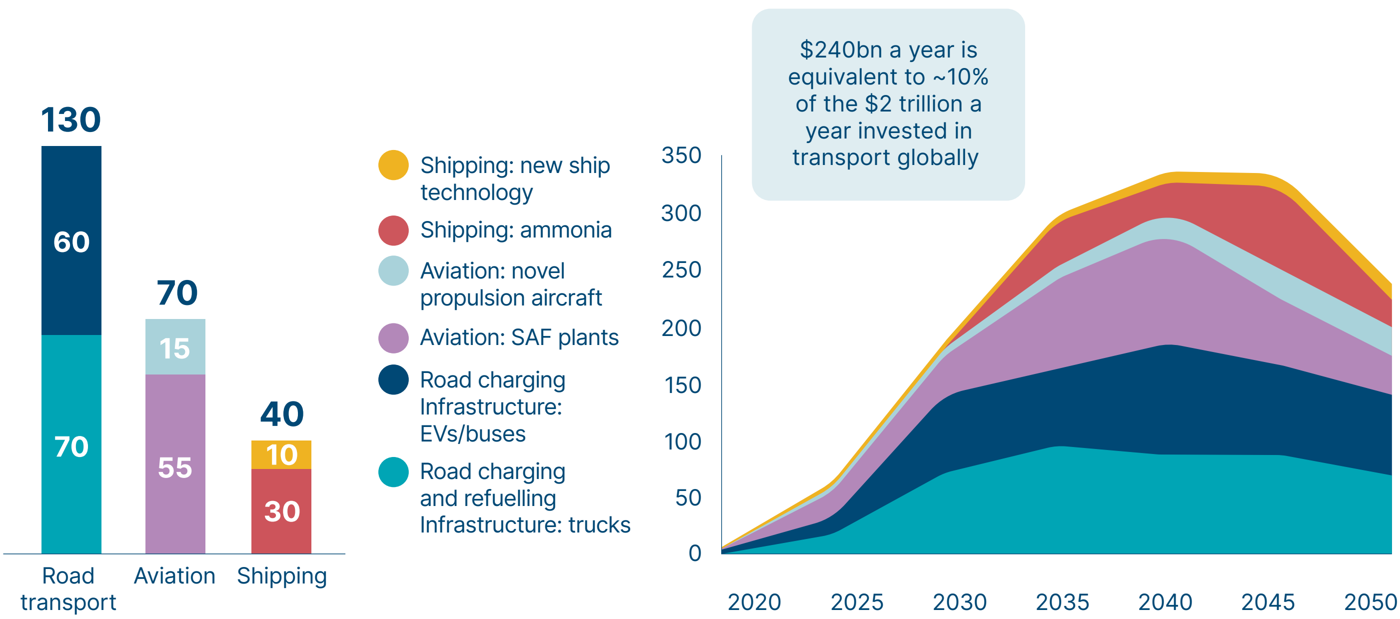
But we still estimate that around $240bn of incremental low-carbon investments per annum will be needed on average between 2021-50 to decarbonise road, air and sea transport. This accounts for around 7% of the estimated $3.5trn per annum low-carbon total – and is also equivalent to around 10% of total current global investment in the transport sector.

Exhibit 27

Investments in low-carbon transport need to reach ~$150bn p.a. in 2030 and peak at ~$400bn p.a. in 2040, driven by zero-carbon fuels for aviation

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); MPP (2022), *Making Zero Emissions Trucking Possible*; MPP (2022), *Making Net-Zero Aviation Possible*; UMAS (2020), *Aggregate Investment for the Decarbonisation of the Shipping Industry (for GMF)*; Penn World Tables (2019), *Capital detail database.*

148 Penn World Tables (2019) - Capital detail database.
149 Statista (2022) Passenger Cars – Worldwide.
150 Although, we note that if the supply of critical raw materials for EV batteries, such as lithium, become increasingly constrained, this may push up prices and delay uptake.

Key elements, as shown in Exhibit 27, are:

- **$130bn per year in road charging and refuelling infrastructure:** Once complete decarbonisation of road transport is achieved, the global vehicle fleet will include something like 2 billion electric cars and 350 million electric vans, trucks and buses. Investment in an extensive road charging infrastructure will therefore be essential, with the required level dependent on how far technological progress increases battery range. Of our estimated total of $130bn per annum, $70bn is required to build charging infrastructure and hydrogen refilling for trucks, with large per unit costs for high capacity chargers.[151] For light duty vehicles, we assume that around $60bn per annum is required to install around 860 million slow residential, 45 million moderate speed public, and 13 million superfast chargers. Of this, the cost of slow residential chargers (potentially around $14bn per annum on average) will typically be absorbed directly by consumers rather than requiring a business investment.

- **$70bn per year in aviation:** For long distances, which account for the bulk of aviation emissions, the primary route to decarbonisation will be through "drop-in" sustainable aviation fuels (SAFs) - whether produced from bioresources or from low-carbon electricity - burnt in existing jet engines. Around $55bn per annum on average could be required to build SAF production plants, with a peak around 2040. At shorter distances, battery electric and hydrogen planes are likely to play a gradually growing role, and investment of around $15bn per annum could be required on average to purchase more expensive aircraft than under business as usual.[152]

- **$40bn per year in shipping:** In shipping, there will be a role for electric or hydrogen-based vessels at shorter distances; but for long-distance shipping, the most likely decarbonisation route is through a switch to either ammonia or methanol as a zero-carbon fuel. Unlike in the case of aviation, this will require new engines and fuel handling systems.[153] Of the $40bn annual total, around 75% ($30bn) is for the infrastructure and production facilities required for ammonia or methanol synthesis, storage and bunkering. The remaining $10bn is investment in new ships – both new and retrofits – including the machinery and onboard engine and storage required to run on ammonia or methanol, as well as investments in energy efficiency (required given the higher fuel costs compared to conventional fuels).[154]

Crucially, the production of new fuels for aviation and shipping – SAFs and ammonia or methanol respectively – will also require investments in hydrogen production capacity and in renewable electricity capacity if hydrogen is produced in a green fashion. For the transport sector as a whole, an estimated $420bn a year would be required for power and hydrogen investments until 2050;[155] much more than the $240bn of total transport specific infrastructure investments. This illustrates that in many end-use sectors rapid early expansion of renewable electricity capacity is the vital building block on which sector decarbonisation will build.

Current costs and required policies

Passenger EVs are already cost competitive with ICEs on a total cost of ownership (TCO) basis, and will likely become no more expensive upfront during the 2020s. TCO parity between zero emission vs diesel/gasoline trucks is expected to be achieved between 2022 and 2034, depending on the region and type of vehicle (urban, regional or long haul).[156,157] Provided appropriate supporting policies, such as ICE bans, well-developed critical raw material supply chains, and charging infrastructure investment are in place, there is therefore unlikely to be a significant "financing challenge", for vehicle purchase in high income countries. Flows of finance to lower income countries may however be required in the 2030s-2050s to ensure faster adoption of EVs and faster run down of the existing stock of ICE cars, buses and trucks than will otherwise occur.

In the shipping and aviation sectors, strong real economy policies such as carbon pricing and clean fuel mandates will need to play a major role (see Chapter 2), but it is also essential that finance supports early first-of-a-kind investments, implying a potential role for public investment banks or for private sector net-zero commitments as discussed in Chapter 3.

151 Systemiq analysis for the ETC (2022), based on MPP (2022), *Making Zero Emissions Trucking Possible*.
152 Note: on a TCO basis, H_2 aircraft could become cheaper, but that it highly depends on future technological developments and the operating profile. Hence, we do include these small investments in our estimates.
153 We note that the magnitude of investments needed is unlikely to be significantly different under other decarbonisation routes, including hydrogen, synthetic methanol, or other fuels.
154 UMAS (2020), *Aggregate investment for the decarbonisation of the shipping industry – for GMF*.
155 These investments are captured within the power and hydrogen figures in Annex 1.1 and 1.2.
156 For instance, MPP found that the Inflation Reduction Act would bring the TCO of battery electric heavy-duty trucks forward with 2-4 years in the US, to 2023 for urban and regional trucks, and 2028 for long-haul trucks.
157 MPP (2022), *Making Zero Emissions Trucking possible*.

A1.5 Industry

Focusing on the hard to abate sectors, which account for 60% of industrial energy consumption and 70% of CO_2 emissions from the industrial sector, around $70bn per year investment could be required on average between now and 2050. Key investment needs include:

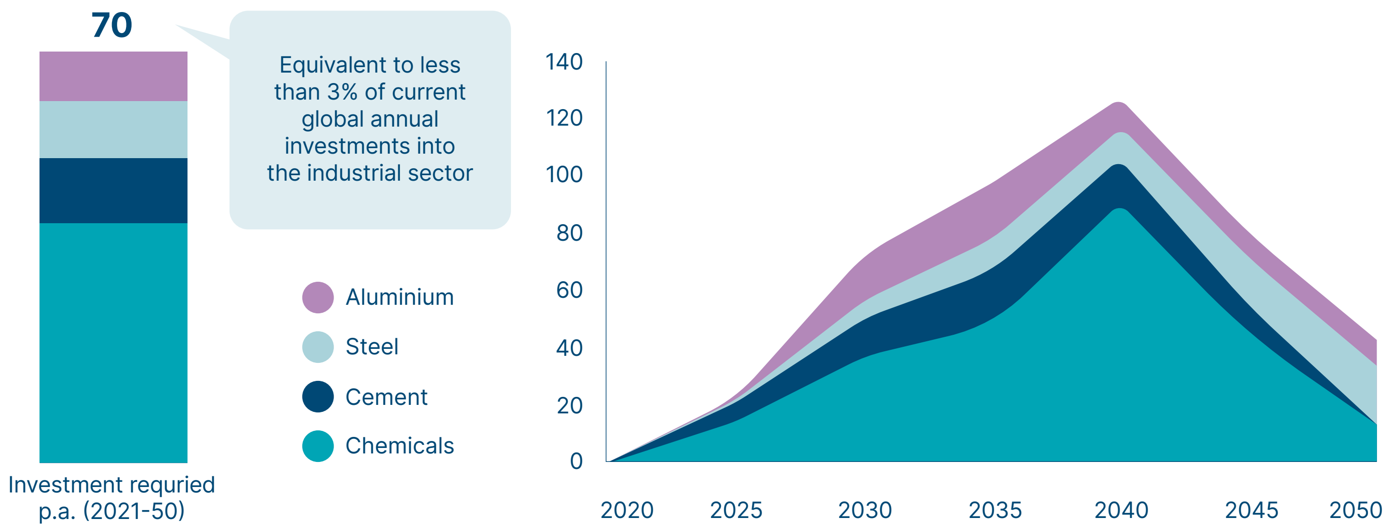
- **$40bn per year in chemicals** to develop and integrate CCS and pyrolysis technologies in the chemicals process.
- **$10bn per year in steel** to transition steel assets to net-zero compatible technologies including hydrogen-based direct reduced iron (DRI) facilities and CCS.
- **$10bn per year in cement** to build cement plants equipped with CCS.
- **$10bn per year in aluminium** to build and deploy low-carbon technologies at smelters and refineries.

Exhibit 28

Industry investments must ramp up rapidly by 2030, when 30% of existing assets face an investment decision

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); MPP (2022), Making Net-Zero Steel Possible; MPP (2022), *Making Net-Zero Aluminium Possible*; Material Economics (2019), *Industrial Transformation 2050.*

Perhaps surprisingly, low-carbon investment in industry accounts for less than 5% of the total $3.5trn needed annually; and the estimated $70bn a year for the hard-to-abate sectors of cement, steel, chemicals and aluminium, is also less than 3% of the $4.8trn currently invested in non-transport machinery and equipment.[158] There are a number of reasons why low-carbon investment in industry is comparatively small:

- A large portion of the industrial sector runs on electromechanical power and uses medium temperature heat which can be easily electrified. As a result, the decarbonisation of power systems will automatically drive decarbonisation of much of industry. This is especially the case for aluminium, where low-carbon power will account for 55-60% of cumulative emission reductions between now and 2050.[159]

158 Penn World Tables (2019), Capital detail database – investments in non-transport machinery and equipment.
159 Mission Possible Partnership (2022), *Making Net-Zero Aluminium Possible.*

- As with other sectors, investment in zero-carbon electricity generation and the production and enabling infrastructure of hydrogen will dwarf the investments in industrial assets. As shown in Exhibit 23, this investment could average $540bn a year to 2050 – five times larger than the investment in assets discussed here. In the aluminium sector, power is often generated on-site via captive coal or hydro power plants. This on-site power investment may have to be undertaken by the sector itself, but these investment costs are captured within the power estimates in Section A1.1.

- In most cases, new technologies will be adopted at the point of capital turnover, lowering overall additional costs.

- In addition to low-carbon technologies, various other options exist to decarbonise industry, including optimising the operational efficiency of equipment and improving material efficiency through recycling and reuse. Many of these measures, however, do not require large scale capital investment.

- In some cases, it is possible to retrofit existing infrastructure and plants, which is significantly cheaper than building new plants. For example, renovations to existing steel plants require about a quarter of the capital expenditure of building new plants.[160]

Current costs and required policies

Investment to decarbonise industry are becoming increasingly attractive. In the steel sector for instance, the economics of direct reduced ironmaking (DRI) are improving. But in most cases, there is still a "green premium" with a higher cost for the low carbon technology. To achieve large-scale investment fast enough, real economy policies such as carbon pricing will be required (see Chapter 2). In addition, there is a targeted role for public investment banks in high income countries to reduce the finance risk of early stage technologies and first of a kind deployments (see Chapter 3).

160 Mission Possible Partnership (2022), *Making Net-Zero Steel Possible*.

A1.6 Prospective decline of fossil fuel investments

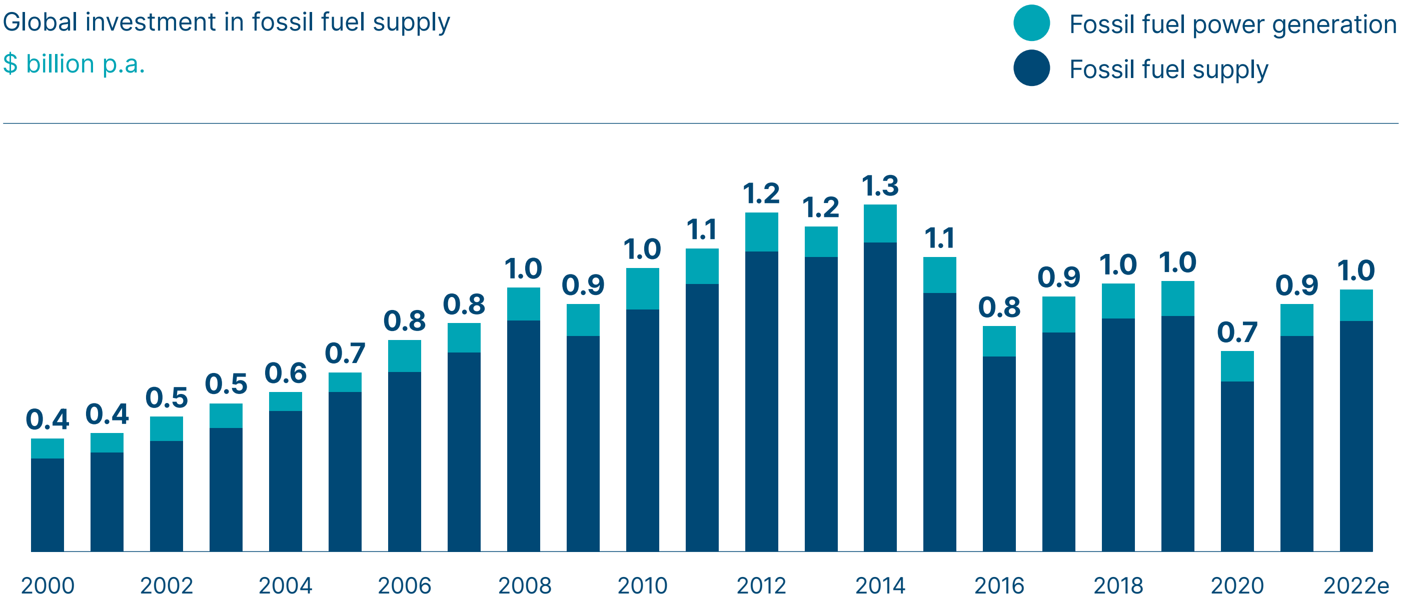
At the same time as a rapid scale up in low-carbon investments, capital investment in fossil fuels will also need to drastically decrease over the next 30 years to achieve a net-zero economy. Investment in fossil fuel production and processing, and in fossil fuel power plants, stood at around $0.9trn in 2021, down from a peak of $1.3trn in 2014.[161]

Exhibit 29

Investment in fossil fuels has been rising since 2020, but remains below pre-covid 19 levels and below its peak in 2014

Global investment in fossil fuel supply

$ billion p.a.



SOURCE: IEA (various years), *World Energy Investment Reports*.

Over the long term, fossil fuel capital investments will need to dramatically decline as fossil fuel use falls. Even in a scenario with no further climate action beyond stated policies, coal and oil use is expected to peak in the mid-2020s, and following recent trends, gas demand is likely to peak in this decade too.[162] In a net-zero scenario, IEA expects that between 2021 and 2050, coal demand declines by 90%, oil by around 80%, and natural gas by more than 70%.

There is significant debate about the feasible and optimal pace of reduction of fossil fuel investments. Some argue that too steep a decline in investment could result in supply declines faster than feasible demand reductions, with resulting price spikes and shortages which threaten energy security. Others believe that constraints on new investment are essential to prevent the emergence of capacity far in excess of future needs, creating political pressure to decelerate the energy transition.

The ETC will develop a detailed assessment of this issue in our upcoming workstream on *Fossil fuels in Transition*, but other organisations have already published indicative estimates. The IEA's current view is that if demand were to fall in line with their net-zero scenario, it could entirely be met without approving the development of any *new long lead time upstream conventional* oil and gas projects, and without any new coal mines or coal mine lifetime extensions worldwide. It would require some investments in already approved fields, continued investment in existing fields, and investments in new tight oil fields, which have much shorter development timelines than conventional fields.[163] The IEA projects that in a net-zero scenario, required annual fossil fuel investment would fall to about $460bn by 2030, decreasing to ~$250bn by 2040 [Exhibit 30].

161 Note: Fossil fuel investments represent capital spending into oil and gas production and processing (including liquefied natural gas), coal supply and fossil fuel power generation. Source: IEA (2022), *World Energy Investment*.

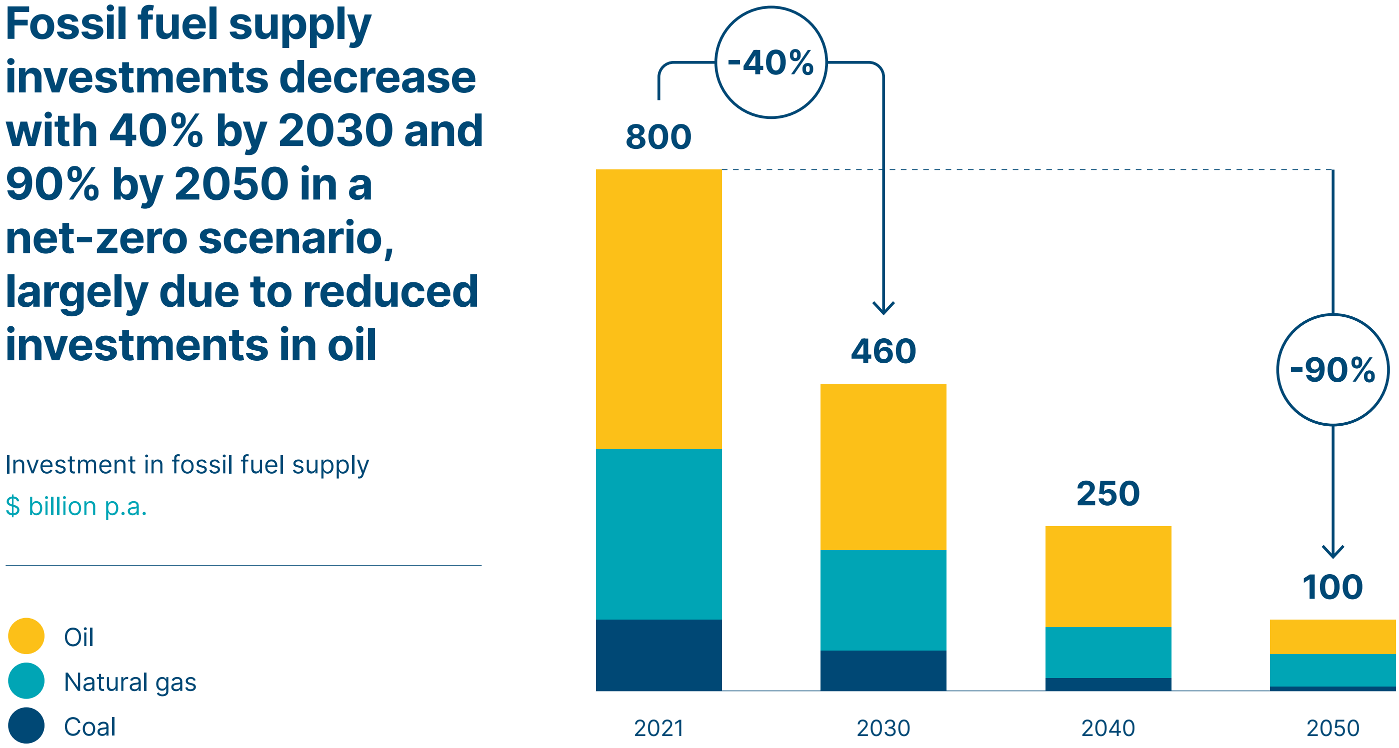
162 IEA (2022), *World Energy Outlook 2022*.

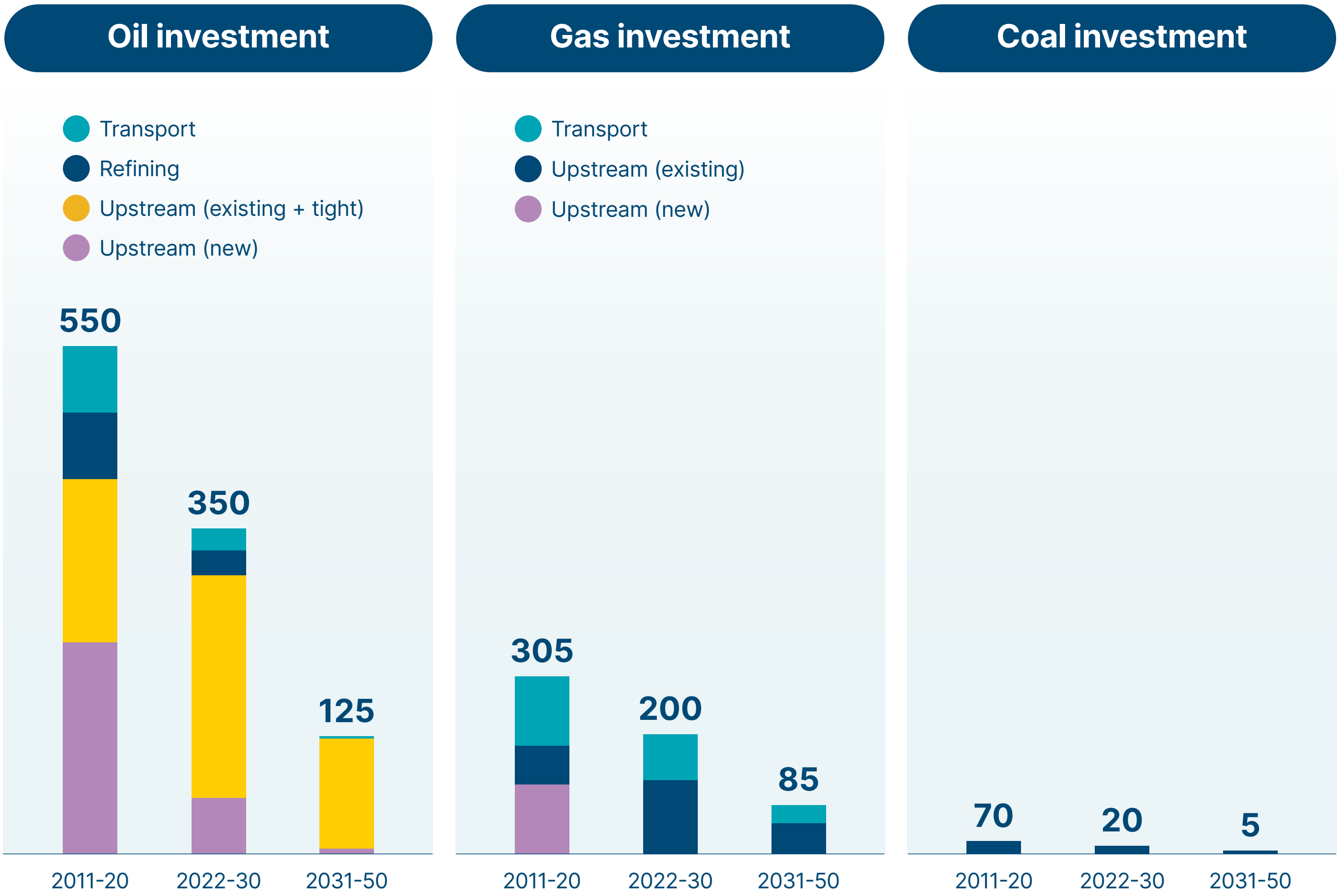
163 IEA specifies that for oil, investments in existing fields includes some low cost extensions of existing fields e.g., the use of in-fill drilling and enhanced oil recovery, as well as tight oil drilling given their short development lead times (can be as quick as 3 months between securing development approval to the start of production vs 3-5 years for conventional upstream projects). For gas, there is no further specification provided beyond the need for investments in existing fields.

Exhibit 30

Fossil fuel supply investments decrease with 40% by 2030 and 90% by 2050 in a net-zero scenario, largely due to reduced investments in oil

Investment in fossil fuel supply
$ billion p.a.





SOURCE: IEA (2022), *World Energy Investment 2022*; IEA (2022), *World Energy Outlook 2022*; BNEF (2022), *Counting Cash in Paris Aligned Pathways* - analysis based on IEA Net Zero scenario updated for upstream oil and gas with IEA (2022), *World Energy Outlook 2022.*

NOTE: New oil includes tight oil investments, in line with approach taken by IEA.

A1.7 Comparison of ETC estimates to IEA, IRENA and BNEF

The ETC's estimates of investment required are of a similar order of magnitude to those produced by IEA, IRENA and BNEF. The IEA's estimate of around $4.5trn a year sits at the top of the spectrum,[164] with IRENA at around $3.8trn[165] and BNEF at the lower end with $3.2trn.[166] While not shown in detail below, McKinsey have a significantly higher estimate of investment required in a net-zero scenario of $9trn a year; however, this includes around $3trn of continued spending on high-emission assets and also spending on the purchase of EVs, which are excluded from our analysis.[167]

The ETC's estimate sits towards the lower end of this range, with an annual average of $3.5trn. The differences are largely accounted for by i) the climate modelling scenarios used, ii) whether or not certain categories of expenditure are included and iii) the inclusion of investment in fossil fuel assets.

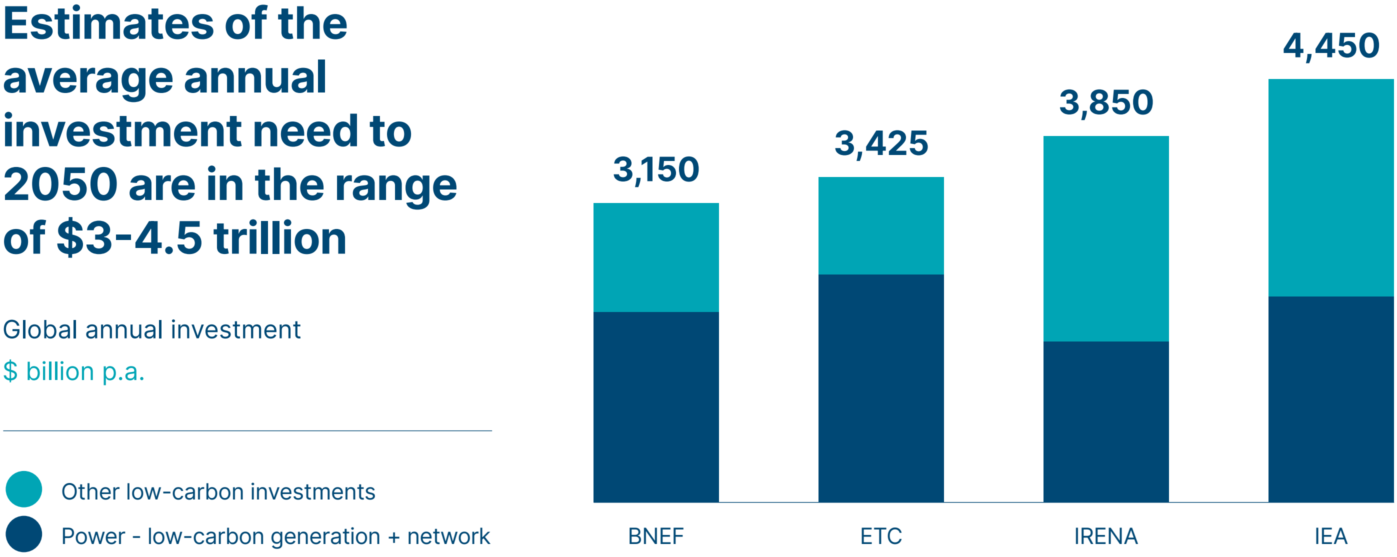
It is challenging to compare specific sector estimates across each organisation, given differences in whether estimates have been done at the sectoral, technology or end-use level. Exhibit 32 shows how each organisation's total average investment estimate is split according to power and other sectors.

Exhibit 31

Estimates of the average annual investment need to 2050 are in the range of $3-4.5 trillion

Global annual investment

$ billion p.a.



SOURCE: Systemiq analysis for the ETC (2023); IEA (2022), *World Energy Outlook 2022*; IRENA (2021), *World Energy Transitions Outlook*; BNEF (2022), *New Energy Outlook 2022*.

All estimates agree on the dominance of power investment, which accounts for the vast majority of total investment. Key differences in sector estimates include:

- **Power:** variances are driven by differences in the underlying assumptions made for total clean power generation over the next three decades and how much investment in networks is needed to enable this expansion. Both IEA and IRENA assume rapid growth in the share of final energy demand which comes from electricity (reaching 50% in the IEA Net Zero scenario), but the ETC is still more aggressive in this respect (with electricity as a percentage of final energy demand over 60% by 2050).

- **Hydrogen:** differences are driven by assumptions on what share of final energy demand hydrogen can account for over the next 30 years and how rapidly production scales up.

164 IEA (2022), *World Energy Outlook 2022.*
165 IRENA (2021), *World Energy Transitions Outlook 2021.*
166 BNEF (2022), *New Energy Outlook 2022.*
167 McKinsey (2022), *The Net Zero Transition: What will it cost, What could it bring?*

- **Buildings:** as discussed in A1.3, it is inherently challenging to estimate the incremental investment required to ensure buildings are zero-carbon. But analysis of each organisations' estimates suggest building is one of the most prominent sectors after power.

- **Transport:** IEA and IRENA's estimates for transport are larger because they consider investments to improve energy efficiency in vehicles, while the ETC focuses only on charging infrastructure (and limited refuelling infrastructure for trucking). Like the ETC, IRENA estimates exclude the purchase costs of passenger EVs. The IEA takes a slightly different approach and includes spending on batteries for vehicles. The cost of EV sales has been excluded frombnEF's estimates shown in Exhibit 32.

- **Industry:** The ETC's estimates only focus on the hard to abate sectors, while the IEA, IRENA andbnEF take a broader look across the sector and across different decarbonisation measures (e.g., investment to build a more circular economy and to improve energy efficiency in subsectors which are already largely electrified).

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The team that developed this report comprised:

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How to Make the Money Flow for a Net-Zero Economy

March 2023

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Energy Transitions Commission