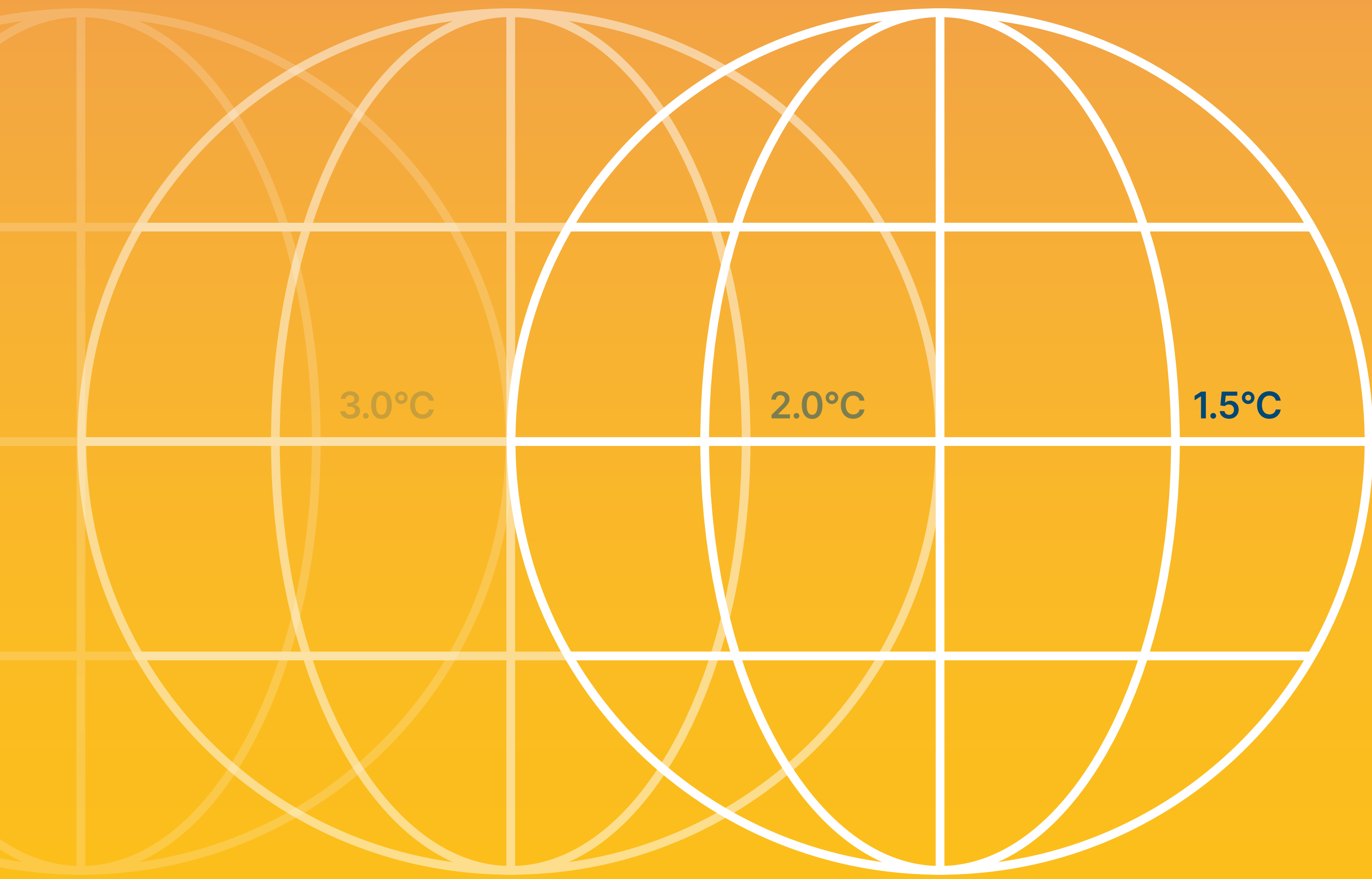
Keeping 1.5°C Alive: Closing the Gap in the 2020s

September 2021



Energy Transitions Commission

Version 1.0

Keeping 1.5°C Alive

Closing the Gap in the 2020s

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. Our Commissioners are listed on the next page.

Keeping 1.5°C Alive: Closing the Gap in the 2020s was developed by the Commissioners with the support of the ETC Secretariat, provided by SYSTEMIQ. This briefing paper has also been developed in close consultation with experts from companies, industry initiatives, international organisations, non-governmental organisations and academia. The publication was developed with input from the UK COP26 team to enhance the available analysis in the lead up to COP26. This briefing paper draws heavily on work developed by Climate Action Tracker (CAT) and the International Energy Agency (IEA), and ETC knowledge partners BloombergNEF. We warmly thank our knowledge partners and contributors for their inputs.

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.

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:
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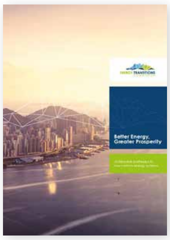
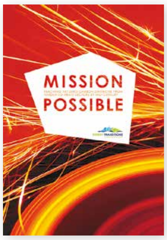
Global Reports

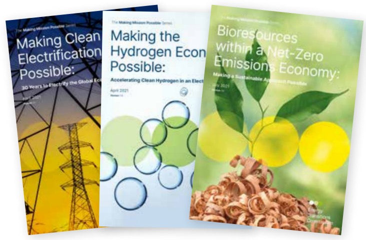


Better Energy, Greater Prosperity (2017) outlined four complementary decarbonisation strategies, positioning power decarbonisation and clean electrification as major complementary progress levers.



Mission Possible (2018) outlined 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) showed 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 – a series of reports outlining how to scale up clean energy provision to achieve a net-zero emissions economy by mid-century. The reports set out specific actions in the 2020s to put this net-zero by 2050 target within reach.

Sectoral and cross-sectoral focuses

Sectoral focuses provided detailed decarbonisation analyses on each on the six harder-to-abate sectors after the publication of the Mission Possible report (2019).

Our latest focus on building heating (2020) details decarbonisation pathways and costs for building heating, and implications for energy systems.

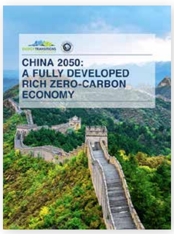
As a core partner of the Mission Possible Partnership, the ETC also completes analysis to support a range of sectoral decarbonisation initiatives:

In October 2020, the corporate members of the Clean Skies for Tomorrow initiative (CST) developed a **Joint Policy Proposal to Accelerate the Deployment of Sustainable Aviation Fuels in Europe.**

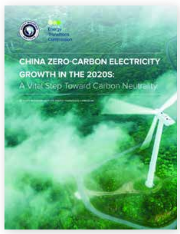
Produced for the Getting to Zero Coalition, **"The First Wave – A blueprint for commercial-scale zero-emission shipping pilots"** (2020) highlights five key actions that first movers can take to make tangible progress towards zero emission pilots over the next three to four years.

Steeling Demand: Mobilising buyers to bring net-zero steel to market before 2030 demonstrates that demand signals from steel buyers to steel manufacturers can help unlock investment and breakthrough technologies needed for net-zero primary steel.

Geographical focuses



China 2050: A Fully Developed Rich Zero-carbon Economy described 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.



China Zero Carbon Electricity Growth in the 2020s: A Vital Step Toward Carbon Neutrality (January 2021). Following the announcement of China's aim to achieve carbon neutrality before 2060 and peak emissions before 2030. This report examines what action is required by 2030 aligned with what is needed to fully decarbonise China's power sector by 2050.

A series of reports on the Indian power system and outlining decarbonisation roadmaps for Indian industry (2019-2020) described how India could rapidly expand electricity supply without building more coal-fired power stations, and how India can industrialise whilst decarbonising heavy industry sectors.

Setting Up Industry for Net-Zero (June 2021) explores the state of play in Australia and opportunities for transition to net-zero emissions in five supply chains – steel, aluminium, liquified natural gas, other metals and chemicals.

Contents

Glossary

Abatement cost: The cost of reducing CO_2 emissions, usually expressed in US$ per tonne of CO_2.

Afforestation and reforestation: "The planting of new forests on land not currently under forest cover. The forests remove carbon from the atmosphere as they grow."[1]

BECCS: A technology that combines bioenergy with carbon capture and storage to produce energy and net negative greenhouse gas emissions (i.e., removal of carbon dioxide from the atmosphere). See 'BiCRS'.

BEV: Battery-electric vehicle.

BiCRS: Biomass carbon removal and storage. This term includes BECCS and other forms of carbon dioxide removal (e.g., biochar).[2]

Biochar: "The thermal decomposition of biomass in the absence of oxygen forms a charcoal known as biochar. This can be added to soils to improve soil fertility and to act as a stable long-term store of carbon."[3]

Bioenergy: Renewable energy derived from biological sources in the form of solid biomass, biogas, or biofuels.

Biofuels: "Liquid fuels derived from biomass, used primarily for transport, including ethanol, biodiesel and other liquids."[4]

Biomass or bio-feedstock: Organic matter, i.e., biogenic material, available on a renewable basis from living or recently living organisms. Includes feedstock derived from plants or animals, such as agricultural and energy crops, wood and forestry residues, organic waste from municipal and industrial sources (including manure), and algae.

Carbon capture and storage or use (CCS/U): 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 carbon capture (DACC) when using this term. The term 'carbon capture and storage' (CCS) refers to the combination of carbon capture with underground carbon storage; while 'carbon capture and use' (CCU) refers to the use of carbon in carbon-based products in which CO_2 is sequestered over the long term (e.g., in concrete, aggregates, carbon fibre). Carbon-based products that only delay emissions in the short term (e.g., synfuels) are excluded when using this terminology.

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 emissions / CO_2 emissions: We use these terms interchangeably to describe anthropogenic emissions of carbon dioxide in the atmosphere.

Carbon offsets: 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.

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.

Circular economy models: Economic models that ensure the recirculation of resources and materials in the economy, by recycling a larger share of materials, reducing waste in production, light-weighting products and structures, extending the lifetimes of products, and deploying new business models based around sharing of cars, buildings, and more.

Direct air carbon capture (DACC): The extraction of carbon dioxide from atmospheric air. This is also commonly abbreviated as 'DAC'.

Direct air carbon capture and storage (DACCS): DACC combined with carbon storage.

EBIT sectors: Energy, building, industry, and transport sectors.

Ecosystem services: Services from nature including nutrient cycling, flood and disease control, and recreational and cultural benefits.[5]

Embedded carbon emissions: Lifecycle carbon emissions from a product, including carbon emissions from the materials input production and manufacturing process.

Greenhouse gases (GHGs): Gases that trap heat in the atmosphere. Global GHG emission contributions by gas – CO_2 (76%), methane (16%), nitrous oxide (6%) and fluorinated gases (2%).

Heavy Goods Vehicles (HGV) or Heavy Duty Vehicle (HDV): Both terms are used interchangeably and refer to trucks ranging from 3.5 tonnes to over 50 tonnes.

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.

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.

Lifecycle emissions: Emissions from the energy, material, and waste flows of a product and their impact on the environment.[6] Life cycle assessments (LCAs) should take into account the greenhouse gas impacts across land use change (if applicable), growth, harvesting, transportation, conversion, and use of bioresources.

Natural carbon sinks: Natural reservoirs storing more CO_2 than they emit. Forests, plants, soils, and oceans are natural carbon sinks.

Natural Climate Solutions (NCS): Actions considered to be a subset of nature-based solutions (NBS) with a specific focus on addressing climate change. NCS has been defined as "conservation, restoration, and/or improved land management actions to increase carbon storage and/or avoid greenhouse gas emissions across global forests, wetlands, grasslands, agricultural lands, and oceans".[7] NCS can be coupled with technology to secure long-term or permanent storage of GHGs, examples include CCS, the use of technologies such as torrefaction to process biomass or monitoring to improve forest management techniques for increased density.

Negative emissions (or 'net negative' emissions): is used for the case where the combination of all sector CO_2 emissions plus carbon removals results in an absolute negative (and thus a reduction in the stock of atmospheric CO_2).

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.

Peatlands: Peatlands contain layers of partially decomposed organic material preserved in waterlogged environments. They contain a large fraction of the world's terrestrial carbon stock and when damaged or destroyed can become large sources of GHG emissions.

Zero-carbon energy sources: Term used to refer to renewables (including solar, wind, hydro, geothermal energy), sustainable biomass, nuclear and fossil fuels if and when their use can be decarbonised through carbon capture.

1 UK Committee on Climate Change (2018), *Biomass in a low-carbon economy.*
2 Sandalow et al. (2021), Biomass carbon removal and storage (BiCRS) roadmap.
3 UK Committee on Climate Change (2018), *Biomass in a low-carbon economy.*
4 BP (2014), *Biomass in the Energy Industry – an introduction.*
5 BP (2014), *Biomass in the Energy Industry – an introduction.*
6 BP (2014), *Biomass in the Energy Industry – an introduction.*
7 Griscom et al. (2017), *Natural Climate Solutions.*

Introduction

In November the world will hold the landmark 26th Conference of the Parties (COP26) in Glasgow, aiming to accelerate global action to avert potentially catastrophic climate change. Ahead of that meeting, many countries, cities, and companies have made commitments to reach net-zero emissions (whether for carbon dioxide or all greenhouse gas emissions (GHGs) by 2050 or 2060). In addition, over 100 countries have submitted new "nationally determined contributions" (NDCs) within the Paris agreement framework, updating their previous targets for reductions to be achieved by 2030. But, the sum of these pledges still falls far short of what is required to deliver a more than 50% chance of limiting global warming to 1.5°C.[1]

This report describes 6 sets of action which if agreed at COP 26 and implemented during the 2020s would make it possible to achieve the 1.5°C target. It focuses on actions which are clearly technically feasible and which could initially be progressed by leading groups of governments and/or companies without the need for comprehensive internationally negotiated agreements. Many of these actions would also deliver significant co-benefits, for example through improved local air quality.

Four of the action categories would entail either nil or even negative costs, or costs which could very easily be absorbed by the global economy:

- These include low cost actions to reduce methane emissions, which has not previously received the attention it deserves, given methane's crucial role in global warming and the big potential for short term reductions and favourable climate impact;
- They also include action to accelerate road transport electrification, energy efficiency improvement, and the decarbonisation of sectors such as steel, cement, shipping and aviation, which until recently were seen as "harder to abate". In some of these sectors indeed technological progress, cost reductions and corporate commitments make it likely that emission reductions will run ahead of current NDC commitments even if no new agreements were made at COP26. But additional commitments and agreements would reinforce the powerful "ambition loop" between national policy, corporate action and technological progress, enabling still faster emissions reduction, while supporting economic growth.

Two categories of action would however entail material economic cost. Committing to no new coal investments is close to costless, but reducing emissions from existing coal plants before end of life would impose some cost, particularly in some lower income developing countries. So too would action to halt deforestation, which has long been identified as a high priority, but with limited progress. Commitments of climate finance support from developing countries will therefore be required to seize the potential in these two specific categories.

The starting point - how big is the gap?

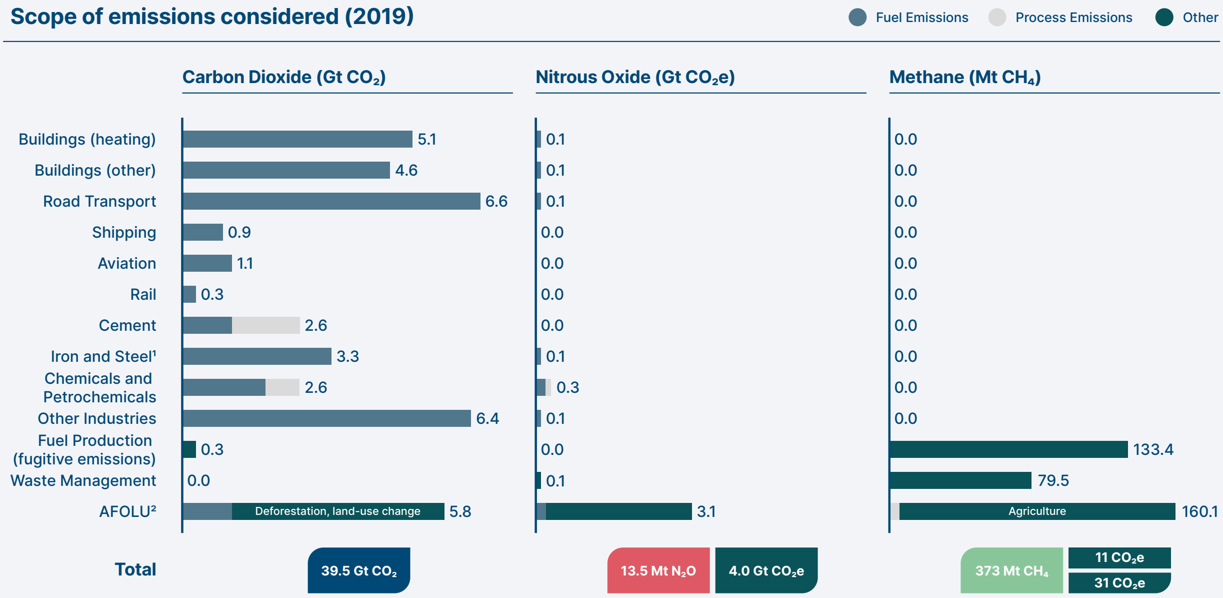
Box A shows the starting point from which emissions reductions must be achieved and explains the complexities involved in assessing the relative importance of carbon dioxide and methane emissions. According to the period considered over which the warming impacts of methane are felt, current CH_4 emissions of around 375 $MtCH_4$/year could be considered as equivalent to anywhere between 11 $GtCO_2$/year (100-year view) and 31 $GtCO_2$/year (20-year view), and the measure of impact of any given methane emissions reduction varies by the same proportion. There is no clear "correct" way to measure the equivalence of methane emissions, but given the vital importance of reducing global warming soon – and the risk of tipping points and feedback loops from continued warming - there is a strong argument for placing as much emphasis on the 20-year period (which implies a 84 times multiplier vs CO_2) as on the 100-year (28 multiplier) approach. Latest analysis by the IPCC suggests that about 40% of global warming so far has been caused by methane rather than carbon dioxide emissions. In this report, we therefore place very strong emphasis on the importance of reducing methane emissions and show the impact of methane reductions on both the 20-year and 100-year bases.[2]

1 The Paris agreement committed the world to limiting global warming to "Well below 2°C, while pursuing efforts to limit the temperature rise to 1.5°C". The IPCC *Special report on Global Warming of 1.5°C*, published in Autumn 2019 argued that a limit of 1.5°C should be the objective given the increasing harm which would result as temperature rises to and beyond that point. It is already close to impossible to ensure a high probability that warming will be limited to 1.5°C. This report focuses on the actions required to give a 50:50 chance of limiting warming to 1.5°C and a 90% chance of keeping it below 2°C.

2 Emissions from other greenhouse gases are also important - particularly nitrous oxide, much of which results from use of fertilisers in the agricultural sector, and fluorinated gases, typically used as refrigerants – however the actions identified in this report focus solely on reducing emissions from carbon dioxide and methane.

Box A: The emissions starting point and key measurement issues

Total emissions today are 40 $GtCO_2$, 4 $GtCO_2e$ from N_2O and 375 $MtCH_4$ from EBIT sectors, waste and AFOLU



NOTES: [1] Due to the production process, process emissions and fuel emissions are typically not separated for iron and steel;
[2] AFOLU: Agriculture, Forestry, and Other Land Use.
Estimates of global greenhouse gas emissions in 2019 range widely as a result of varying assumptions, including different assumptions on GWP of methane.

SOURCE: SYSTEMIQ analysis for the ETC based on: IEA (2020), *Energy Technology Perspectives*; EDGAR database; SSP database by IIASA; IEA (2020), *Methane Tracker*.

The main gases responsible for global warming are carbon dioxide, methane, nitrous oxide and fluorinated gases. Estimated 2019 emissions are shown in the box above, at around 40 $GtCO_2$, 13.5 Mt N_2O and around 375 $MtCH_4$. In each case, the “forcing effect” which induces global warming, is a function of the atmospheric concentration of the gas at any time. Differences in the average lifetime of gases have implications for whether emissions reductions objectives should focus on stocks (the total quantity) or flows (the annual rate), and for how to compare the relative importance of carbon dioxide and methane emissions:

- Carbon dioxide and nitrous oxide are both long-lived gases, which take many decades or centuries to dissipate. Annual flows must therefore fall to zero to prevent further increases in atmospheric concentrations and thus temperature, and emission reduction strategies should ensure that cumulative future emissions do not exceed defined maximum “budgets”. One tonne of N_2O has a forcing effect equal to about 260 times a tonne of CO_2, and today’s 15 Mt of annual N_2O emissions can thus be considered equivalent to around 4 $GtCO_2$.

- By contrast, methane is a relatively short-lived gas. Concentrations and the forcing effect would therefore stabilise if the flow of new methane emissions ceased to rise. However, this does not mean that the appropriate objective should be simply to stabilise rather than reduce methane emissions. The fact that methane is short-lived means that reducing methane emissions is the most powerful lever to reduce short-term temperature rises and risks of unlocking climate feedback loops. Appropriate objectives for methane emissions are therefore expressed in terms of how fast annual flows should fall over time rather than “budgets”.[3]

Given the different lifetimes of carbon dioxide and methane, estimates of the “carbon equivalent” effect of methane emissions depends on the timescale assumed. Over 100 years, a tonne of methane emitted today has a forcing effect (and therefore impact on temperature on average over the period) about 28 times that of a tonne of carbon dioxide emitted today. However, viewed over 20 years, methane’s impact is around 84 times greater per tonne emitted. (These were corrected to 29.5 and 82.5 respectively in the IPCC’s recent AR6 report). Neither measure is definitively “correct”, but the possibility of climate feedback loops and the need to limit temperature increases as rapidly as possible argues for a strong focus on the 20-year time frame and 84-times multiplier measure.

3 ETC Consultation Paper (2021) *Reaching climate objectives: the role of carbon dioxide removals.*

Using the 100-year approach referenced in many external sources, current total GHG emissions amount to about 55 $GtCO_2$ equivalent ("CO_2e", see exhibit in Box A) and that figure would continue to rise under a business-as-usual scenario. Analysis suggests that policies already in place could deliver a reduction to as low as 51 $GtCO_2e$ by 2030. New NDC commitments could bring emissions down by another 2-5 $GtCO_2e$, to a level around 46-49 $GtCO_2e$ in 2030. However, reductions in total emissions to somewhere around 25-30 $GtCO_2e$ by 2030 would be needed to put the world on a pathway which would limit global warming to 1.5°C.[4] The world, therefore, faces an "emissions gap" of around 20-23 $GtCO_2e$ between what needs to be achieved and what is likely to be committed to in NDCs agreed by COP26.[5]

Six sets of actions to close the gap

Almost all of this gap could be closed via the feasible actions identified in this report. Methane emissions could be cut by 40%, delivering about 130 $MtCH_4$ of reduction not already included in current NDCs. This would be equivalent to a CO_2e reduction of around 3.5 Gt on the 100-year (28 multiplier) basis, and around 11 Gt on the 20-year basis (84 multiplier) (Exhibit 1). Feasible actions could reduce carbon dioxide emissions by an additional 17 $GtCO_2$ beyond NDC commitments, with 6.6 Gt CO_2 of reductions delivered by "Nature-Based Solutions" and over 10 $GtCO_2$ via accelerated reduction of emissions from the energy, building, industry and transport (EBIT) sectors (Exhibit 2).

In order to achieve this, we propose a programme of action involving six action areas:

1. **Significant and rapid reductions in methane emissions**, delivering an additional reduction of 3.5 $GtCO_2e$ (100-year view) to 11 $GtCO_2e$ (20-year view) beyond current NDCs, depending on the time period assumed. This could be achieved via two distinct categories of action:

    - Emissions arising from fuel production, transport, and use, which currently amount to around 135 Mt CH_4, could and should be reduced by 60% or more by 2030, led by reduction of 75% in US, Russia, Canada and China. Coal-related emissions will automatically fall if coal use is phased out in the power sector, while emissions arising from leaks in the oil and gas production and distribution system could be radically reduced through an array of technically feasible actions. Many of the actions required to achieve this will entail negative, zero, or minimal cost, but rapid progress will only be achieved through strong action by key governments, companies, and the financial sector supported by strong regulation, independent monitoring, and certification.

    - Reducing emissions in the waste and agricultural sectors will be more challenging. Low-cost opportunities clearly exist, but progress will require actions by very large numbers of companies and individual producers across the world or entail consumer behaviour shifts towards more plant-based and less meat-based diets. However, a strong international focus on achieving the potential reductions, supported by multiple forms of national, corporate, city, and consumer action, could deliver reductions of 30% by 2030.

Given the vital importance of reducing methane emissions fast, COP26 should therefore be used as an opportunity to launch an initiative to reduce annual methane emissions by at least 40% by 2030, or 150 $MtCH_4$ per year, building on (but strengthening) the Global Methane Pledge.

2. **Halting deforestation, beginning reforestation and other carbon sequestration opportunities**. The potential and need to reduce carbon dioxide emissions by ending deforestation has long been recognised. By 2030, 3.6 $GtCO_2$ of annual emissions could be eliminated if deforestation ceased, and almost 3 $GtCO_2$ per annum could be removed from the atmosphere via reforestation and other nature-based actions to sequester carbon in soils and restored ecosystems. Development of new technology is not necessary to achieve this (though it can be an enabler), and in principle the costs of abatement are low, but success will require a combination of:

    - Flows of finance from developed to developing countries to cover the short-term opportunity cost of preserving tropical forests rather than exploiting them for alternative activities such as feedstock crops or cattle rearing, and to support reforestation of around 300 million hectares of land by 2030. Estimates suggest that the cost of such action would be low compared with other mitigation options – for instance nearly 2 $GtCO_2$ could potentially be avoided at a cost of less than $10 per tonne of CO_2, with a further 1 $GtCO_2$ available at less than $100 per tonne of CO_2.[6] Estimates for reforestation and afforestation are consistently in the range of around $5-50/$tCO_2$.[7] Large-scale financial flows will be required to achieve the potential reductions – for example $200 billion per annum would be required to achieve 5 $GtCO_2$ of reductions at an average cost of $40 per tonne.

    - Jurisdictional approaches to land management at a regional or national level, that ensure emissions are genuinely reduced, rather than simply displaced.

    - Widespread changes in consumer behaviour to begin a shift from meat-based to more plant-based diets.

4 The GHG emissions level baselines and pathways in this report are based on analysis from Climate Action Tracker. Further details on this analysis and comparison with other methodologies are included in the Annex. CAT's estimates for NDCs are consistent with the September 2021 update of the UNFCCC *NDC Synthesis Report*.

5 The emissions gap would be larger if using a 20-year multiplier for methane, however this report consistently uses the 100 year multiplier when referring to the 2030 emissions gap in CO_2e.

6 Based on estimates in Griscom et al. (2017) *Natural Climate Solutions*.

7 Royal Society (2018) *Greenhouse Gas Removal*. Fuss et al. (2018) *Negative emissions—Part 2: Costs, potentials and side effects*.

In addition to nature-based forms of carbon sequestration it is possible to achieve 0.1 $GtCO_2$ carbon removal by 2030 via carbon capture technologies combined with geological storage of CO_2, whether via BiCRS (biomass carbon removal and storage) or DACCS (direct air capture of CO_2 plus storage). Early projects in the 2020s can ensure these technologies are available to deploy at scale beyond 2030.

Highly feasible actions to reduce methane can deliver an additional ~130 $MtCH_4$ (3.5-11 $GtCO_2e$) beyond current NDCs in 2030

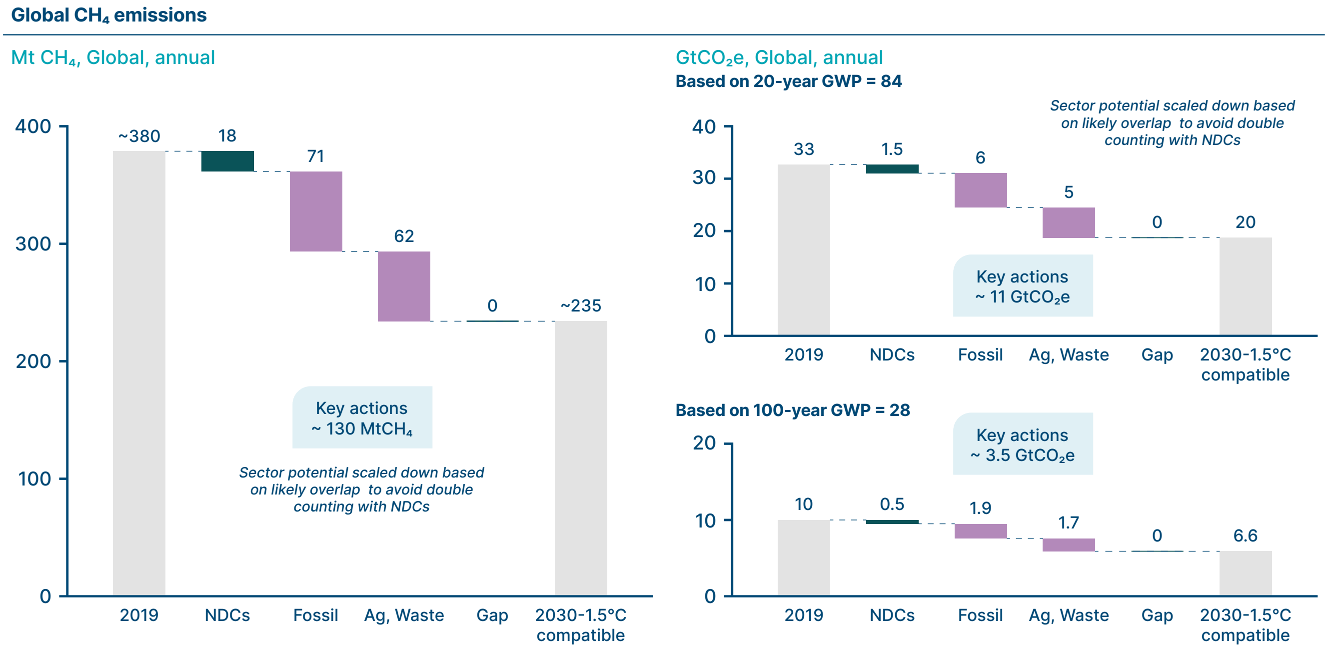


Exhibit 1

NOTE: NDC emissions reductions are based on average of CAT "pledges and targets" pathway adjusted for CH_4. 1.5C compatible levels in 2030 are based on IPCC 1.5C no/low overshoot scenario median.

SOURCE: IPCC (2018), *Global warming of 1.5°C. An IPCC Special Report*, Climate Action Tracker (CAT), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Highly feasible actions to reduce carbon dioxide can deliver an additional ~17 $GtCO_2$ reductions beyond current NDCs in 2030

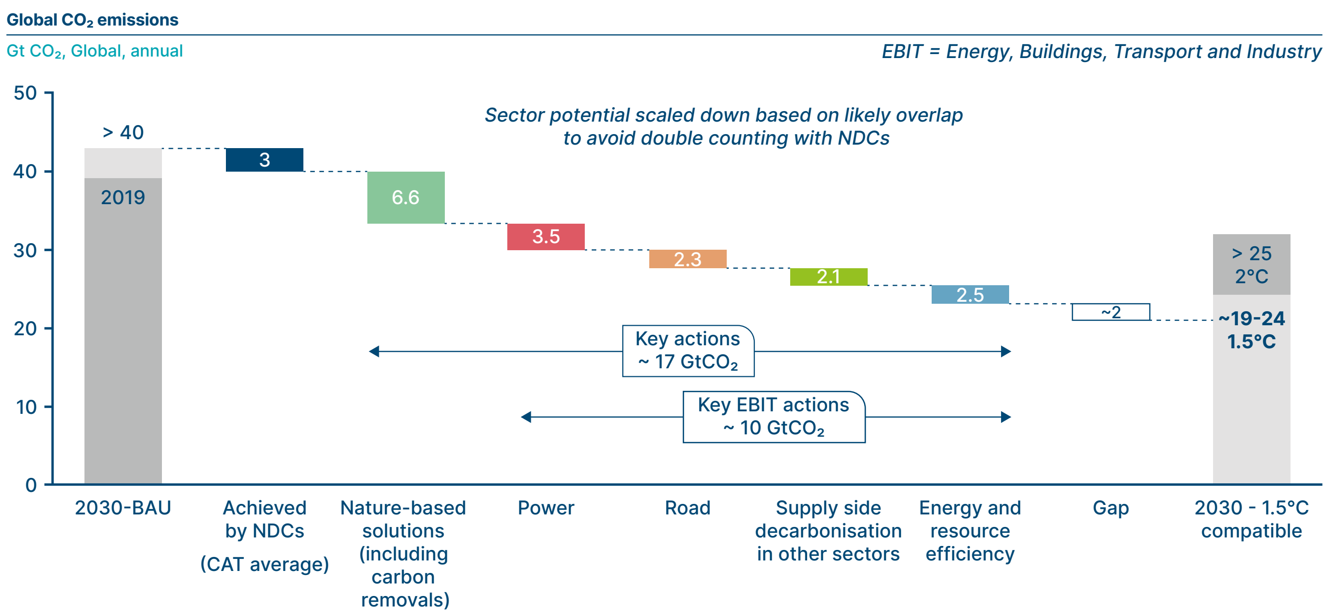


Exhibit 2

NOTE: 2030 BAU CO_2 emissions are estimated based on CAT CO_2e 2030 BAU average (53$GtCO_2e$) minus current methane levels in GWP=25 terms (9.3 $GtCO_2e$). NDC emissions reductions are estimated based on average of CAT "pledges and targets" pathway adjusted for CO_2. 1.5°C and 2°C compatible levels in 2030 are based on IPCC 1.5°C no/low overshoot scenario ranges.

SOURCE: IPCC (2018), *Global warming of 1.5°C. An IPCC Special Report*, Climate Action Tracker (CAT), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

A crucial priority for COP26 should be to gain as strong an agreement as possible on ending deforestation, supported by appropriate flows of international climate finance. An end to deforestation, the beginning of reforestation and other nature-based solutions should indeed (along with action to eliminate emissions from existing coal plants – see below) be the highest priority for use of the funds which rich developed countries have committed to international climate finance.

3. **Decarbonising the power sector – accelerating coal phase-out**. Power sector CO_2 emissions were over 13 Gt in 2019, with 9.5 Gt of this arising from coal-fired power. In addition, coal-related CH_4 emissions of an estimated 40 $MtCH_4$ produce an equivalent impact of 1 $GtCO_2e$ (100-year view) to 3 $GtCO_2e$ (20-year view). Accelerating the move beyond coal power generation is therefore one of the highest potential actions to reduce emissions in the short term. An additional 3.5 $GtCO_2$ reductions, beyond current NDC commitments, together with proportional cuts in coal-related methane, could be achieved via a combination of three actions:

    - Clear international agreement to build no new coal plants, scrapping the vast majority of the 300 GW of proposed new coal capacity still in the pipeline. This is a close to costless commitment since renewables are now cheap enough to deliver increases in power production and consumption at total system costs fully competitive with new coal.[8]

    - Commitments by all OECD countries to completely phase out any unabated coal generation by 2030 – either through closing coal plants entirely or by adding CCS. The costs of this will be very small relative to the GDP of rich countries.[9]

    - Action to phase out ~760 GW older existing coal plants (e.g. plants greater than 20 years old) in middle-income and developing economies. This may entail a significant net cost and should be a high priority for the use of climate finance funds by which the rich developed world supports accelerated decarbonisation in lower-income developing countries.

A strong agreement between major countries to move beyond coal in the 2020s is therefore a vital COP26 priority. This should align and expand on existing initiatives such as the Powering Past Coal Alliance and entail financial support from developed countries to middle-income and developing countries.[10]

4. **Accelerating road transport electrification:** Technological progress and cost reduction in batteries and electric vehicles (EVs) now make it possible to drive road transport electrification far more rapidly than seemed feasible five years ago. Within the next decade, shifting to passenger EVs will be a negative cost transition, delivering savings to consumers rather than additional costs. National strategies for vehicle electrification included in the NDCs have begun to reflect this potential, but in most cases still do not reflect the size of the potential zero-cost prize. Agreement at COP26 to ban all sales of ICE light-duty vehicles by 2035, combined with city-based action to restrict the use of existing ICE vehicles beyond defined future dates, could lead to around 20% of cars on the road being electric by 2030 and deliver around 2 $GtCO_2$/year of reductions, with an additional 0.6 $GtCO_2$/year of savings possible from low or negative cost action to improve heavy-duty truck efficiency.

A strong agreement to commit to ending sales of light-duty ICE vehicles by 2035 at the latest is therefore a crucial COP26 priority, supported by clear targets from countries and car manufacturers.

5. **Accelerating supply decarbonisation in buildings, heavy transport, and heavy industry.** As the Energy Transitions Commission (ETC) showed in its *Mission Possible* report in November 2018, it is technically and economically feasible for even the so-called "harder to abate" sectors of the economy – such as steel, cement and chemicals, long-distance aviation and shipping – to reach net zero emissions by mid-century at a trivial cost to global economic growth and living standards. Many leading companies in these sectors have now made net zero by 2050 commitments.

    Until recently however, most published pathways for emission reductions in these sectors assumed a strongly convex shape, with very limited progress to 2030, followed by gradual acceleration in the 2030s. Most current NDCs therefore reflect this minimal near term ambition. The Mission Possible Partnership (MPP) is now working to define and agree sectoral pathways to 2030 and on to 2050. In some sectors these will still suggest only moderate reduction potential in the 2020s given the inherent challenges created by long lasting capital assets. But action to maximise progress could still deliver an additional reduction of around 1 $GtCO_2$ per annum by 2030, and enable full decarbonisation of these industries between 2030-2050. The concentrated and inherently global nature of these industries makes them natural targets for internationally agreed action at COP26. Actions focused on key enabling technologies – in particular hydrogen and CCS – could support sectoral focused initiatives.

8 ETC (2021) *Making Clean Electrification Possible*.
9 ETC (2021) *Making Clean Electrification Possible*.
10 The PPCA encourages countries and corporates to commit to phase out coal by 2030 in the OECD and EU, and by no later than 2050 in the rest of the world.

International agreements to accelerate electrification of parts of industry and buildings – e.g. via the deployment of heat pump and other technologies relevant to residential heating and of light industry - could also help deliver an additional 1 $GtCO_2$/year of emissions reductions.

COP26 should aim to achieve agreements between leading coalitions of countries, companies and sectoral organisations to drive accelerated decarbonisation of the steel, cement, aviation and shipping sectors. Leading countries could also commit to accelerated electrification (e.g. via heat pumps), and scaling up clean hydrogen.

6. **Energy and resource efficiency:** Many past analyses have identified a major opportunity to reduce emissions by improving the energy efficiency of buildings, equipment and materials use, and through wider changes to increase overall "energy productivity" (energy use per unit of GDP) through, for instance, better-designed cities, digital technologies, and more circular production systems. However, progress has been disappointly slow and has declined in recent years, in part because it requires action by many millions of economic actors across the world. Moreover, many aspects of required policy are inherently local in nature, limiting the potential role for international agreements. But an international agreement for specific standards and regulations focused on improving the energy efficiency of new buildings could deliver 1.4 $GtCO_2$ per year reduction by 2030, with another 1.5 $GtCO_2$ potentially from a series of other actions (e.g. retrofits to existing buildings and improved longevity and recycling of consumer goods). Early action to encourage less carbon-intensive city design is essential in the 2020s to deliver faster progress in the 2030-40s.

Government commitments to adopt best-in-class building standards and product efficiencies should therefore be a priority at COP26.

The infographics on the following pages set out a selection of specific actions which could be taken to seize the opportunities identified and highlights potential discrete international agreements that could be used to increase ambition at COP26. A comprehensive list of actions is found at the end of this report.

Almost inevitably, agreements made at COP26 will not be sufficient in themselves to make it certain that a 1.5°C pathway can be achieved. But if COP26 can gain agreement that these are the areas for highest potential short-term action, achieve some progress on each, and put in place processes for future reinforcement of commitments over the next two years – leading to a stocktake in 2023 - it could still play a crucial role in keeping alive the potential to limit global warming to 1.5°C.

The rest of this report sets out this argument in detail, covering in turn:

- **The need for faster progress in the 2020s.**
- **What has changed since Paris? Technologies, costs, and scientific understanding.**
- **Assessing the potential to go beyond NDCs: methodology and approach.**
- **Feasible actions to accelerate emissions reductions – 6 key categories for priority action.**
- **Adding it up – can we close the gap?**
- **Actions at and after COP26.**

Energy
Transitions
Commission

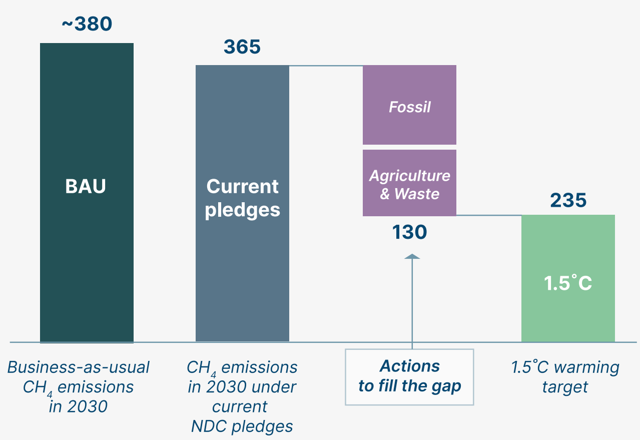
HOW TO KEEP 1.5˚C ALIVE

WHAT IT WILL TAKE

REDUCE METHANE EMISSIONS BY 40%

CH_4

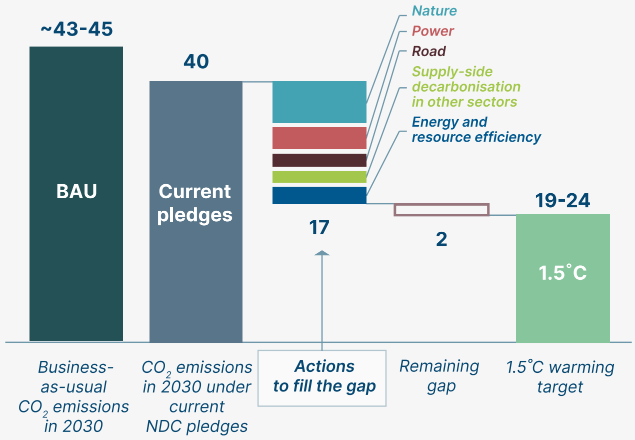
Global annual methane emissions ($MtCH_4$), 2030



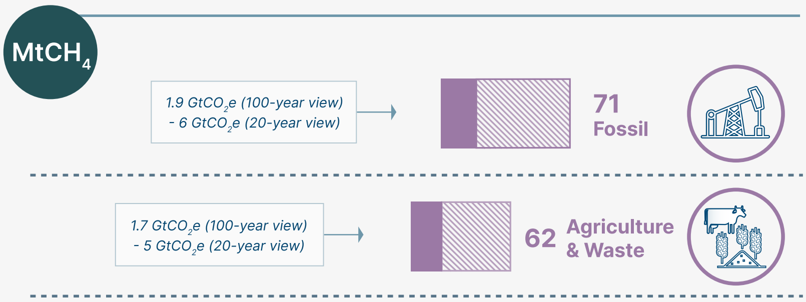
REDUCE CARBON DIOXIDE EMISSIONS BY 45%

CO_2

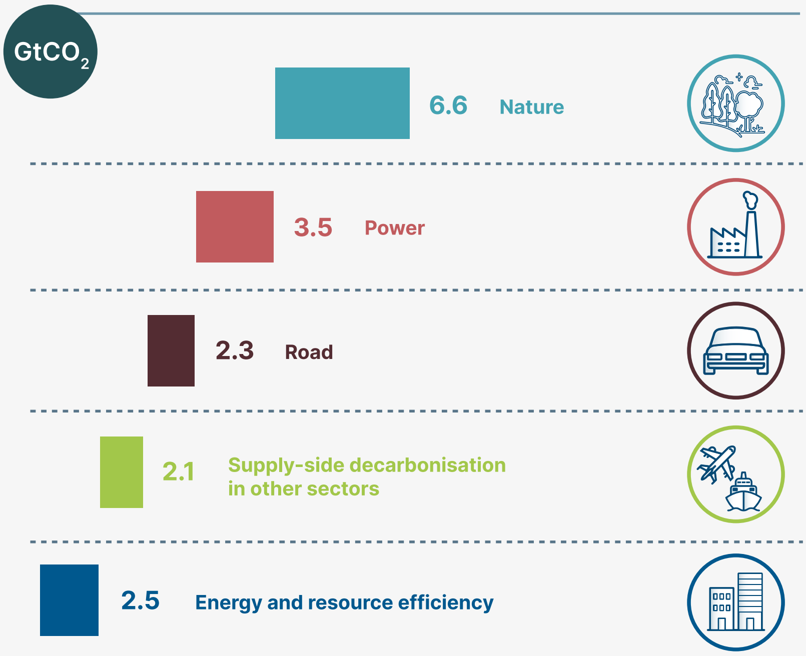
Global annual carbon dioxide emissions ($GtCO_2$), 2030



CLOSING THE METHANE EMISSIONS REDUCTION GAP



CLOSING THE CARBON DIOXIDE EMISSIONS REDUCTION GAP



COP26 TARGET OUTCOMES

- Countries and companies to cut global fossil methane emissions by 60% in the 2020s (building on the Global Methane Pledge)
- Country and company commitments to cut non fossil methane emissions by 30% in the 2020s (building on the Global Methane Pledge)
- Strong agreement on ending deforestation and driving ecosystem restoration, supported by clear commitments for international climate finance from developed nations
- Strong agreement between major countries to move beyond coal in the 2020s, with clear commitments to no new coal, and developed country support for early exit
- Strong agreement to commit to ending sales of light-duty ICE vehicles by 2035 at the latest, supported by clear targets from countries, cities and auto manufacturers
- Strong agreement between countries, companies and sectoral organisations for accelerated decarbonisation of the steel, cement, aviation and shipping sectors
- Strong agreement to make energy and resource efficiency key features of future NDCs, supported by adoption of best-in-class building standards, product efficiencies

NDCs are Nationally-Determined Contributions

Energy Transitions Commission

HOW TO KEEP 1.5˚C ALIVE

WHAT WE NEED TO DO

STAKEHOLDERS

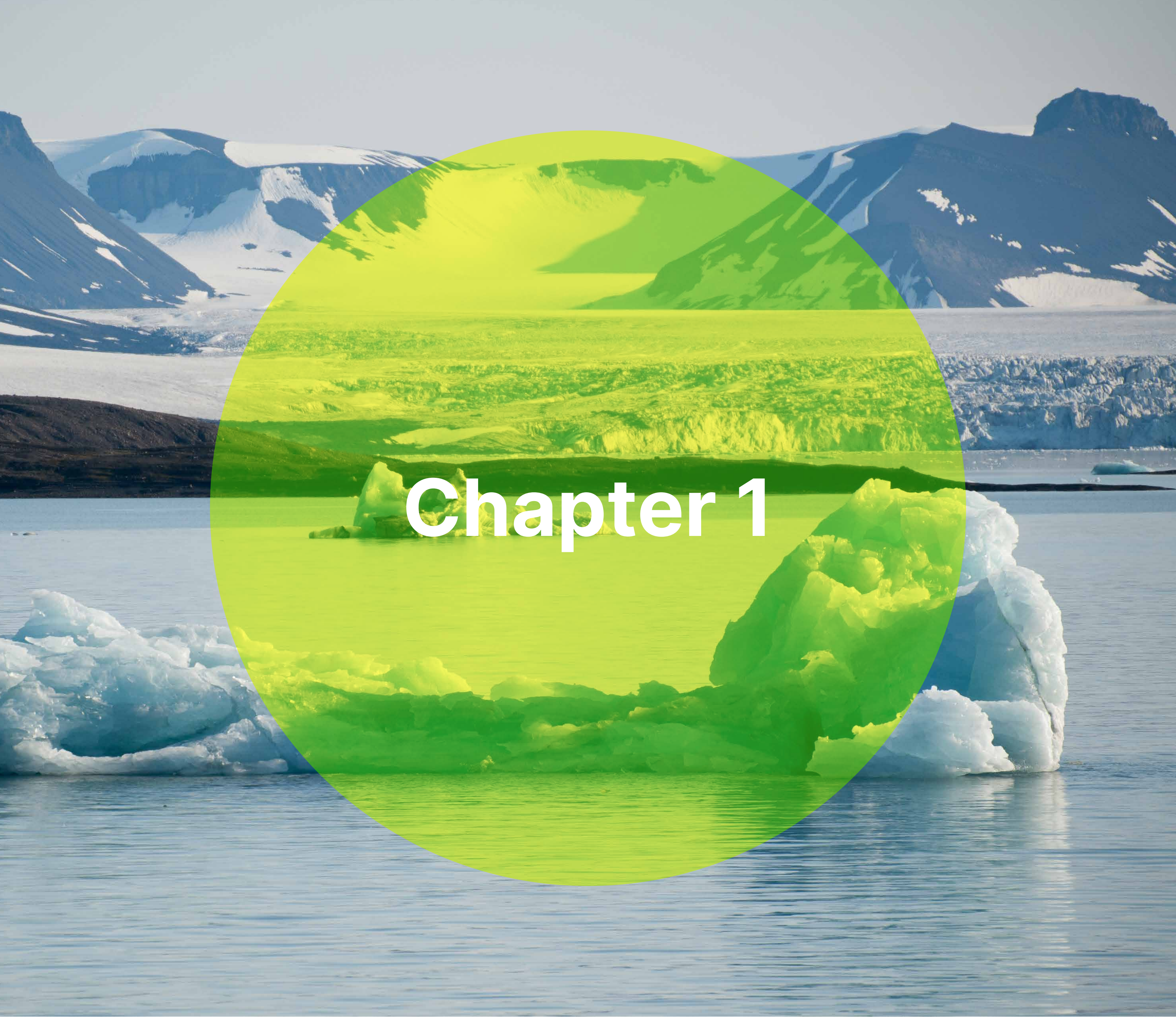
GOVERNMENTS
- Developed countries
- Developing countries
- Cities

FINANCIAL INSTITUTIONS
- Multilateral Financial Institutions
- Private capital

PRODUCERS AND BUYERS IN KEY INDUSTRIAL SECTORS
- Fossil
- Energy-intensive
- Logistics
- Commodity Traders
- Food and Agriculture
- Mining and Forestry
- Auto manufacturers
- Water

INDIVIDUAL CONSUMERS
- Individuals

	ADDITIONAL EMISSIONS REDUCTIONS BY 2030	WHAT – ACTIONS FOR THE 2020s	STAKEHOLDER
METHANE	Fossil 71 $MtCH_4$	• Limit maximum leakage rates to well below 1%, starting in top emitting countries, backed by large fines and certification schemes (e.g. MiQ) • Funding for satellite monitoring of methane leakage	
METHANE	Agriculture & Waste 62 $MtCH_4$	• Reducing food waste on farms and in transit via logistics and technology • Food product labelling highlighting emissions impact and support for development of alternative proteins to drive diet shift • Investment in wastewater treatment and waste collection	
CARBON DIOXIDE	Nature 6.6 $GtCO_2$	• Rapid scale-up in finance from developed countries, and ambitious corporates • Commitment to deforestation-free supply chains • R&D funding for high-yield crops; campaigns to promote lower-impact diets	
CARBON DIOXIDE	Power 3.5 $GtCO_2$	• Immediate end to new coal financing • Targeted financial support from developed countries for early coal retirement	
CARBON DIOXIDE	Road 2.3 $GtCO_2$	• Global light-duty ICE sales ban by 2035 at the latest • Fleet-wide fuel efficiency standards for heavy-duty vehicles, and incentives for low-carbon fuels • Commitments and funding for EV charging infrastructure	
CARBON DIOXIDE	Supply-side decarbonisation in other sectors 2.1 $GtCO_2$	• Introduce policy support to overcome "green premiums" (e.g. carbon pricing, mandates or product standards, public procurement) • Commitments to procure low-carbon materials and goods (e.g. green steel)	
CARBON DIOXIDE	Energy and resource efficiency 2.5 $GtCO_2$	• Global commitments to adopt best-in-class building & appliance efficiency • Low-carbon travel zones in cities; increased tax on business class flights • Separate collection of waste and recyclables, delivered by local government; commitments to repair from industry	



The need for faster progress in the 2020s

To date, the world has seen man-made warming of around 1.1°C above preindustrial levels and, as the recent IPCC report warns, is already seeing the impact of climate change.[11] To avoid severe harm to human welfare, global warming should ideally be limited to 1.5°C and the probability of exceeding 2°C kept very small (e.g. less than 10%). This will require not only reducing carbon dioxide emissions to around zero by mid-century, but reducing them by 40-50% by 2030, while also cutting methane emissions by about 40%. National commitments already made, or likely to be made by COP26, fall well short of this requirement. Estimates suggest that current submitted NDCs, together with legally binding net zero commitments, put the world on a trajectory to 2.4°C of warming by the end of the century.[12]

The carbon budget and methane emission reductions

As explained in Box A, there is no single "correct" way to express all GHGs (and in particular methane) in one summary "CO_2 equivalent" figure. In calculating the remaining "carbon budget" – e.g. how much carbon dioxide can be cumulatively emitted while limiting global warming to any given temperature – the IPCC, therefore, assumes a future rate of reduction for methane and other non-carbon dioxide emissions and then calculates the acceptable level of future cumulative carbon dioxide emissions likely to trigger a certain level of warming. Exhibit 3 shows the IPCC's range of assumptions for methane reduction in 1.5°C scenarios, with a median cut of around 40% by 2030 and around 55% by 2050.

If methane emissions did fall along this median pathway, the remaining carbon budget – i.e. emissions that would be possible from 2020 onwards - with a 50% chance of limiting warming to 1.5°C (and a roughly 90% chance of limiting to below 2°C) would be about 500 $GtCO_2$ (Exhibit 4).[13] Slower progress on reducing methane emissions, would decrease the carbon budget available.

There are an infinite number of pathways for annual carbon emissions which could produce an "area under the curve" equal to this 500 $GtCO_2$ budget, particularly if we assumed that an overshoot of the budget in the first 30 years could be offset by negative emissions after 2050. But given potential feedback loops and tipping points within the climate system, it is unacceptably risky to rely on large scale negative emissions later in the century, and the IPCC pathways which avoid such reliance show that CO_2 emissions need to be cut from today's 40 $GtCO_2$ to below 25 $GtCO_2$ by 2030. Including other GHGs in carbon dioxide equivalence – and using the conventional 100 timeframe and 28 multiplier for methane - this implies that total emissions need to fall from around 53 $GtCO_2e$ today to around 25-30 $GtCO_2e$ by 2030.[14]

Current commitments fall far short of this requirement.

Under IPCC pathways for low/no 1.5C overshoot, methane emissions must decline by ~35% by 2030

Methane

Methane in IPCC SR 1.5 Low Overshoot Pathways

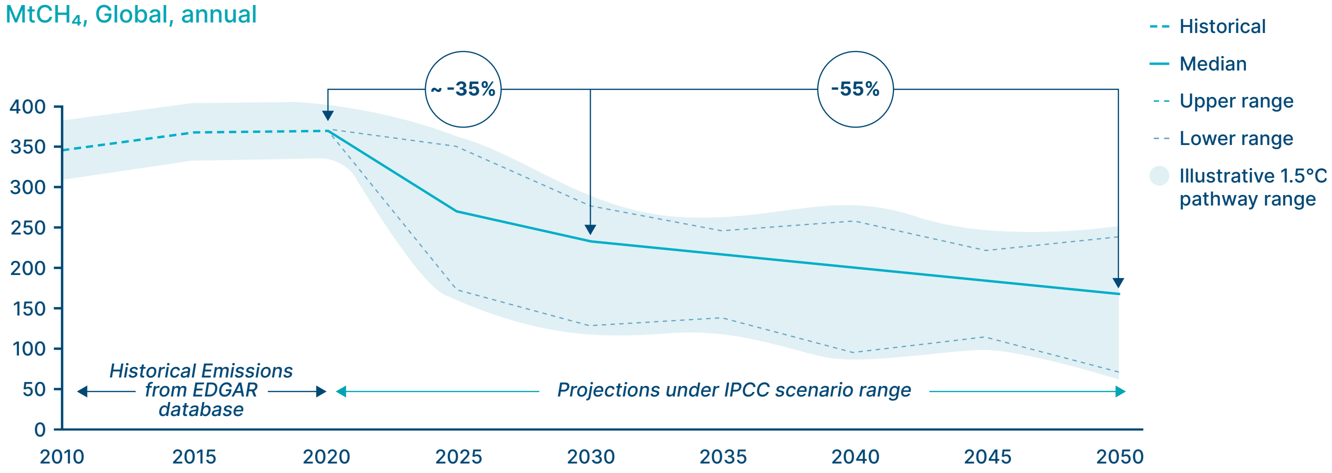


Exhibit 3

NOTE: Historical values for methane emissions have a very high range of uncertainty.

SOURCE: EDGAR database, IPCC (2018), ***Global warming of 1.5°C. An IPCC Special Report***

11 IPCC (2021), *Climate Change 2021: The Physical Science Basis (AR6).*

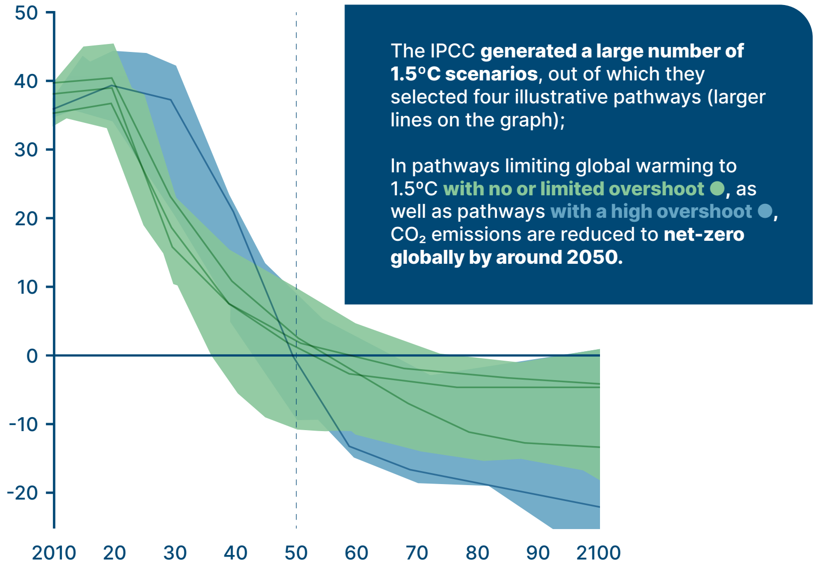
12 WRI (2021) *Closing the Gap*.

13 Five key elements of the science which underpins the carbon budget were revised for the publication of the IPCC's Sixth Assessment Report. These included: 1) estimates of historical warming to date, 2) the amount of warming each tonne of CO_2 produces (the Transient Climate Response to Cumulative Emissions (TCRE)), 3) how much warming occurs once net-zero is reached, 4) climate warming driven by non-CO_2 greenhouse gas emissions (e.g. methane), and 5) earth system feed-backs not otherwise covered (e.g. permafrost thaw and wildfire). Overall, the revision of each these five factors resulted in relatively little change for a 50% percentile 1.5°C carbon budget, however the upper and lower percentiles have narrowed in range.

14 Using the 20-year timeframe and GWP=84 multiplier, this would equate to a need to fall from around 75 $GtCO_2e$ today to around 40 $GtCO_2e$ by 2030.

To have a 50% chance to remain <1.5°C warming, IPCC estimates the remaining carbon budget to be ~500 Gt CO_2 from 2020

Global emissions pathway characteristics in the IPCC 1.5°C report
Gt CO_2/year



Chosen carbon budget in this report

	50% chance	67% chance	~90% chance
<1.5°C	**500** Gt CO_2 from 2020	**400** Gt CO_2 from 2020	N/A
<1.7°C	**850** Gt CO_2 from 2020	**700** Gt CO_2 from 2020	N/A
<2°C	**1350** Gt CO_2 from 2020	**1150** Gt CO_2 from 2020	**500** Gt CO_2 from 2020

CH_4 and N_2O reductions corresponding to chosen carbon budget

CH_4 reduction by 2050	N_2O reduction by 2050
~50% (42%-76% range)	~30% (-25% - 48% range)

SOURCE: IPCC (2018), Global Warming of 1.5°C

Exhibit 4

SOURCE: IPCC (2021), *Climate Change 2021: The Physical Science Basis* (AR6).

Current pledges relative to need.

An increasing number of countries have set targets to achieve zero emissions at, or close to mid-century. As of September 2021, 55 countries covering 70% of global CO_2 emissions (and 70% of global GDP) have made net-zero commitments, including China, the United States, and the European Union (Exhibit 5).[15] Momentum has also grown across the industry, with over 3000 businesses and 173 largest investors committing to achieve zero emissions by 2050.[16]

Short-term ambitions out to 2030 are reflected in the NDCs which are submitted under the Paris agreement. These NDCs typically set targets for emissions reduction (or reductions in carbon intensity) and describe measures and policies which national governments will take to meet them. Under the Paris agreement framework, NDCs should be updated every five years, with the objective being to establish a "ratchet mechanism" in which targets can only be tightened.

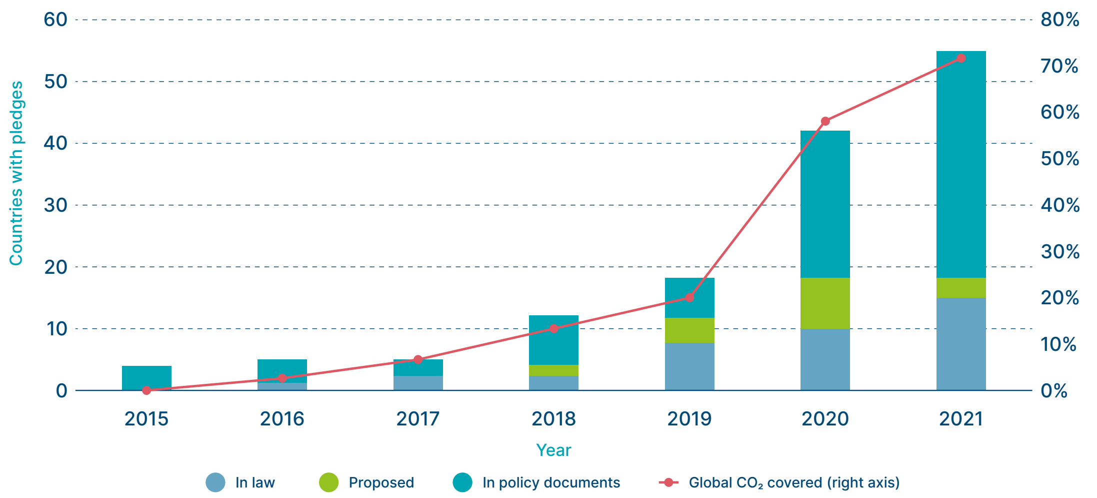
This ratchet mechanism has led to some increase in ambition, with further tightening of emission reduction targets compared with those submitted immediately after Paris (Table 1). Since September 2020, new NDCs have been submitted by over 115 countries while 48 countries have stated their intention to enhance ambition or action in a new or updated NDC. Estimates from Climate Action Tracker suggest that the aggregate impact of these new commitments could reduce 2030 emissions by an additional 2-5 Gt of CO_2e equivalent below the trajectory implied by current policies (Exhibit 6).[17]

However, this still leaves a gap of about 20 GtCO_2e compared with the pathway required to deliver a 50% probability of limiting global warming to 1.5°C.

Further GHG reductions – in particular for carbon dioxide and methane – must therefore be achieved if we are to close the gap.

15 ECIU (2021) *Net Zero Tracker;* IEA (2021) *Net Zero by 2050: A Roadmap for the Global Energy Sector*.
16 3067 businesses and 173 of the biggest investors have signed up to the Climate Ambition Alliance committed to achieving net zero by 2050 at the latest. See UNFCCC (2021) *Race to Net Zero*.
17 Climate Action Tracker (2021) *CAT Emissions Gap*.

In 2021, more than 70% of all global emissions were covered by a form of net-zero target



- Acceleration in net-zero commitments
- Net-zero targets account for around 70% of global GDP
- 15 countries have made their net-zero target a legal obligation

Exhibit 5

SOURCE: IEA (2021), *Net Zero by 2050*, Energy & Climate Intelligence Unit (2021), Net-Zero Emissions Race 2021 Scorecard.

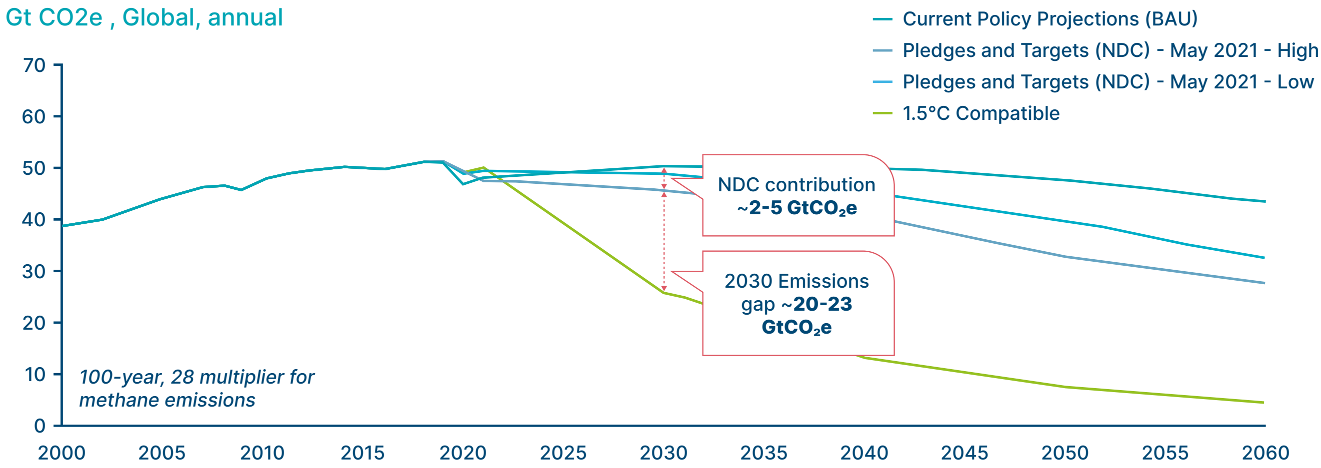
Table 1: NDC commitments for key countries

Country (and % of current global GHG emissions)	2016 NDC	Updated NDC 2020/21	NDC coverage	Detail on sectoral coverage
EU (7.5%)	At least 40% domestic reduction in GHG by 2030 compared to 1990.	NDC: Commits to the net domestic reduction of at least 55% in GHG emissions by 2030 compared to 1990. Domestic policy: Net Zero target for 2050.	Sector coverage is economy-wide including LULUCF. GHG target covers all emissions, including methane.	Targets set for certain sectors (e.g. renewable energy, energy efficiency). International Methane Emissions Observatory (IMEO) set up to monitor CH_4 emissions using company data, satellite tech and scientific studies.
USA (12.7%)	A 26-28% GHG emissions reductions below 2005 by 2025 (incl. LULUCF).	NDC: 50-52% GHG emissions reductions below 2005 by 2030 (incl. LULUCF). Domestic policy: Net Zero target for 2050.	Target includes LULUCF and covers emissions from all sectors and GHGs, including methane.	Climate plan covers full decarbonisation of power sector by 2035. US President Biden has reinstated methane regulations, and established a cooperative forum with Canada, Norway, Qatar and Saudi Arabia to create methane strategies.
China (26.1%)	Aim to have carbon emissions peak before 2030 and to lower carbon dioxide emissions per unit of GDP by 60-65% from the 2005 level.	NDC: No formal updated NDC has been submitted. Domestic policy: China has proposed to lower carbon dioxide emissions per unit of GDP by over 65% from the 2005 level. Separate target announced in 2020 for net-zero GHG by 2060 (excl. LULUCF).	Target includes LULUCF forest stock but no emissions target, and no emissions target for methane.	Specific targets on carbon dioxide emissions by GDP, share of non-fossil fuels in primary energy consumption, forest stock and installed capacity of wind and solar power all increased in updated NDC.
India (7.1%)	2030 unconditional target of 33-35% below 2005 emissions intensity of GDP by 2030, and non-fossil share of cumulative power generation capacity 40%. All excluding LULUCF. LULUCF specific target additional carbon sink of 2.5-3 $GtCO_2e$ by 2030.	NDC: No formal updated NDC has been submitted. Domestic policy: Target of 450 GW of renewable electricity by 2030. National hydrogen strategy.	Did not specify the coverage of GHG gases and sectoral coverage in metrics of the emissions intensity target in 2015 NDC.	Targets set for full electrification for households and coal power development.
Japan (2.5%)	2030 unconditional target of 26% below 2013 by 2030 for GHG emissions reductions. Long-term goal of 80% GHG emission reduction by 2050 (baseline not specified).	NDC: resubmitted without change in 2020. Domestic policy: A new 2030 GHG emissions reduction target was announced revising 26% below 2013 levels to a 46% reduction by 2030, working towards a 50% reduction. Net Zero target for 2050.	Economy-wide coverage including LULUCF. GHG emissions target include methane.	Specific coverage of road transport sector in targets. Some sectoral roadmaps.

Sources: Climate Action Tracker (2021) *Countries*; WRI (2021) *Climate Watch: Historical GHG Emissions*.

Currently pledged NDCs are insufficient to stay on 1.5°C path – remaining "emissions gap" of ~20-23 $GtCO_2e$ by 2030 (Climate Action Tracker)

Global GHG Emissions: emissions based on pledged and current policies



Note: CAT estimates of the emissions gap are slightly lower than estimates cited by the UNEP Emissions Gap report, due to differing assumptions taken across baselines (e.g. factors such as COVID-19 adjustments in baseline emissions trajectories, range of uncertainty of NDCs, and range of IPCC's 1.5°C compatible scenarios. See Technical Annex for further detail.

Exhibit 6

NOTES: [1] Current Policies Scenario is based on implemented policies and country baseline trajectories from government and international sources. The Pledges and Targets Scenarios represents a quantification of country-by-country NDC commitments. The "1.5°C compatible" Scenario is defined as the median of pathways that limit global warming to 1.5°C, or below, throughout the 21st century with no or limited (<0.1°C) overshoot.

SOURCE: Climate Action Tracker, 2021.

What has changed since Paris? Technologies, costs, and scientific understanding

Many of the options to reduce emissions discussed in this report were already known at the time of the Paris Agreement and in some cases informed the initial NDCs submitted. Since then, however, the need for rapid emissions reductions has become more apparent, and progress in developing technologies and reducing costs has increased the potential for rapid low-cost reductions. In particular;

- **Technology and cost developments have greatly increased the potential for rapid emission reductions** in the power sector, in road transport, and parts of heavy industry (e.g. via electrification or the use of hydrogen).

- **Improving scientific understanding has shown the vital need for forceful action** on deforestation and methane emissions.

Technological progress and cost reductions

Global emissions have not yet started to fall. But technology and cost developments – in part driven by the momentum which the 2015 Paris Agreement helped create – have now made possible far more rapid and low-cost reductions than seemed feasible at Paris.[18]

- **Technological progress and large-scale deployment has driven dramatic falls in the cost of wind and solar power** (Exhibit 7), as a result, renewables are now the cheapest way to generate electricity in most regions, and are increasingly cost-competitive with fossil fuel-based generation on a total system cost basis.[19]

- **Collapsing battery costs and improved energy densities have made battery-electric light-duty vehicles increasingly competitive** with ICE vehicles, with further major cost reductions and performance improvements certain to occur (Exhibit 8).[20]

- **Dramatic reductions in the cost of electrolysers are now a prospect**, making possible significant cuts in the cost of green hydrogen production.[21]

Opportunities for the rapid and cost-effective decarbonisation of power systems and light-duty road transport have greatly increased as a result. Furthermore, work by the ETC and the Mission Possible Partnership has shown that the supposedly harder-to-abate heavy industry sectors (steel, cement, and chemicals) and long-distance transport (shipping and aviation) could all be decarbonised by 2050 at a trivial cost to global growth or living standards.[22]

These developments create a new context that is not yet fully reflected in countries' strategies and NDCs. Together they make possible far more rapid emission reductions in the 2020s than were previously envisaged, with consequent earlier and sharper reductions in coal, oil, and gas use.

National and international strategies should therefore seize this opportunity, driving further technological progress, scale deployment, and faster emissions reductions. Major reports by the ETC have set out the actions required to ensure that progress is fast enough to deliver net-zero emissions by 2050.[23]

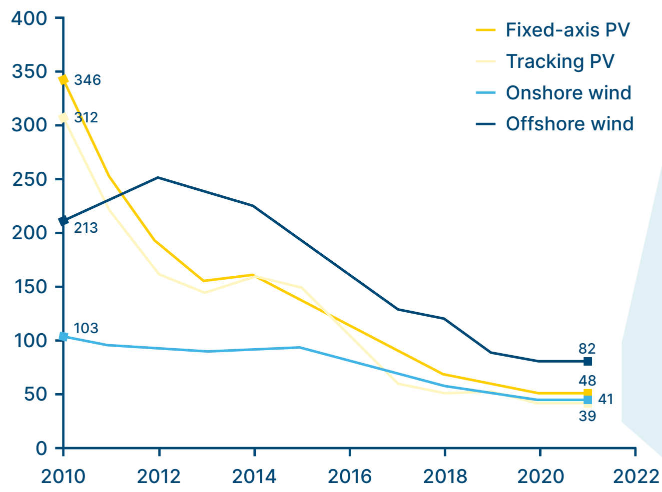
The potential for more rapid progress should also be matched by an increased ambition for the 2020s. Three of the priorities identified in this report – faster power sector decarbonisation, road transport electrification, and supply decarbonisation of other end uses – respond to this opportunity. Furthermore, the development and commercialisation in the 2020s of zero-carbon energy technologies for energy-intensive sectors driven will be vital to ensure deep decarbonisation in the 2030s and 2040s.

18 See SYSTEMIQ (2020), *The Paris Effect: How The Climate Agreement is Reshaping the Global Economy*.
19 See ETC (2021) *Making Clean Electrification Possible.*
20 See ETC (2021) *Making Clean Electrification Possible.*
21 See ETC (2021) *Making the Hydrogen Economy Possible*.
22 ETC (2018) *Mission Possible*, ETC (2020) *Making Mission Possible,* Mission Possible Partnership.
23 ETC (2020), *Making Mission Possible*; ETC (2021) *Making Clean Electrification Possible;* ETC (2021) *Making the Hydrogen Economy Possible*.

Wind and solar LCOE have dramatically decreased in the last 10 years with latest lowest auction prices for solar PV below $20/MWh

PV and wind LCOE global benchmarks

LCOE, $/MWh, 2020 real



Lowest auctions prices

Solar PV

- Portugal: $13.2/MWh (lowest offer) (Aug 2020)
- India: $38/MWh for solar + batteries delivering 80% of hours per year (June 2020)
- Abu Dhabi: $13.5/MWh (lowest offer) for 2 GW (April 2020)
- Qatar: $15.7/MWh for 800 MW (Jan 2020)
- Saudi arabia: $16.9/MWh for 900 MW (2019)
- Portugal: $16/MWh for 1.4 GW (July 2019)

Offshore wind

- UK: $51/MWh (£39.7/MWh) for 6 GW (2019)
- France: $48/MWh for 600 GW (2019)

Onshore wind

- Chile: $32.5/MWh for 240MW (mixed with solar and geothermal)
- US: average wind price at $20/MWh (2017)
- Mexico: $20.6/MWh for 250 MW (2017)

LEFT HAND SIDE: The global benchmark is a country weighted-average using the latest annual capacity additions.

RIGHT HAND SIDE: Economics of auction prices may be favoured by local tax treatments and other implicit subsidies.

SOURCE: Press research; BloombergNEF (2021) *1H 2021 LCOE Update.*

Exhibit 7

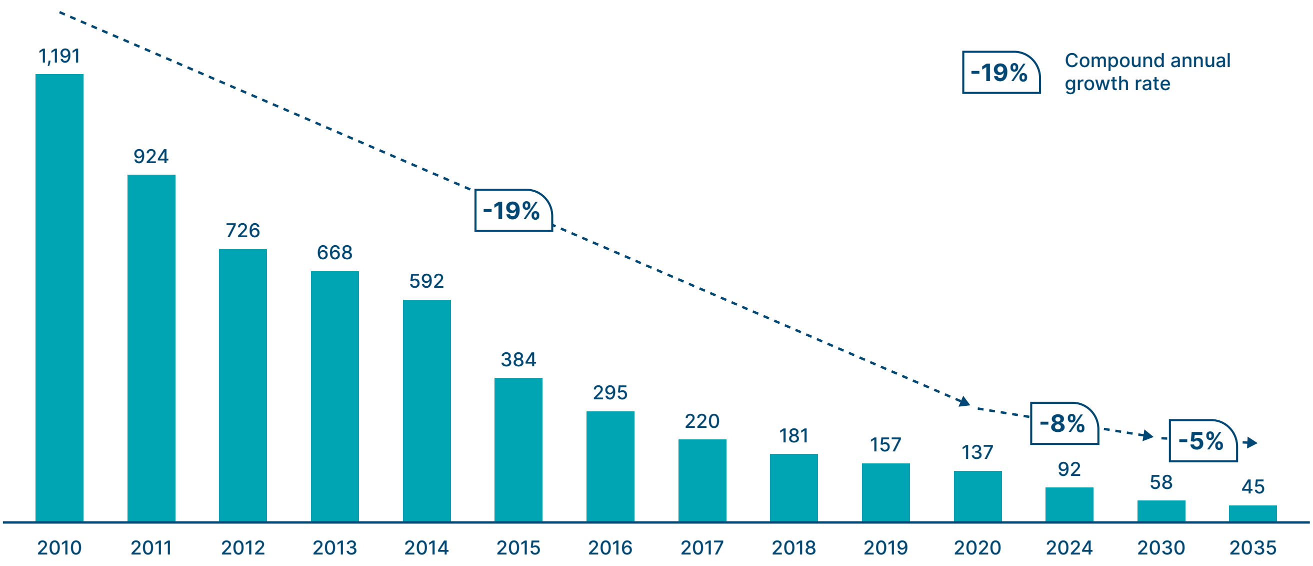
Battery prices have decreased annually by 19% in the last decade and are expected to fall below US$100/kWh by 2024

Lithium-ion battery pack prices - Observed

Real 2020 $/kWh

Battery prices - Outlook

Predicted



SOURCE: Bloomberg New Energy Finance Lithium-ion Battery Price survey (2020).

Exhibit 8

Deforestation and methane emissions – improved scientific understanding

New technologies – in particular synthetic meats – may soon make it possible to dramatically reduce the impact of food production on the natural environment and climate. But these developments are at an early stage, and the technologies relevant to nature-based solutions have evolved slowly rather than dramatically over the last five years. However, increasing scientific understanding makes rapid action to cut deforestation and to start reforestation even more vital than 5 years ago.

In particular:

- **The IPCC Special Report on 1.5°C, published in Autumn 2018, made a compelling case for seeking to limit global warming to 1.5°C**. This would be impossible without a rapid end to deforestation alongside significant carbon removals delivered by nature-based solutions.

- **Latest deforestation trends and scientific analysis has increased the risk that major tropical rainforest could switch from being a net sink to a net source** of carbon dioxide emissions.[24]

Meanwhile, trends in methane emissions and scientific analysis have greatly increased the importance of cutting methane emissions fast. The IPCC AR6 report estimates that methane emissions have been responsible for 0.5°C of warming since the pre-industrial era, compared with 0.8°C for CO_2 (with some offsetting reductions resulting from aerosol and other gases).[25] Estimates of total methane emissions are inherently less certain than for carbon dioxide (illustrating the vital importance of more effective measurement) but methane emissions have almost certainly risen by around 10% over the last 20 years.[26] As the world continues to warm, and the adverse impacts of climate challenges become ever more apparent, it is vital to focus on short-term opportunities to reduce forcing effects and mitigate temperature increases. Cutting methane emissions is the largest such opportunity.

24 See, for example, Gatti et al (2021) *Amazonia as a carbon source linked to deforestation and climate change*.
25 Figure SPM.2 in IPCC (2021) *Summary for Policymakers* in *Climate Change 2021: The Physical Science Basis (AR6)*.
26 NOAA (2021) *Trends in* CH_4.

Assessing the potential to go beyond NDCs: Methodology and approach

This report aims to identify actions that could deliver significant reductions in emissions in the 2020s and which are not already included in NDCs. To do this we have:

- **Used the IEA's Net Zero pathway report**, as well as a number of other analyses as a starting point;[27]
- Applied a set of criteria to **assess the feasibility of implementation;**
- **Estimated how far the identified initiatives are already included within NDCs.**

The IEA's Net Zero report

In May 2021 the IEA published a landmark report on how to achieve net-zero by 2050. This report aimed to describe the emissions pathway required to meet a carbon budget compatible with a 1.5°C objective, without significant reliance on negative emissions after 2050 or on nature-based offsets in the next 30 years.

It sets out how the world could achieve a 38% reduction in CO_2 emissions by 2030, with near-total decarbonisation of the global power system by 2040 and the application of electricity, hydrogen, bioenergy, and CCS to decarbonise the road transport, buildings, and the so-called hard-to-abate sectors (e.g. heavy industry, aviation, shipping). It also identified opportunities for energy efficiency improvement and consumer behaviour change, which account for 18% and 7% respectively of the emissions reductions between 2020-30; behaviour change is then responsible for a higher share (18%) of subsequent emission reductions between 2030 and 2050 (Exhibit 9).

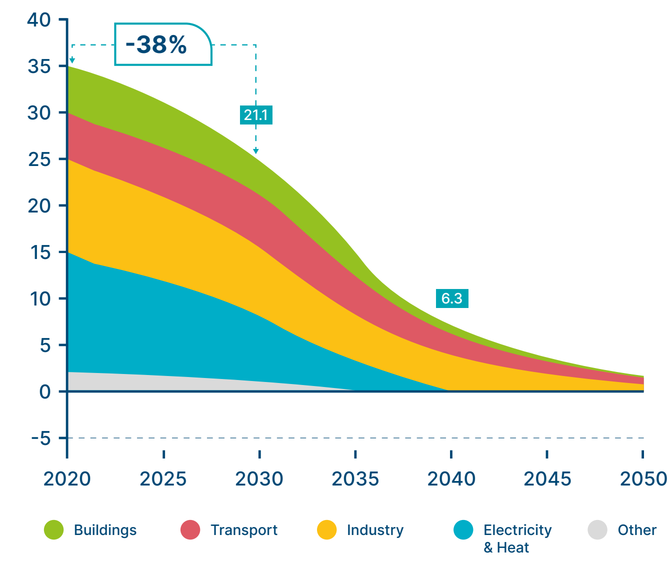
All the reductions described by the IEA for the 2020s are clearly technically possible using technologies that are already available for commercial deployment.

Exhibit 9

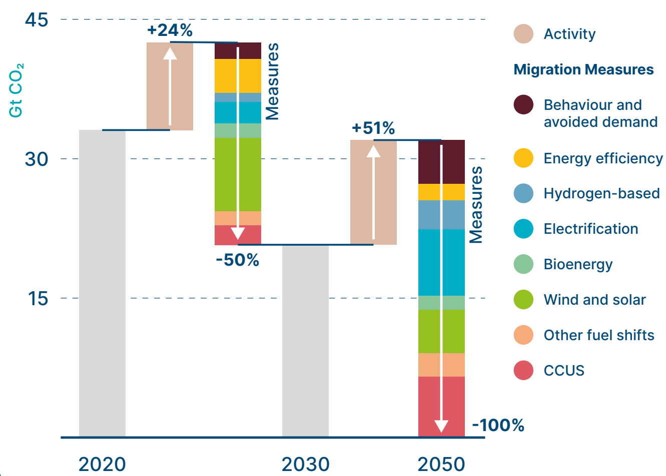
The IEA has developed a scenario driven by the need to reduce CO_2 emissions on a path compatible with 1.5°C without the use of nature-based offsets

IEA NZS; Pathway to Net Zero

Gt CO_2 , Global, annual



IEA NZS: Emissions reductions by mitigation measure, 2020-2050



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

Additional assessment criteria

The IEA's recent report is an excellent starting point for identifying technically feasible emission reductions in the 2020s. In this report we draw on the IEA work but, in addition, apply three further sets of criteria to assess how feasible actual implementation will be:

27 See Technical Annex for full methodology and external references.

- **Is the action either potentially cost-saving/cost-competitive?** And if not, is the additional cost incurred one that could easily be absorbed by rich developed countries, whether in their domestic economy or through climate finance support to low-income developing countries?

- **Is the action politically attractive for other reasons?** For instance, because of co-benefits such as reduced local air pollution or job creation.

- **Could the action be accelerated through an initiative or agreement launched at or after COP26?** For example, can the action be driven by a small number of leading countries (rather than requiring comprehensive international agreements) and/or by a relatively small number of companies: are there already existing initiatives that could be leveraged and reinforced?

Adjusting for existing commitments in NDCs

To assess the potential for additional reductions in the 2020s beyond current commitments, we need to avoid double counting between the actions we have identified, and the abatement already included in current NDCs.

However, quantifying what is included in NDCs for each sets of actions is challenging. NDCs vary greatly in their detail and specificity and are not submitted in a consistent format with an easily quantifiable link between emissions targets and sectoral actions. Indeed, a 2016 ETC assessment of the NDCs submitted under the 2015 Paris Agreement suggested that 60% of the abatement in the NDCs was unspecified, with no indication of how the emissions reduction target would be achieved.[28]

To adjust for the potential already included in NDCs across our six groups of action, we, therefore, make a high-level assessment of the likely overlap of current NDCs for each action we have quantified (high overlap; moderate overlap; low overlap), drawing on a literature review of NDC commitments.[29] We then scale down the total feasible potential for each sector based on the assessed overlap with current NDCs. This ensures that the additional actions we identify do not include the average of 3.5 GtCO_2e included in current NDCs (Exhibit 10).

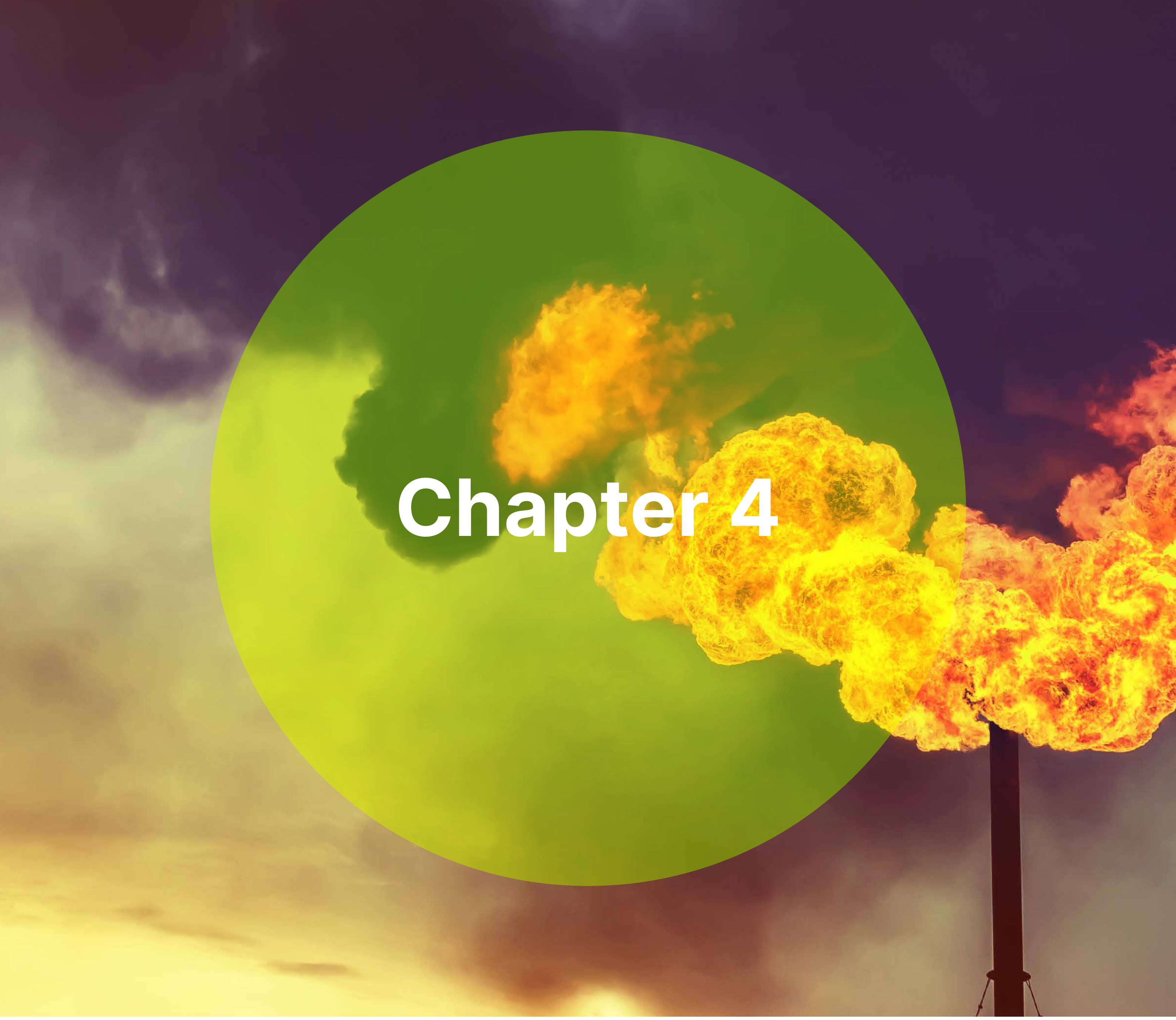
Exhibit 10

Critical actions across six different sectors: 6 key steps

	1 Total potential by 2030	2 Total feasible potential by 2030	3 Assessment of overlap with NDCs	4 NDC overlap scaling	5 NDC overlap reduction	6 Additional feasible potential by 2030 beyond NDCs
Accelerating emissions reductions from methane	~4.2 [12.6] Gt CO_2e	4 [11] Gt CO_2e	Moderate	~ -10-15%	-0.5 [1.5] Gt CO_2e	3.5 [11] Gt CO_2e
Nature Based Solutions (including carbon removals)	~11 Gt CO_2	7.6 Gt CO_2	Moderate	~ -10-15%	-0.9 Gt CO_2	6. 6 Gt CO_2
Decarbonising the power sector	~8 Gt CO_2	4.6 Gt CO_2	High	~ -20-30%	-1.2 Gt CO_2	3.5 Gt CO_2
Decarbonising road transport	~2.8 Gt CO_2	2.6 Gt CO_2	Moderate	~ -10-15%	-0.3 Gt CO_2	2.3 Gt CO_2
Supply-side decarbonisation in other sectors	~3 Gt CO_2	2.2 Gt CO_2	Low	~ -5%	-0.1 Gt CO_2	2.1 Gt CO_2
Energy and resource efficiency	~4.5 Gt CO_2	2.9 Gt CO_2	Moderate	~ -10-15%	-0.4 Gt CO_2	2.5 Gt CO_2
TOTAL	~33 Gt CO_2	~24 Gt CO_2			-3.5 Gt CO_2	21 Gt CO_2e

NOTE: Methane emissions in [ ] represent equivalence to carbon dioxide under a 20-year timeframe, assuming GWP=28.

28 Energy Transitions Commission (2016), *Pathways from Paris, Assessing the INDC Opportunity*.
29 See Technical Annex for further detail on our scaling down methodology.



Feasible actions to accelerate emissions reductions – 6 key categories for priority action

Using the criteria described in section 3, we have identified the potential to reduce emissions faster than NDC commitments during the 2020s. This section sets out the detailed findings, starting with reducing methane emissions and following with five key opportunities to accelerate carbon dioxide reductions.

4.1 Significant and rapid reductions in methane emissions

The IPCC AR6 report estimates that methane emissions have been responsible for 0.5°C of warming since the pre-industrial period, compared with 0.8°C produced by carbon.[30] Since methane emissions are short-lived in the atmosphere, cutting methane emissions is the quickest way to reduce global temperature, offsetting the impact of the growing stock of carbon in the atmosphere. Though cutting methane emissions is not a substitute for action on CO_2. In general, there has been insufficient focus on the need to reduce methane emissions, many NDCs pay little attention to it, and over the last 10 years, methane emissions have continued to rise.

A range of initiatives has recently been developed to address methane, which includes the European Union's 2020 Methane Strategy, state-level targets set by New York and California, and industry-led efforts such as upstream oil and gas methane intensity targets from the OGCI, reporting frameworks such as the Oil and Gas Methane Partnership (OGMP), and certification standards such as MiQ.[31] In September 2021, the Global Methane Pledge was launched by the US and the EU, who were joined by other large emitters in an agreement to reduce methane emissions by 30% by 2030. However, ETC analysis in this section suggests potential to achieve a 40% reduction, particularly in the largest emitting countries, with 60% reductions in fossil fuel emissions and 30% in the waste and agricultural sectors.

Cutting methane emissions dramatically by 2030 should therefore be a high priority at and after COP26.

In 2019, global methane emissions were estimated to be around 375 $MtCH_4$ (equivalent to 31 $GtCO_2e$ if a 20-year GWP factor is applied, and 11 $GtCO_2e$ with a 100-year view), with around 135 $MtCH_4$ from fuel production, transport and use, around 80 $MtCH_4$ from waste management, and around 160 $MtCH_4$ from the agriculture sector.[32] There are opportunities to cut all categories of these emissions, with a distinction between:

- **Fossil fuel derived emissions**, where there are low-cost opportunities to cut emissions by at least 60% by 2030.
- **Waste and agricultural emissions**, where dramatic early reductions will be more difficult due to the very large number of producers and consumers involved, but where COP26 should still seek to achieve consensus around the necessity and possibility of significant reductions, reaching at least a 30% reduction by 2030.

Reducing methane emissions in the fossil fuel supply chain

Oil, gas, and coal are together responsible for around 120 $MtCH_4$, with 80 $MtCH_4$ in oil and gas and 40 $MtCH_4$ in coal.[33] In the oil and gas sector, emissions are highest in Russia, the US, and a set of other large oil and gas producing countries, followed by a large tail of countries with small emissions volumes together accounting for around 25% of the oil and gas total (Exhibit 11). Coal emissions are concentrated in key mining locations, with over 50% of coal mine methane emissions coming from China.[34]

30 IPCC (2021) *Climate Change 2021: The Physical Science Basis (AR6).*

31 MiQ is a not-for-profit initiative that has designed a gas certification system which introduces natural gas to the market that has been differentiated based on methane emissions during production.

32 EDGAR Database.

33 IEA (2020) *Methane Tracker*. Additional non-waste and non-agricultural methane emissions come from other energy sources such as biomass.

34 UN (2021) *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions*; Global Methane Initiative (2015) *Coal Mine Methane Country Profile: China*.

Methane emissions from fossil fuels were estimated around 120 $MtCH_4$ in 2019 – for oil and gas, high concentration in Russia and US, with a 'longer tail' in other countries

Methane

Oil and gas methane emissions by country, 2019

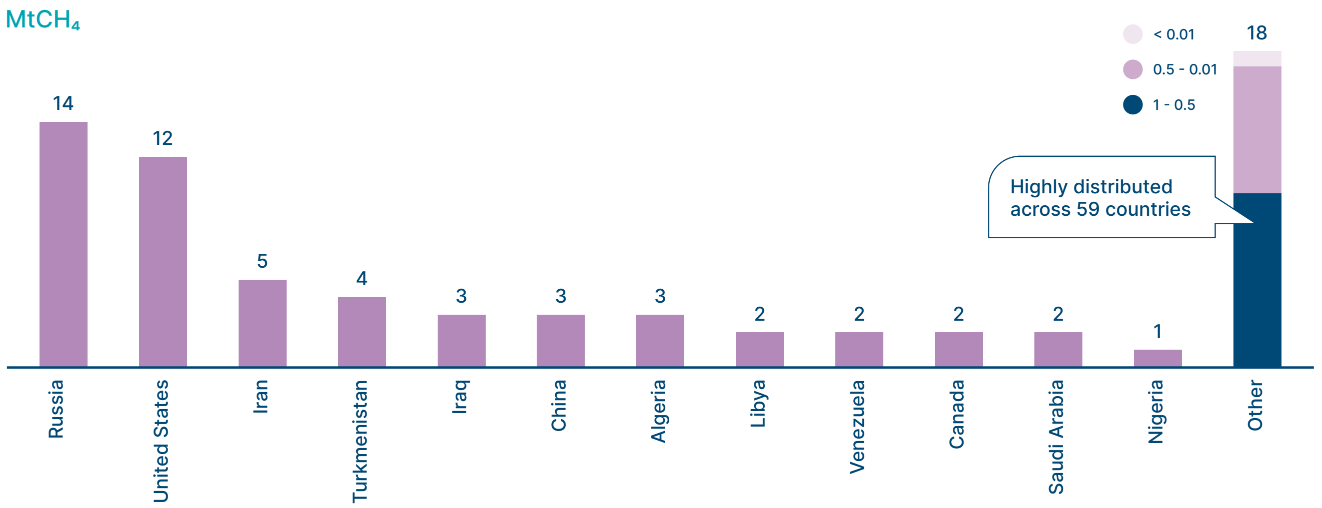


Exhibit 11

SOURCE: IEA (2021) Methane Tracker data. Total 2019 methane emissions would be equivalent to 10 GtCO2e or 30 GtCO2e using GWPs of 28 and 84 respectively.

Moving beyond coal in power generation would eliminate methane emissions from coal mining as well as CO_2 from coal combustion (see opportunity for action 3: 'Decarbonising the power sector – accelerating coal phase out'). In addition, where coal mining does for a time continue (whether for thermal or coking coal) there are several low-cost ways to reduce emissions, including pre-mining degasification and oxidation of ventilation air methane.[35]

But even closed coal mines can continue to produce methane emissions for decades after closure if extraction and utilisation schemes are not put in place.[36] The scale of these emissions is not adequately understood but one estimate suggests that abandoned coal mines could be responsible for as much as 40 $MtCH_4$ in 2020, in addition to the estimated 40 $MtCH_4$ from coal mines still in use.[37] Action to reduce abandoned coal mine methane emissions, for instance via deliberate flooding, are therefore essential.

Our estimate assumes that 80% of coal-based methane emissions from existing mines (32 $MtCH_4$ per annum) could be eliminated at a low cost before 2030.

Oil and gas methane emissions could in principle be reduced dramatically at very low costs.[38] Abatement costs vary according to fossil fuel prices, as reduced leakage allows producers to sell more fuel (providing a larger benefit the higher the gas price, and decreasing abatement costs). IEA estimates suggest that at current gas prices over 30 $MtCH_4$ could be eliminated at negative cost, while a further 20 $MtCH_4$ can be eliminated at costs equivalent to below $50 per tonne of CO_2 even if we used the 100 year/28 multiplier basis, or below $20 per tonne on the 20 year/84 multiplier basis (Exhibit 12). Compared with many carbon abatement opportunities now being pursued or which will have to be pursued to achieve a zero-carbon economy, cutting fossil fuel methane emissions is a low-cost opportunity. Indeed, the average cost of eliminating 50 $MtCH_4$ from the oil and gas system – with a CO_2 equivalent value of 1.4 Gt (100-year view) to 4.2 Gt (20-year view) – is no more than around $5 per tonne of CO_2 equivalent, even in years with low gas prices.

The scale of the potential is also illustrated by the major variations in methane leakage rates – the volume of methane leaked as a percentage of total extraction - which are witnessed around the world, with base case estimates ranging from 0.01% in Norway to 1.3% in Russia and 2.2% in the USA, and over 5% in certain Middle Eastern and African countries (Exhibit 13).[39]

35 UN (2021) *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions.*

36 Kholod et al. (2020) *Global methane emissions from coal mining to continue growing even with declining coal production.*

37 Other estimates, such as Kholod et al. (2020) suggest that methane emissions from coal mining could be significantly higher than IEA estimates.

38 Key cost-saving and low-cost abatement actions include replacement of devices (e.g. pumps, electric motors, compressor seal or rods, etc), installation of new emissions control devices (e.g. vapour recovery units, blowdown capture, flares, plungers), and deploying leak detection and repair (LDAR).

39 The Oil and Gas Climate Initiative (OGCI), representing major oil and gas companies, has set a target to reach 0.2% by 2025. However, the best-in-class standard is Norway's current level below 0.05%.

Existing technologies can reduce ~30 $MtCH_4$ emissions from oil and gas at negative abatement costs

Marginal abatement cost curve for oil and gas related methane emissions (2019)

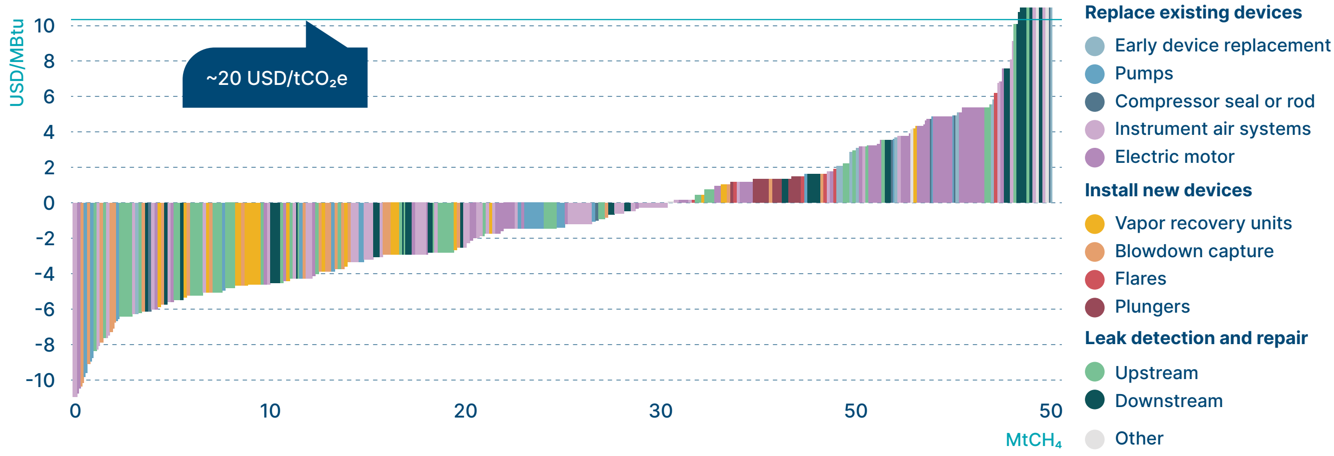


Exhibit 12

SOURCE: IEA, Methane Tracker, 2020. Note: Abatement costs depend on fossil fuel prices, and abatement costs increase in years with low gas and oil prices.

Estimated Methane Leakage Rates by Country

Country	Oil and Gas Methane Leakage Rate (%) – Baseline estimate
Norway	0.01%
Netherlands	0.01%
United Kingdom	0.25%
Qatar	0.3%
UAE	0.7%
Romania	0.9%
Egypt	1.1%
Oman	1.2%
Nigeria	1.2%
Russia	1.3%
Algeria	1.6%
United States	2.2%
Libya	5.1%
Yemen	5.3%
Angola	6.7%

Exhibit 13

NOTE: Methane leakage rate measurements include high degree of uncertainty. This data represents EDF's central baseline estimate, EDF also develops high/low ranges.

SOURCE: Greif, Constantin, and Julius Ecke. 'Scenarios, Effectiveness and Efficiency of EU Methane Pricing in the Energy Sector'. Berlin: Environmental Defense Fund, 25 January 2021. https://www.edf.org/sites/default/files/content/Enervis-Study-January-2021.pdf.

The detailed actions to reduce these emissions will need to be taken by oil and gas companies across the world, with the largest IOCs and NOCs playing a major role, applying the wide range of technical options which the IEA has identified. However, forceful action will also require clear monitoring and detection of methane leaks. Here international satellites can play an increasingly effective role, and strong national regulations should be introduced to specify maximum acceptable leak rates and apply large fines for excess leaks. Certification schemes should be introduced to enable customers to assess the full climate impact of their oil or gas consumption.

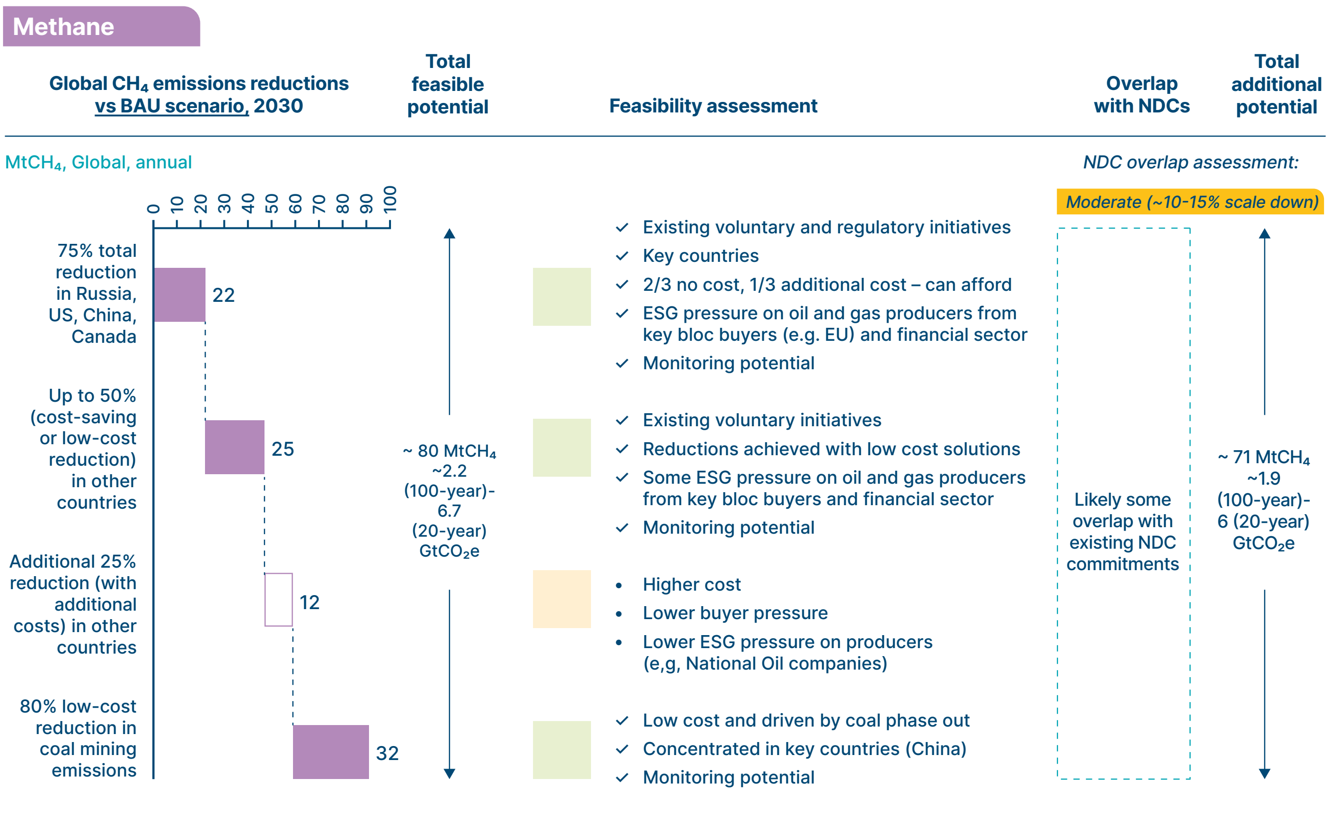
Some of these priorities are already being pursued by existing initiatives, but COP26 could play a major role in gaining global consensus around the need and potential for forceful action, aligned around a global target of a 60% reduction by 2030, supported by internationally agreed mechanisms for monitoring and national reporting which will create incentives for national and corporate action.

Exhibit 14 sets out our scenario for potential methane fossil fuel emission reductions, with 80 $MtCH_4$ eliminated by 2030, which would be equivalent to 2.2 $GtCO_2$ (100 year view) – 6.7 $GtCO_2$ (20 year view) of emissions reductions. 97% of country NDCs do cover methane emissions to some degree, and 13 countries, including Russia and Canada, have specifically set methane reduction targets, but the assessed overlap with current NDCs is still small, leaving an estimated additional potential of ~70 $MtCH_4$ by 2030.[40]

Exhibit 15 describes the specific actions required.

Methane (Fossil): 2030 emissions reduction scope and feasibility

Exhibit 14



Shaded / green – higher feasibility   Unshaded / yellow – lower feasibility

NOTE: Range for methane emissions illustrates CO_2 equivalence using GWPs of 28 and 84.

SOURCE: Expert interviews, IEA. UN (2021) *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions.*

40 UNFCCC (Feb 2021) *Nationally Determined Contributions under the Paris Agreement: Synthesis report by the Secretariat.*

Accelerating reductions from methane: Fossil sector

	100-year view		20-year view
Total feasible potential by 2030	80 $MtCH_4$	2.2 $GtCO_2e$	6.7 $GtCO_2e$
% NDCs scale down of sector	~ 10-15%	~ 10-15%	~ 10-15%
Additional feasible potential by 2030 beyond NDCs	71 $MtCH_4$	1.9 $GtCO_2e$	6 $GtCO_2e$

Target outcomes from COP26

Agreement between leading countries and companies to cut fossil methane emissions by 60% in the 2020s (building on the Global Methane Pledge) and to agree framework and common standards for monitoring and reporting (e.g. building on MiQ).

2030 objectives

- **75% emissions cut from oil and gas in major emitters** (United States, Canada, Russia, China)
- **50% cut from oil and gas in all other countries**
- **80% low-cost reduction in coal mining emissions**

Supporting actions at international, national and company level in the 2020s	Primary actors
• **Commitments to standardised international satellite monitoring programmes** for methane emissions measurement	• Developed and developing country governments • Fossil producers
• **Strong national regulations, starting in the top emitting countries, specifying maximum acceptable leak rates** (well below 1%) and applying large fines for excess leaks • Demand-side pressure from large bloc-buyers setting maximum acceptable leak rates	• Developed and developing country governments • Fossil producers
• **Clear and ambitious commitments from companies** (e.g. going beyond OGCI's goal of 20% reduction by 2025) to take actions and deploy technologies (e.g. replacement of pumps, electric motors, and other devices, installation of new emissions control devices such as vapour recovery units, deploying leak detection and repair)	• Fossil producers
• **Increase reforestation** via leader-level pledges, building on initiatives (e.g. REDD+, Bonn Challenge), in line with high integrity standards (e.g. IUCN)	• Fossil producers
• **Clear commitments by the financial sector to cease funding oil and gas companies which fail to meet appropriate methane reduction standards**	• Fossil producers • Multilateral financial institutions, banks, asset managers

Exhibit 15

Reducing methane emissions in the Waste and AFOLU sectors

Methane emissions from agriculture and waste were estimated around 160 $MtCH_4$ and 80 $MtCH_4$ respectively in 2019, accounting for 70% of total methane emissions. Key drivers of emissions from the agriculture sector include enteric fermentation from animals and animal manure management. In waste, key drivers include food that is wasted and rots before reaching consumers (e.g. on the farm, or in transit/storage); as well as landfill and wastewater, where methane is produced when organic waste decomposes in an oxygen-free environment (anaerobic decomposition).

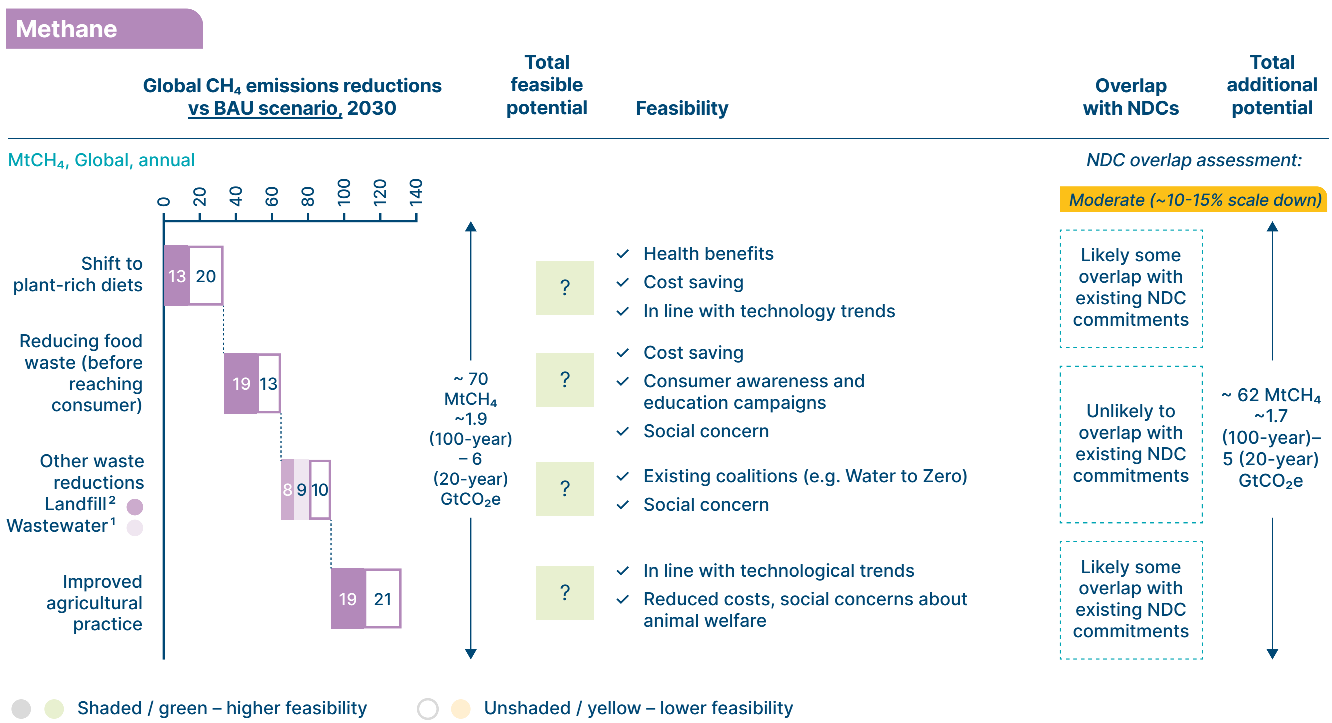
There are many low-cost opportunities to reduce these emissions, via consumer behaviour shifts (e.g. towards plant-based diets), actions to reduce waste through better supply chain management, and improved agricultural and waste management practices. Key technology developments – including the application of digital technology to supply chain monitoring and management, and synthetic/plant-based meat alternatives – are steadily increasing the potential for emissions savings. However, estimates of potential emissions reduction in these sectors are inevitably less certain due to a large number of individual producers and consumers involved, therefore we have only assessed a proportion of the total potential abatement here as highly feasible.

Our estimate suggests that 70 $MtCH_4$ (25% of the total) with a CO_2 equivalent value of 1.9 $GtCO_2e$ (100-year view) to 6 $GtCO_2e$ (20-year view) could be eliminated by 2030 (Exhibit 16). Given a moderate assessed overlap with actions already included in current NDCs, the estimated additional potential reduction is 62 $MtCH_4$ per year by 2030. Exhibit 17 sets out the actions to pursue that opportunity.

Reducing methane emissions in agriculture and waste will also reduce Nitrous Oxide (N_2O) emissions, particularly as reduced food waste and less feed-intensive food production will reduce the use of fertilizer in agriculture. Further actions along the agriculture and waste value chain could reduce N_2O in particular via improved management of cropland nutrients. Scaling these Nitrous Oxide emissions reductions with the actions identified in Exhibit 16 suggest a further 0.5-1 $GtCO_2e$ of emissions reductions (2-4 MtN_2O) could be possible.[41]

Exhibit 16

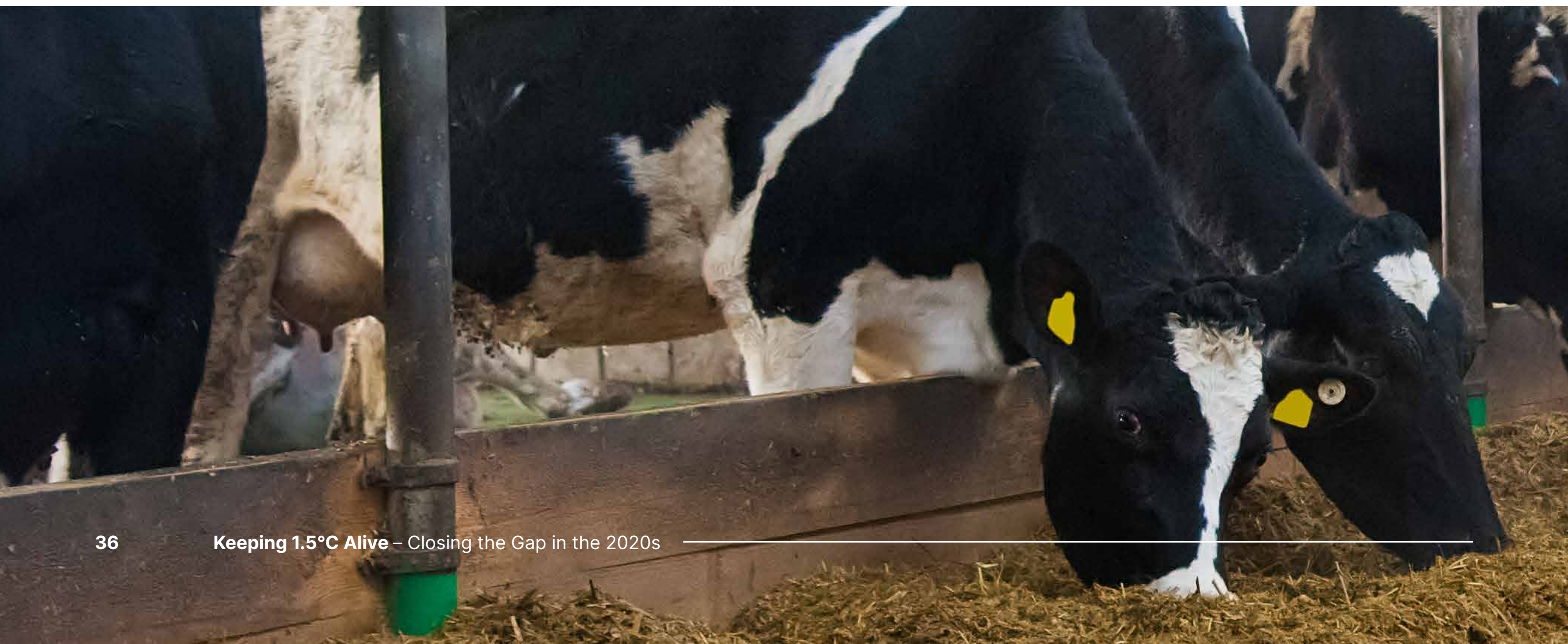
Methane (Agriculture and Waste): 2030 emissions reduction scope and feasibility



NOTE: Range for methane emissions illustrates CO_2 equivalence using GWPs of 28 and 84.
[1] SDG6.2 - increasing treated wastewater from 20% to 60% globally.
[2] Upper middle-income countries reduce emissions by 45%, high income by 75%.

SOURCE: Based on feasible mitigation potential from Roe et al. (2019), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

41 Roe et al (2019), *Contribution of the land sector to a 1.5 °C world*. N_2O savings would be in addition to the aggregated savings identified in this report.



Accelerating reductions from methane: Agriculture and Waste sector

		100-year view	20-year view
Total feasible potential by 2030	70 $MtCH_4$	1.9 $GtCO_2e$	6 $GtCO_2e$
% NDCs scale down of sector	~ 10-15%	~ 10-15%	~ 10-15%
Additional feasible potential by 2030 beyond NDCs	62 $MtCH_4$	1.7 $GtCO_2e$	5 $GtCO_2e$

Target outcomes from COP26

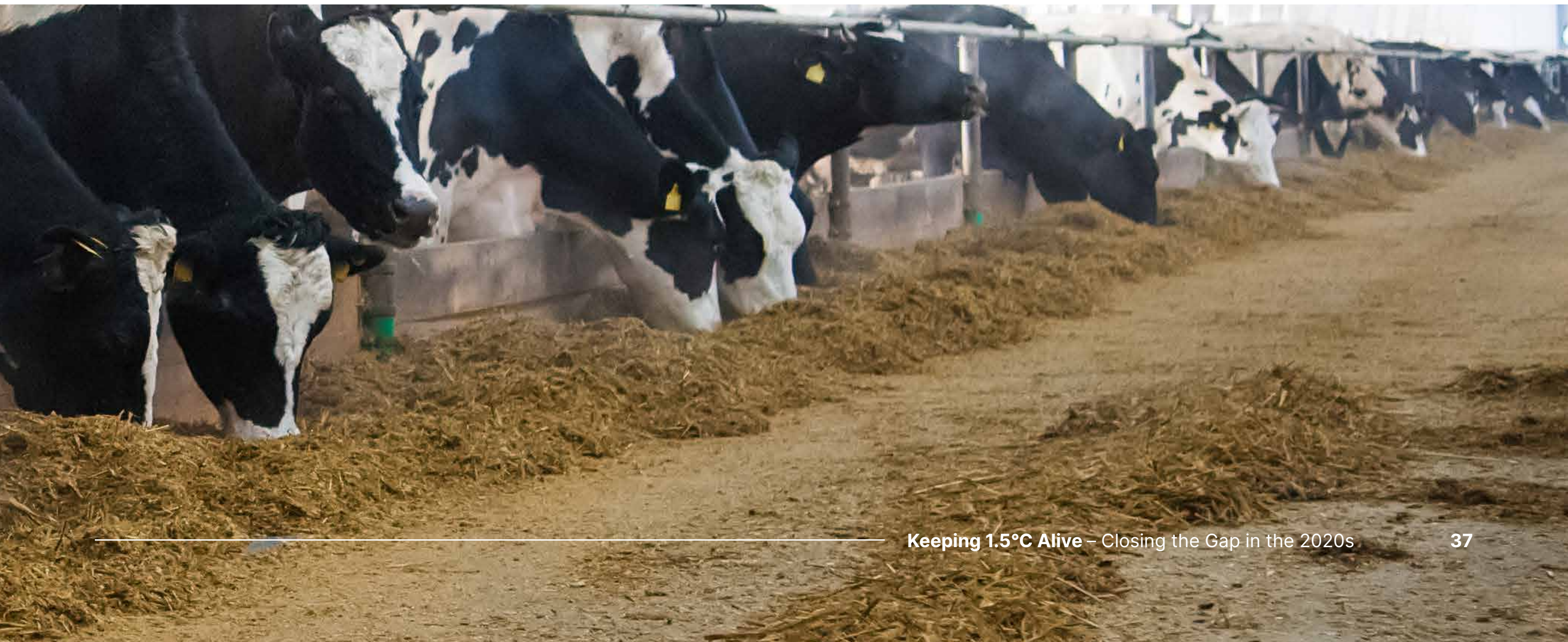
Country and company commitments to cut non fossil methane emissions by 30% in the 2020s, building on the Global Methane Pledge.

2030 objectives

- **20% of people eating plant-rich diets globally**, up from 10% today
- **30% reduction in emissions from food-chain waste**
- **20% reduction in emissions from wastewater and landfill**

	Supporting actions at international, national and company level in the 2020s	Primary actors
Agriculture	• **Individual action encouraged by government and industry public awareness campaigns** to scale adoption of plant-rich diets	• Consumers • Developed, developing country and local governments • Leading food and agriculture companies, and sectoral associations
Agriculture	• **Commitment to develop labelling** for low-methane meat, milk, and rice, and work with value chain to set low-methane standards,	• Leading food and agriculture companies, and sectoral associations
Agriculture	• **Support for development of alternative proteins**	• Leading food companies • Developed and developing country governments
Agriculture	• **Commitment to phase out policy support** for intensive livestock farming and distorting subsidies	• Developed and developing country governments
Waste	• **Industry commitments to reducing food waste arising on farms and in transit,** e.g. via technology to improve supply chain effectiveness and procurement standards	• Leading food, agriculture, and commodity trading companies and sectoral associations
Waste	• **Investment in wastewater treatment,** particularly in developing countries **enabled by development finance** • **Investment in waste collection,** including separating organic and non-organic wastes, and recyclables	• Water companies • Local governments • Multilateral financial institutions

Exhibit 17



4.2 Halting deforestation, beginning reforestation and other carbon sequestration opportunities

Current levels of (net) carbon dioxide emissions resulting from the Food and Land use sector (FOLU) are estimated to be around 6 $GtCO_2$.[42,43] But the total potential to mitigate climate change is greater than this 6 $GtCO_2$ figure, since the net figure reflects a combination of gross emissions sources of 16 $GtCO_2$ (deriving primarily from deforestation to provide land for livestock and livestock feed production, cultivation of soil and oxidation of wood products) and gross carbon removals into sinks equal to around 11 $GtCO_2$ (through forests and other ecosystems which sequesters carbon dioxide).[44,45] There are clear opportunities both to reduce the sources (e.g. by ending deforestation) and to increase the sinks (e.g. through reforestation). If the world is to have any chance of limiting global warming to 1.5°C, AFOLU emissions, particularly from land use change, must switch from being a major source to a significant net sink of emissions as soon as possible.

In total we estimate total potential to reduce net emissions by as much as 12 $GtCO_2$ by 2030 via (Exhibit 18):

- **A rapid end to deforestation, particularly in tropical regions**. Clearing a hectare of tropical forest for agriculture, can emit over 400 tonnes of CO_2.[46] And if current rates of deforestation continue, this would release over 40 $GtCO_2$ into the atmosphere during the 2020s. In addition, it is vital to end the conversion of coastal wetlands and peatlands to agricultural uses. Together, actions to reduce FOLU related carbon dioxide sources could reduce annual emissions by 5 $GtCO_2$ by 2030.

- **Reforestation** which could potentially remove more than 3 $GtCO_2$ per year by 2030 and **restoring coastal wetlands and peatlands** a further 1 $GtCO_2$.

- **Improvements in forest management and improved sequestration of carbon in soils** could remove a further 3 $GtCO_2$ (e.g. through improved farming techniques, or in the form of biochar). [47]

It has long been recognised that nature-based solutions could deliver emission reductions costs which are low compared with other mitigation options. Estimates suggest for instance that nearly 2 $GtCO_2$ of deforestation could be avoided at a cost of less than $10 per tonne of CO_2, with a further 1.5 $GtCO_2$ available at less than $100 per tonne of CO_2.[48] Estimates for reforestation and afforestation are consistently in the range of around $5-50/$tCO_2$.[49] New technologies such as synthetic meat, genetic manipulation to increase crop yields or the application of digital technology to supply chain management and monitoring could contribute to faster progress. Consumer behaviour shifts towards plant-rich diets (which would also reduce methane emissions) could also play a major role.

However, 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 farming), and the need for solutions to take into account multiple factors, including:

- **Options to improve agricultural productivity** but also to secure alternative livelihoods for forest-based communities.

- **Uncertainties over existing land tenure rights**.

- **The misaligned incentives** - including the "opportunity cost" of using the land - of multiple relevant actors connected along value chains from local individual farmers, through intermediate businesses to consumers across the world.

- **The need for jurisdictional approaches** to manage the use of land at a national or regional level, which ensures that emissions are genuinely reduced rather than simply displaced. In some cases countries may need direct support to develop these approaches.

- **Impacts on biodiversity, water supply, ecosystem services** and other nature benefits as well as on CO_2 emissions.

42 FOLU CO_2 emissions are expressed as the overall net figure which results from the combination of gross emissions and gross removals. FOLU CO_2 emissions are generated primarily from the anthropogenic impacts of deforestation and other land use change. These emissions generated are in part offset by carbon sinks, which sequester emissions. Note 'FOLU' emissions are also at times referred to in the UNFCCC framework as 'Land Use, Land Use Change and Forestry' emissions (LULUCF).

43 Does not include non-CO_2 emissions in this estimate.

44 IPCC (2019) *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*.

45 It is important to acknowledge the significant uncertainty in these levels, since the emissions resulting when a hectare of forest is cut down or burnt varies very significantly depending on specific local circumstance.

46 Probos (2020) *Tropical forests – the facts and the figures*.

47 See Technical Annex for full details on methodology and sources, drawing in particular on the assessment in Roe et al (2019) *Contribution of the land sector to a 1.5 °C world*.

48 Based on estimates in Griscom et al. (2017) *Natural Climate Solutions* and Roe et al. (2021) *Land-based measures to mitigate climate change: potential and feasibility by country*.

49 Royal Society (2018) *Greenhouse Gas Removal*. Fuss et al. (2018) *Negative emissions—Part 2: Costs, potentials and side effects*.

As a result, even low-cost opportunities may not be grasped without international agreement which commits major countries to action, supported by flows of climate finance which can offset the short-term incentives for deforestation and make reforestation and other nature-based solutions economic. Some initiatives already exist, and are driving some progress (e.g REDD+, the Forest Investment Program) [50], but a dramatic increase in scale is now required. These financial flows will have to involve major intergovernmental contributions but could also entail a major role for the private purchase of carbon removal credits by companies, supported by the development of appropriate carbon markets.

The ETC will shortly issue a report on Carbon Dioxide Removals which will explore the potential for and relative merits of different forms of financial flows, but it is clear that the required scale is very large. Achieving 5 GtCO_2 emissions reductions at a cost of $40 per tonne would require a financial flow of $200 billion per annum. Such natural climate solutions (along with the phase-out of existing coal emissions considered in the next section) should be the highest priority use of international climate finance commitments.

Estimating a credible target for emissions reductions in the FOLU sector in the 2020s is therefore inherently more difficult than in relation to some other categories of action, but the technical potential is so great that achieving a best possible agreement and commitments at COP26 and after should be among the highest priorities. We estimate that a feasible programme of actions could reduce net emissions by around 7.5 GtCO_2 by 2030, of which 4.6 GtCO_2 result from reduced sources, with 2.9 GtCO_2 reflecting increased sinks (carbon removals).

In addition to nature-based forms of carbon sequestration it is possible to achieve carbon removal via carbon capture technologies combined with geological storage of CO_2, whether via BiCRS (Biomass Carbon Removal and Storage) or DACCS (direct air capture of CO_2 plus storage). The forthcoming ETC report on carbon removals assesses this opportunity, alongside nature-based solutions. The potential for BiCRS is limited by the supply of truly sustainable biomass[51] but the potential for DACCS is in technical terms limitless. It will however take time to reduce DACCS costs to reasonably affordable levels (e.g. $100 per tonne) and to build large-scale operations. For both technologies, early projects in the 2020s can pave the way for a larger scale up of engineered greenhouse gas removals beyond 2030. We estimate a realistic potential to use BiCRS and DACCS to achieve around 0.1 GtCO_2/year of additional emission reductions by 2030. All of this would be additional to current NDCs (Exhibit 19).

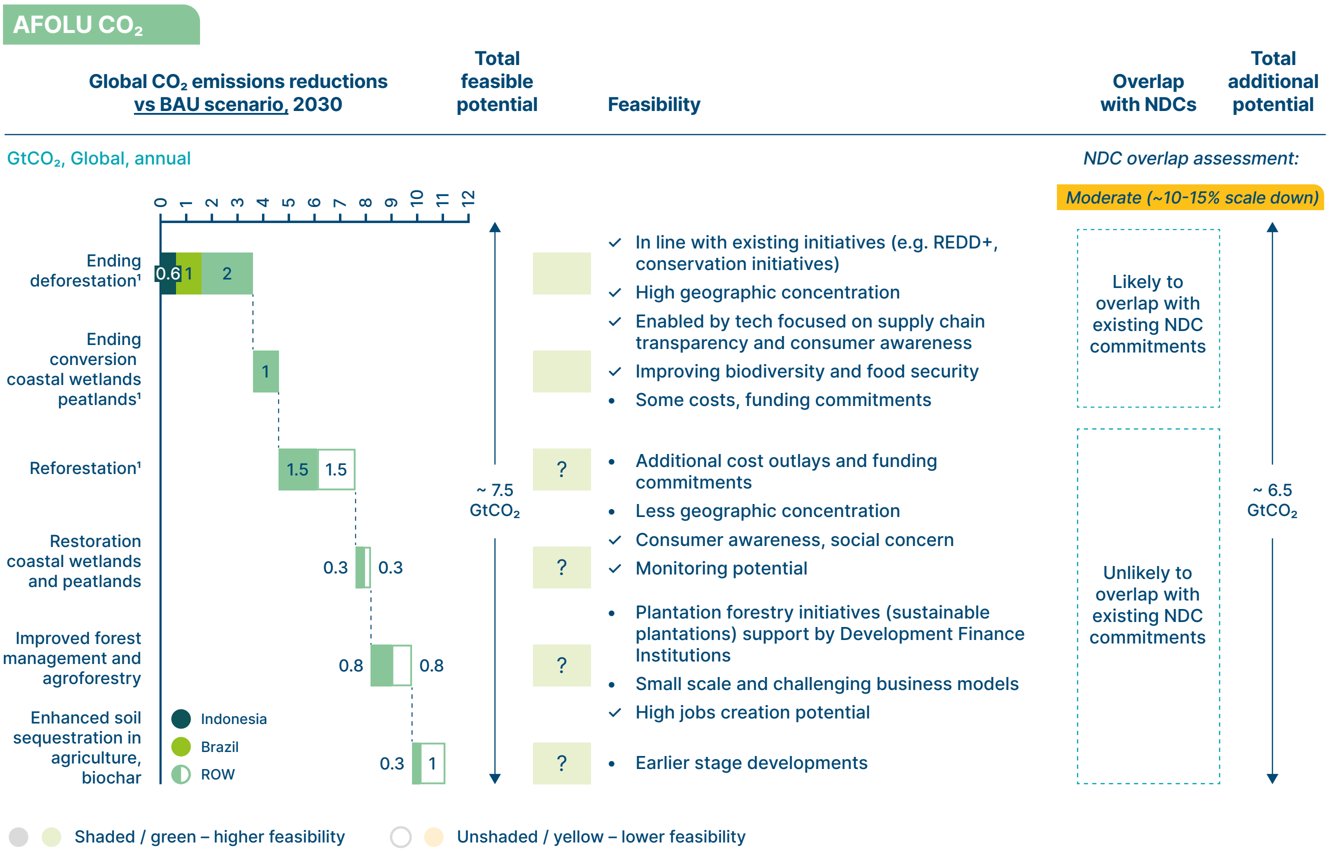
A majority of enhanced NDCs do reference nature-based solutions in their mitigation and adaptation strategies, but clear numerical targets are often lacking.[52] After allowing for a "moderate" overlap with current NDCs, we estimate additional potential reductions at 6.6 GtCO_2 per year by 2030. Specific actions required to deliver this are described in Exhibit 20.

50 The Climate Investment Fund's a Forest Investment Program (FIP) provides direct investments to address the drivers of deforestation and forest degradation providing grants and low-interest loans to governments, communities and business stakeholders. See CIF (2020) *Sustainable Forests*.

51 See ETC (2021) *Bioresources within a Net-Zero Emissions Economy: Making a Sustainable Approach Possible.*

52 WWF (2021) *NDCs – A Force for Nature? 3rd Edition Enhanced NDCs.*

Nature: 2030 emissions reduction and removals scope and feasibility

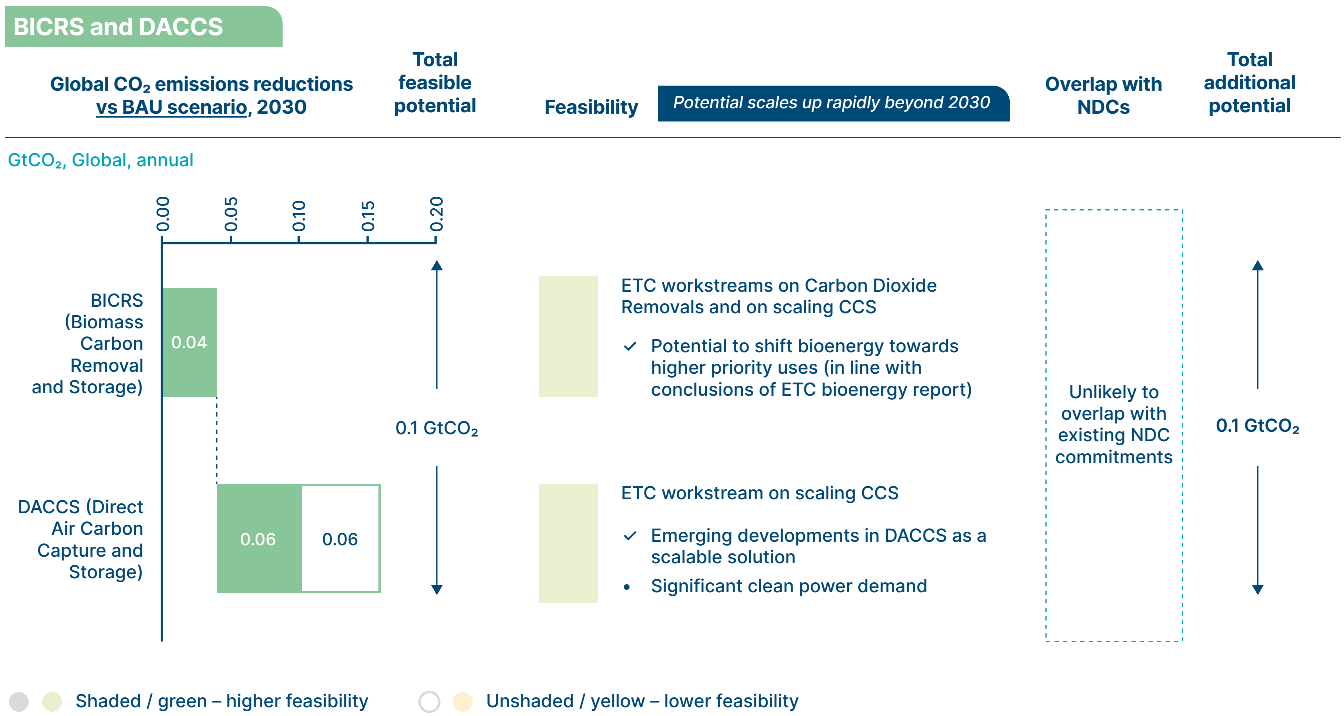


NOTE: [1] "Maximum additional" mitigation potential by 2030 from Griscom et al. (2017). Estimate is constrained to be consistent with meeting human needs for food and fiber.
[2] "Cost effective" mitigation at <$100/tCO₂ in 2030 from Griscom et al. (2017). Estimate is constrained to be consistent with meeting human needs for food and fiber, and avoiding negative impacts to biodiversity (no establishment of forests where they are not the native cover type).

SOURCE: Roe et al. (2019)

Exhibit 18

BiCRS and DACCS: 2030 emissions removals scope and feasibility



Source: Hanna R, Abdulla A, Xu Y, Victor DG. (2021), "Emergency deployment of direct air capture as a response to the climate crisis". Nat Commun., SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Exhibit 19

Nature-based solutions (including carbon removals)

Total feasible potential by 2030	7.6 $GtCO_2$
% NDCs scale down of sector	~ 10-15%
Additional feasible potential by 2030 beyond NDCs	6.6 $GtCO_2$

Target outcomes from COP26

A strong agreement on ending deforestation, supported by clear commitments for international climate finance from developed nations.

Key 2030 targets

- **95% reduction in deforestation and conversion of coastal wetlands and peatlands**, in tandem with support for sustainable livelihoods for dependent communities
- **1.8 Gt of CO_2 removals from afforestation** (on ~300 Mha) **and restoration of coastal wetlands and peatlands**, building on the Bonn Challenge
- **0.8 Gt of CO_2 removals from improved forest management & agroforestry**
- **0.3 Gt of CO_2 removals from enhanced soil sequestration in agriculture and biochar** (adoption of regenerative agriculture on ~400 Mha); **0.1 Gt of CO_2 removals from scaling BICRS and DACCS**

Supporting actions at international, national and company level in the 2020s	Primary actors
• **Commitment to halt deforestation** (esp. in Brazil, Indonesia, DRC), supported by financial support from developed countries (e.g. via Green Climate Fund, debt for nature swaps, grants)	• Developed and developing country governments
• **Commitments to develop deforestation-free supply chains**, building on existing initiatives (e.g. FACT Dialogue), and supported by due diligence standards, technology adoption for supply chain traceability, and individual action and public campaigns to scale deforestation-free consumption	• Leading food, agriculture, mining, forestry, and commodity trading companies and sectoral organisation • Consumers, encouraged by public information
• **Increase reforestation** via leader-level pledges, building on initiatives (e.g. REDD+, Bonn Challenge), in line with high integrity standards (e.g. IUCN)	• Developed and developing country governments
• **Expansion of carbon market mechanisms**, including Voluntary, non-Voluntary (e.g. EU ETS, CORSIA) with full accounting of land-use emissions and for high-quality, additional offsets	• Task Force on Scaling Voluntary Carbon Markets (TFSVCM), other offset related initiatives, potential buyers • Developed and developing country governments
• **Commitment to eliminating distorting agricultural subsidies** (e.g. soy, palm) **and support for high-yield crops** improving agricultural productivity	• Developed and developing country governments
• **Promote diet shift, "healthier calories", and reduced consumption** particularly in developed countries	• Developed and developing country governments • Leading food and agriculture companies Consumers
• **Commitments to accelerate standards and guidelines** for CO_2 storage development and appraisal process, sustainability of biomass feedstock	• Developed and developing country governments

Exhibit 20

4.3 Decarbonising the power sector – accelerating coal phase out

Power sector emissions were 13.2 $GtCO_2$ in 2019, of which 9.5 $GtCO_2$ came from coal-fired power. China accounts for just under half of all coal-fired power emissions (4.5 $GtCO_2$), and India for one-tenth (1 $GtCO_2$).[53] And while the pace of new coal developments has slowed, new coal plants are still being built in China and many developing countries. Even in OECD countries there are still 1.2 Gt of emissions from coal fired stations.

Reducing emissions from coal generation is therefore among the highest priority and highest potential actions. [54] It entails two distinct elements:

- First, **ensuring that the near totality of new growth of electricity capacity and generation**, concentrated primarily in developing economies, **is zero-carbon.**

- Secondly, by reducing emissions from existing coal generation in line with the IEA's Net Zero pathway which assumes that **the world can achieve zero carbon power systems by 2040, and earlier in developed economies**. This could be achieved by (i) retiring existing coal plants (in particular the older less efficient ones) before end of life, (ii) by using coal generating plants for less of the year, increasingly providing a backup to renewable generation, (iii) by adding CCS.

The first step is a close to costless action in most parts of the world. Solar PV or onshore wind is now the cheapest form of new power generation in countries that make up two-thirds of the global population and 90% of electricity generation.[55] ETC analysis of the Chinese and Indian power systems, shows moreover that it is technically feasible to rely entirely on zero carbon power sources (primarily VRE) for all electricity supply growth from now on, and such a strategy will impose very limited or no extra system cost, including allowance for all storage and flexibility requirements.[56] Fourty-four countries have already committed to 'no new coal', and the bulk of proposed new coal power is located in a small subset of countries, where action could be targeted.[57]

A crucial objective of COP26 should therefore be to gain agreement on a "no new coal" strategy, building on the UN's No New Coal initiative, supported by strong commitments from all major financial institutions and development banks, and national export credit agencies not to finance any new coal developments. We estimate that such a commitment could reduce 2030 emissions by another 0.7 $GtCO_2$.

The phase out of existing fossil assets will present a greater challenge, in particular given the relatively young age of the coal fleet in China and India, where recent additions have been concentrated (Exhibit 21). While in some locations the cost of new renewables is already below the marginal cost of running coal plants – therefore making the early coal retirement economically favourable - some existing plants, particularly those supported by existing Power Purchase Agreements (PPAs) over multiple years, will continue to be economic in years ahead unless significant carbon prices are imposed.[58] In these cases, early retirement of coal plants, or running them at lower utilisation rates may impose additional costs.[59] Adding CCS to these plants could extend their lifetime and increase their utilisation but would also come at additional cost. However, given the size of the opportunity, action to reduce existing coal emissions must be a high priority:

- In developed countries this should be accepted as a necessary contribution towards global climate mitigation, and COP26 should aim for a commitment that all OECD countries will close down unabated coal plants by 2030. This could deliver 1.2 $GtCO_2$ per year of emission reductions by 2030.

- In the case of lower-income developing countries, such as India or Indonesia, the early exit of a large portion of the existing coal fleet at additional cost will require support from climate finance, with some of the cost borne by richer developed economies, and the retirement of coal assets will also require well thought-out strategies for a just transition for affected workers.

53 BloombergNEF (2020) *New Energy Outlook*.

54 The focus of this set of actions is on coal retirement and its displacement via variable renewables (VRE) to meet power system demand and system growth (supply-side); effect of mitigation potential from additional electrification that is met via zero-carbon power (demand-side) is captured in other sectors.

55 ETC (2021) *Making Clean Electrification Possible*.

56 See TERI/ETC India (2020) *Renewable Power Pathways: Modelling the Integration of Wind and Solar in India by 2030* and RMI/ETC China (2021) *China Zero-Carbon Electricity Growth in the 2020s: A Vital Step Towards Carbon Neutrality*.

57 E3G (2021) *No New Coal by 2021*.

58 ETC (2021) *Making Clean Electrification Possible*.

59 See RMI (2020) *How to Retire Early* for an estimate of the costs of an early coal phaseout.

Power sector emissions in 2019 were 13 $GtCO_2$, with a significant share coming from coal in key regions; challenge is relatively young age of the coal fleet

Coal

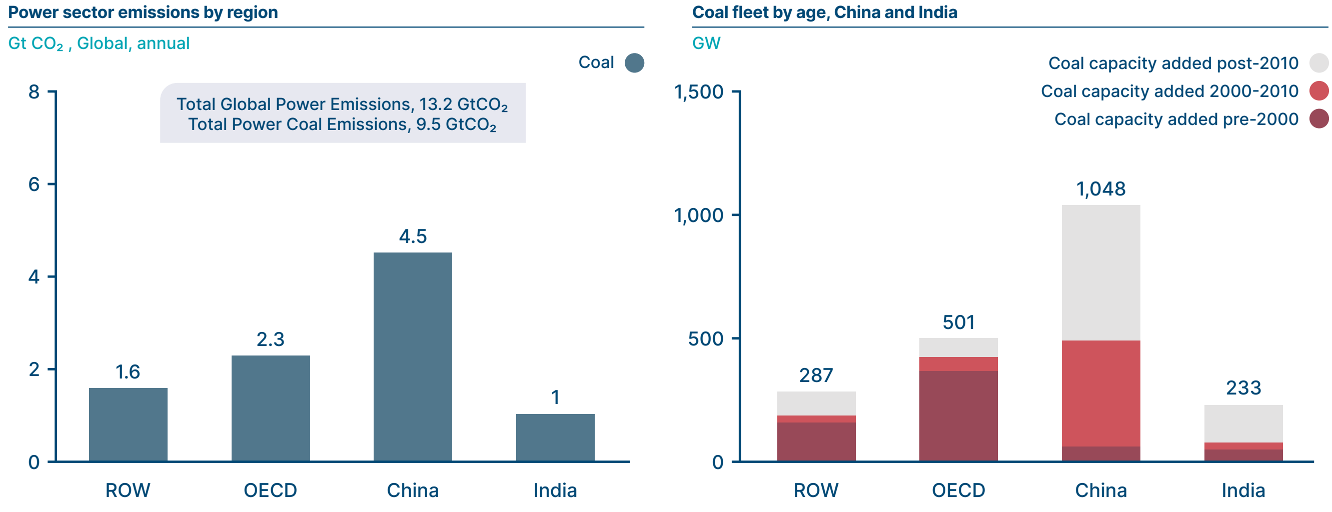


Exhibit 21

SOURCE: BloombergNEF (2020) *New Energy Outlook*, Global Energy Monitor Coal Plant database, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Phasing out existing non-OECD coal assets which will be 20 or more years old in 2030 (~760 GW including China and India), could in total reduce emissions by 2.7 $GtCO_2$/year by 2030, with 2.4 $GtCO_2$/year assessed as higher feasibility. A further 2.7 $GtCO_2$/year could be eliminated if newer non-OECD coal assets were retired early or equipped with CCS, but this is unlikely to be a feasible objective within the next 10 years and we consider only a small proportion of this to be possible (around 0.1 $GtCO_2$/year). Higher feasibility potential for coal phase out is also underpinned by the need for Just Transition strategies, via funding for early retirement and re-skilling on coal miners. At national level, employment effects from coal phase out will usually be more than offset by the extra jobs created by renewables, at least during the next 30 years of rapid capacity expansion.[60]

The COP26 Presidency is already aiming to gain a “no new coal” commitment at COP26; and many OECD countries are accelerating existing coal phase out. Going beyond this to phase out, coal in lower income countries would require significant commitment of developed country funds. If, for instance, the additional cost incurred for retiring coal assets early were two cents per kWh of electricity produced, the cost per Gt of emission reductions would be about $20-$25 billion.[61]

Alongside ending deforestation and increasing reforestation, this is the highest priority potential use of the climate funds which developed countries have promised.

In total, actions related to coal phase-out could deliver 4.6 $GtCO_2$ per year of emissions reductions by 2030, or 3.5 $GtCO_2$ after adjustment or actions already in NDCs (Exhibit 22). A significant share of the no new coal and OECD coal phase out reductions is probably already coverered by current NDCs, 87% of which refer explicitly to plans for VRE expansion alongside quantitative domestic targets for increased renewable energy share (for instance those submitted by the EU, China, India and Japan). [62] But early phase out of existing coal is not yet envisaged by China nor by any low income developing country. The specific actions to deliver this reduction are set out in Exhibit 23.

60 ETC (2021) *Making Clean Electrification Possible.*

61 Assuming 1000 Mt of emissions comes from 1 to 1.25 million GWh of coal generation, or 1000-1250 billion kilowatt-hours. At two cents per kilowatt-hour this is $20-$25 billion.

62 UNFCCC (Feb 2021) *Nationally Determined Contributions under the Paris Agreement: Synthesis report by the Secretariat;* IRENA (2019), *NDCs in 2020: Advancing renewables in the power sector and beyond,* International Renewable Energy Agency, Abu Dhabi.

Coal: 2030 emissions reduction scope and feasibility

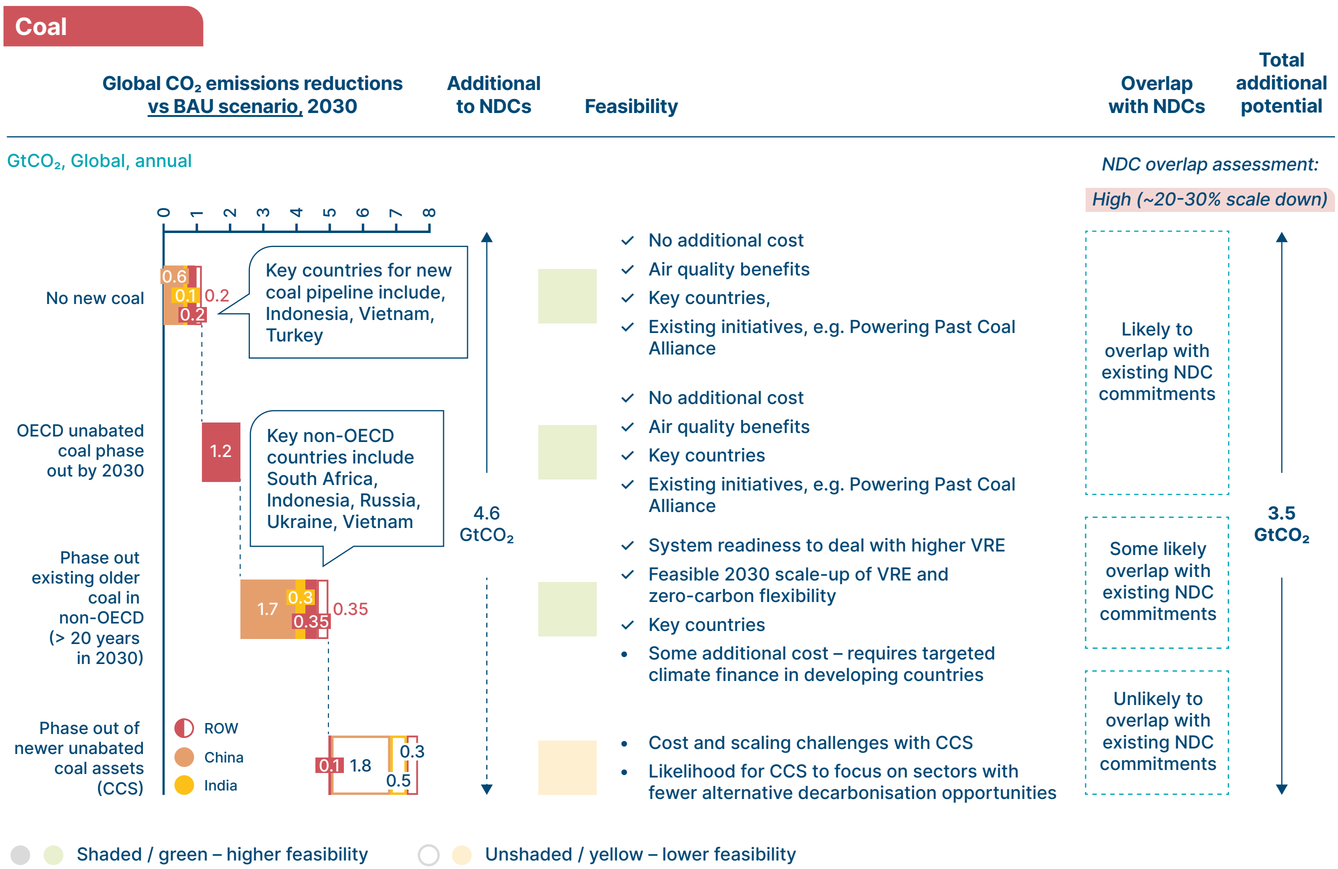


Exhibit 22

NOTE: CCS assumes 90% capture rate.

SOURCE: BloombergNEF (2020) *New Energy Outlook*, Global Energy Monitor Coal Plant database, IEA (2021) *Net Zero by 2050: A Roadmap for the Global Energy Sector*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Decarbonising the power sector

Target outcomes from COP26

Agreement between leading countries and companies to cut fossil methane emissions by 60% in the 2020s (building on the Global Methane Pledge) and to agree framework and common standards for monitoring and reporting (e.g. building on MiQ).

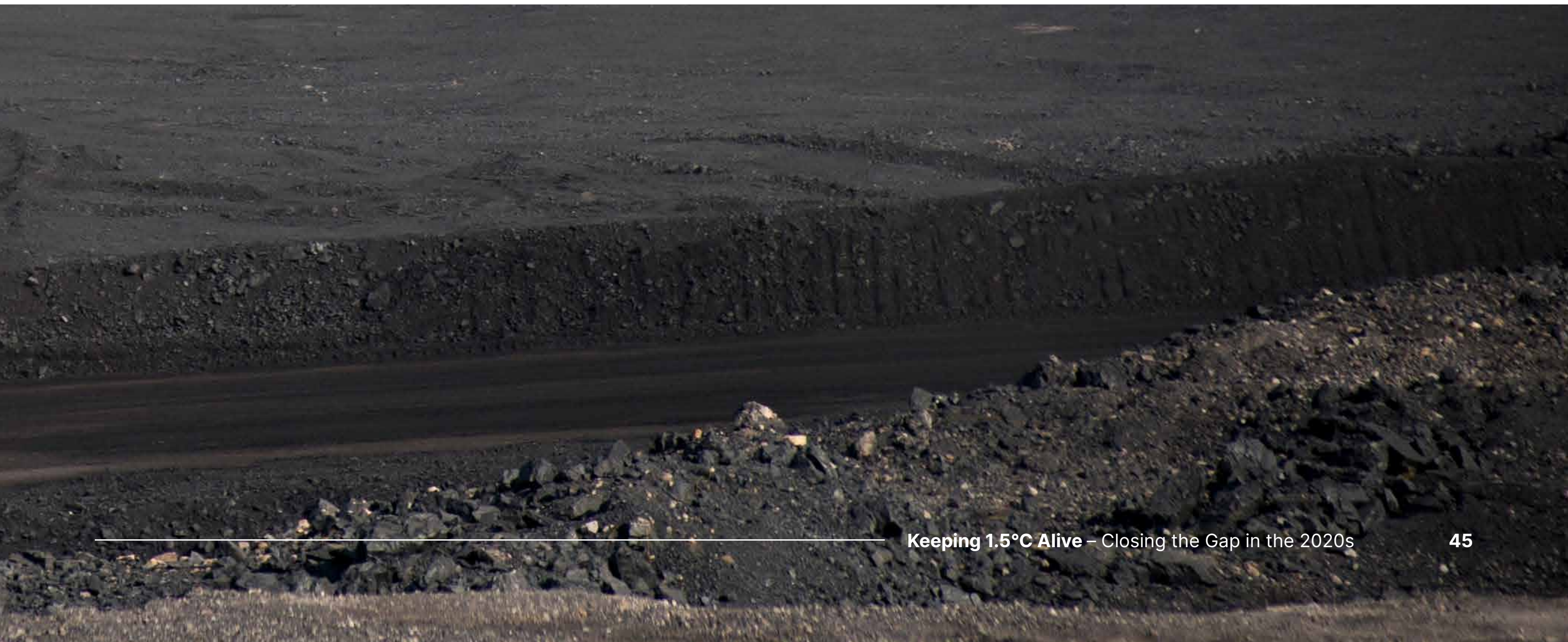
Total feasible potential by 2030	4.6 $GtCO_2$
% NDCs scale down of sector	~ 20-30%
Additional feasible potential by 2030 beyond NDCs	3.5 $GtCO_2$

2030 objectives

- **No new coal from 2022**
- **2030 coal phase out in OECD**
- **Phase out older existing coal plants built before 2010**

Supporting actions at international, national and company level in the 2020s	Primary actors
• **Commitment to 2030 unabated coal phase out in OECD** (e.g. via Powering Past Coal Alliance), alongside support for Just Transition strategies **Commitment to halt new coal projects** (esp. in China and India)	• China and India government • Developed country governments
• **Targeted financial support from developed countries** for early coal retirement in developing countries (e.g. India), e.g. via commitments from Green Climate Fund and/or via philanthropic/private sector capital	• Developed country governments • Multilateral financial institutions • Banks • Philanthropic capital
• **Immediate commitments not to finance new coal power plants, new coal mines or coal mine extensions, and to cease financing companies in coal mining during the 2020s**	• Multilateral financial institutions • Banks
• **Commitments to increased corporate procurement of renewables**, via initiatives such as RE100, in addition to **government-set quantitative targets** for growth of zero-carbon generation and reduction of grid carbon intensity (gCO_2/kWh)	• Energy-intensive industry • Tech, finance, consulting • Developed and developing country governments
• **Immediate end to fossil fuel subsidies** alongside redistributive measures • **Introduction and extension of carbon pricing**	• Developed and developing country governments

Exhibit 23



4.4 Accelerating road transport electrification

Road transport emissions were 6.5 GtCO_2 in 2019, with over half generated in the United States, Europe and China. Despite the dip in emissions driven by the Covid-19 pandemic, when emissions fell to 5.6 GtCO_2 in 2020, projections for road transport demand highlight growing emissions through the 2020s. This is driven by growth in the global vehicle stock, despite improvements in vehicle efficiency.[63]

However, technological progress and cost reductions now make it possible to phase out light duty Internal Combustion Engines (ICEs) far more rapidly than seemed feasible when the Paris agreement was signed. Battery prices have fallen 85% in 10 years and are projected to fall below $100/kWh by 2024, reaching $60/kWh by 2030, and still lower levels in the 2030s. Given the far lower fuel costs of EVs, some estimates suggest that the total cost of ownership (TCO) of EVs is already lower than that of ICEs for some segments. This advantage will extend to all light-duty segments and some heavy-duty segments over the next decade. Upfront costs could reach parity for some categories of light-duty vehicle as early as the mid-2020s and for most light-duty segments before 2030.[64]

New business models in the mobility sector, such as ride-hailing and car-sharing, are driving increased EV penetration (since low marginal operating costs already outweigh higher upfront costs when vehicle utilisation) and many delivery and mobility companies seeking to demonstrate sustainability credentials to customers and financiers are also early adopters.

EVs can also deliver other important co-benefits, such as improved local air quality. City governments have been increasingly focused on the promotion of better air quality, a trend that is heightened in the context of a global pandemic caused by a respiratory illness.[65] In addition many countries see a switch to EVs as an opportunity to grow industrial competitiveness in a new domain (e.g. as China has shown via the growth of domestic EV battery and car manufacturers).

ICE Sales Phase Out Announced plans

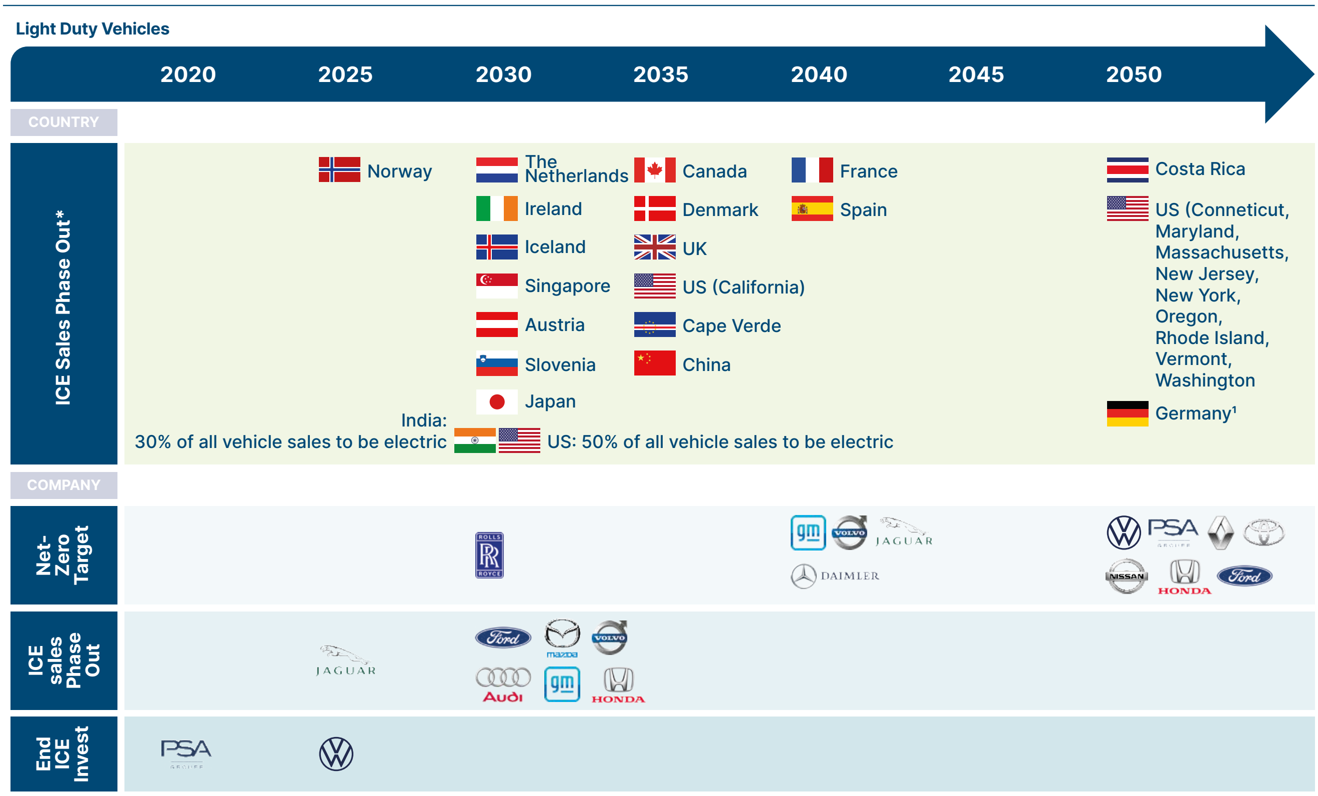


Exhibit 24

NOTES: * Selected markets. ICE phase out for some countries still includes hybrids.
¹ Not in national Climate Protection Plan.

SOURCES: ICCT (June 2021), BNEF (2021) *Long Term Electric Vehicle Outlook*, T&E, BNEF (2021) *Hitting the EV Inflection Point*.

63 BloombergNEF (2020) *Long-Term Electric Vehicle Outlook*.
64 BloombergNEF (2020) *Long-term Electric Vehicle Outlook*; ETC (2021) *Making Clean Electrification Possible*.
65 See for example London's Ultra Low Emission Zone (ULEZ).

As a result, and even without additional policy impetus, EVs are likely to account for the vast majority of light-duty vehicle sales by 2040, and in many countries even earlier. Many leading auto manufacturers have made commitments to selling only electric or hybrid vehicles by 2035 or earlier, and an increasing number of countries are also setting dates for the prohibition of ICE sales (Exhibit 24). Many NDCs however do not yet reflect the likely pace of development, let alone create pressure for further acceleration.

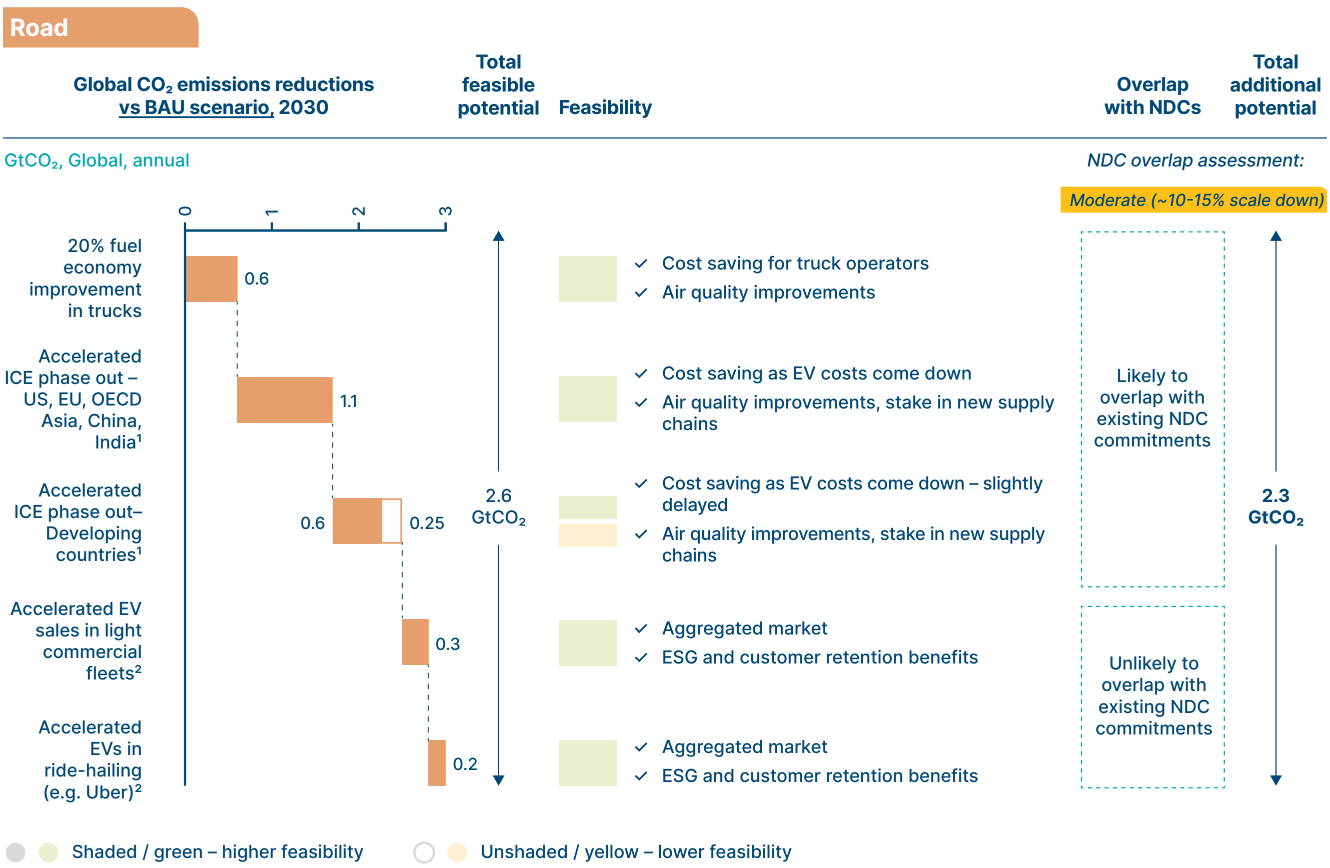
There is therefore a major low-cost opportunity to cut emissions faster than current NDCs assume. With vehicle sales and production concentrated in a relatively small number of countries and companies, ICE phase out agreements for light-duty vehicles between leading countries and companies could drive still faster technological progress and cost reduction, further reducing the cost of decarbonisation for other countries (in particular in the developing world).

An agreement at COP26 between leading countries and companies to ban all light-duty ICE sales by 2035 at the latest, supported by major city commitments to phase out the use of existing ICEs in city centres during the 2030s, and required investments in charging infrastructure, would therefore be a credible objective. Significant improvements in heavy-duty truck fuel efficiency could also be driven by agreements between major countries and companies, but may, in some instances come with additional cost.[66]

In total we estimate a technical potential of 3.0 $GtCO_2$/year reduction by 2030 of which as much as 2.75 $GtCO_2$/year should be feasible to achieve. Some of this potential is included in current NDCs, which often include references to energy efficiency improvement, but few of which make explicit reference to dates for ICE phase out.[67] Overall we estimate that about 2.3 $GtCO_2$/year of reduction could be additional to current NDCs (Exhibit 25). The key actions to achieve this are described in Exhibit 26.

Exhibit 25

Road: 2030 emissions reduction scope and feasibility



NOTE: ¹ Assuming that in 2030 EVs are 20% of global car stock, 54% 2/3W stock, 23% bus stock, 22% van stock, 8% truck stock (25% EV fleet average across segments).
² Assuming trajectory to 100% EV sales by 2030 in 'leader' countries, and 80% in 'laggard' countries for relevant fleets, equivalent to 24% LDV EV stock by 2030 (vs 15% EV stock in 2023 in BAU).

SOURCE: BloombergNEF (2020) *New Energy Outlook*, IEA (2021) *Net Zero by 2050: A Roadmap for the Global Energy Sector*, SYSTEMIQ analysis for The Climate Group (2021), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

66 Though additional costs for upfront vehicle purchase, could be offset by reduced fuel consumption over the lifetime.
67 UNFCCC (Feb 2021) *Nationally Determined Contributions under the Paris Agreement: Synthesis report by the Secretariat.*

Action from national Governments, and city and corporate actors at COP26 beyond can deliver over 2 Gt/year of emissions reductions by 2030

Decarbonising road transport

Total feasible potential by 2030	2.6 $GtCO_2$
% NDCs scale down of sector	~ 10-15%
Additional feasible potential by 2030 beyond NDCs	2.3 $GtCO_2$

Target outcomes from COP26

A strong agreement to commit to ending sales of light-duty ICE vehicles by 2035 at the latest, supported by clear targets from countries, cities and auto manufacturers.

2030 objectives

- **Achieve 20% global EV stock** in light duty vehicles
- **Achieve 10% global non-ICE stock** for heavy goods vehicles (HGVs)
- **Achieve 25% EV stock in corporate and mobility fleets** by 2030
- **Achieve 20% fuel efficiency** improvement in HGVs

Supporting actions at international, national and company level in the 2020s	Primary actors
• **Light-duty ICE sales bans by 2035**, and commitments from major automakers for 100% zero-emission vehicles by 2035	• Developed and developing country governments • Major auto manufacturers
• **Commitments to 100% new EV purchases in corporate and mobility fleets** by 2030 at the latest (e.g. via EV100)	• Logistics companies (e.g. Amazon) • Transport network companies (e.g. Uber)
• **Commitment to stringent fleet-wide fuel efficiency standards** for cars, vans and HGVs in gCO2/km from the 2020s	• Developed and developing country governments
• **Remove subsidies for petrol and diesel, maintain or increase taxation on petrol and diesel** to create incentives for heavy-duty transition	• Developed and developing country governments
• **Commitments to EV charging infrastructure rollout** with clear international standards, alongside potential road tolls and fees for ICE vehicles, scrappage schemes for ICE vehicles	• Developed and developing country, city governments
• **Bans and restrictions on use of ICE light duty vehicles in major cities aiming for comprehensive bans in most major cities** (reinforcing and accelerating the Cities Race to Zero and the C40 Green and Healthy Streets Declaration)	• City governments

Exhibit 26

4.5 Accelerating supply decarbonisation in buildings, heavy industry and heavy transport

At the time of the Paris agreement, most analysis assumed that it would be difficult and very expensive to decarbonise sectors where direct electrification was either impossible or more difficult than in light duty road transport. But the ETC's *Mission Possible* report of November 2018 showed that it is possible for all the so-called "hard-to-abate" sectors – such as steel, cement, chemicals, long-distance aviation and shipping – to achieve zero emissions by 2050 at very low costs to economic growth and consumer living standards. Key technologies to foster the transition alongside direct electrification include hydrogen, bioenergy and CCS.

Many leading companies and sectoral organisations within these sectors have now made commitments to achieve net zero emissions by 2050, and sectoral programmes within the MPP are developing feasible pathways from today to that 2050 objective.

These pathways are often "convex curve" in shape, with only limited progress in the 2030s, followed by acceleration in the 2030s. This in part reflects the inherent difficulty of achieving major early emission reductions in sectors which have long lasting capital assets such as steel or cement plants, ships or planes.

However, a feasible set of actions could still deliver over 1 $GtCO_2$ per year of additional emissions reductions from the hard to abate industrial and long-distance transport sectors, plus another 1 Gt from accelerated electrification of residential heating and industry (Exhibit 27).

- In the steel sector, which currently accounts for around 3 $GtCO_2$ of emissions per annum globally, analysis by the Net Zero Steel Initiative illustrates that up to 1.3 $GtCO_2$ could be eliminated by 2030 if carbon pricing reaching around $60/$tCO_2$ by 2030, or equivalent mechanisms were imposed. This level of decarbonisation would require around 50 near-zero carbon steel plants by 2030. This would result in increased steel prices, but the total cost impact on consumer living standards and economic growth would be minimal. Additionally, steel production is concentrated in a relatively small number of countries (China, Japan, Korea, the EU, the US and India), and leading steel companies have already committed to net zero by 2050. This increases the potential for coordinated action between a small group of countries and companies.

- Opportunities are smaller in long-distance shipping and aviation both because these account for smaller current emissions (about 1 Gt in each case) and because the costs of abatement per tonne of CO_2 are much higher. Despite this, forceful early action is essential to make a path to decarbonisation possible in the 2030s and 40s, through scaling up a market for low-carbon fuels. Additionally, the existence of international regulating bodies in these sectors, such as the IMO and ICAO, creates natural coordinating mechanisms which are missing in other sectors. Feasible commitments to ensure that 10% of the fuel burnt in shipping and aviation comes from new low carbon fuels by 2030 could together deliver 0.2 $GtCO_2$/year of additional abatement by 2030.

- MPP work on possible decarbonisation pathways in the chemicals and cement sectors is at an earlier stage, but it is likely that these sectors could also deliver abatement which is not covered by existing NDCs. A forthcoming report from the Global Cement and Concrete Association[68] suggest that today's 2.7 $GtCO_2$/year of cement and concrete -related emissions could be cut to around 2.3 $GtCO_2$/year by 2030, en route to zero by 2050.

- There is a major opportunity to drive accelerated decarbonisation in industry, as well as residential heat via more rapid electrification, with this heating opportunity concentrated in richer developed countries.

Progress in all of these sectors will be driven by a combination of direct electrification, and the use of hydrogen, CCS, and biofuels (in particular in aviation). Green hydrogen will play a major role, and coordinated international action to spur its development could play an important role in supporting sectoral decarbonisation initiatives.

In residential heat there are major opportunities to accelerate electrification using heat pumps,[69] with upfront investments delivering subsequent fuel cost reductions. Specific strategies in this arena are inherently national, given different starting points, but there could be a role for COP26 to galvanise action across the major affected countries (primarily richer nations in Northern latitudes) and to spur technological progress in heat pump efficiency improvement. National policies could complement this by banning new gas boiler installations. We estimate potential to reduce emissions by 1 $GtCO_2$/year by 2030.

In total, we estimate a reduction opportunity in these sectors of 2.2 $GtCO_2$/year by 2030, of which 2.1 $GtCO_2$/year would be additional to NDCs. This reflects the very limited ambition in most current NDCs for early decarbonisation of either the supposedly hard to abate sectors or residential heating.[70]

Action required to deliver this is described in Exhibit 28.

68 GCCA (October 2021) *Concrete Action.*

69 Or, in cases where electrification via heat pumps is difficult, using resistive heating (though this requires additional low-carbon electricity generation).

70 UNFCCC (Feb 2021) *Nationally Determined Contributions under the Paris Agreement: Synthesis report by the Secretariat.*

Other supply-side decarbonisation: 2030 emissions reduction scope and feasibility

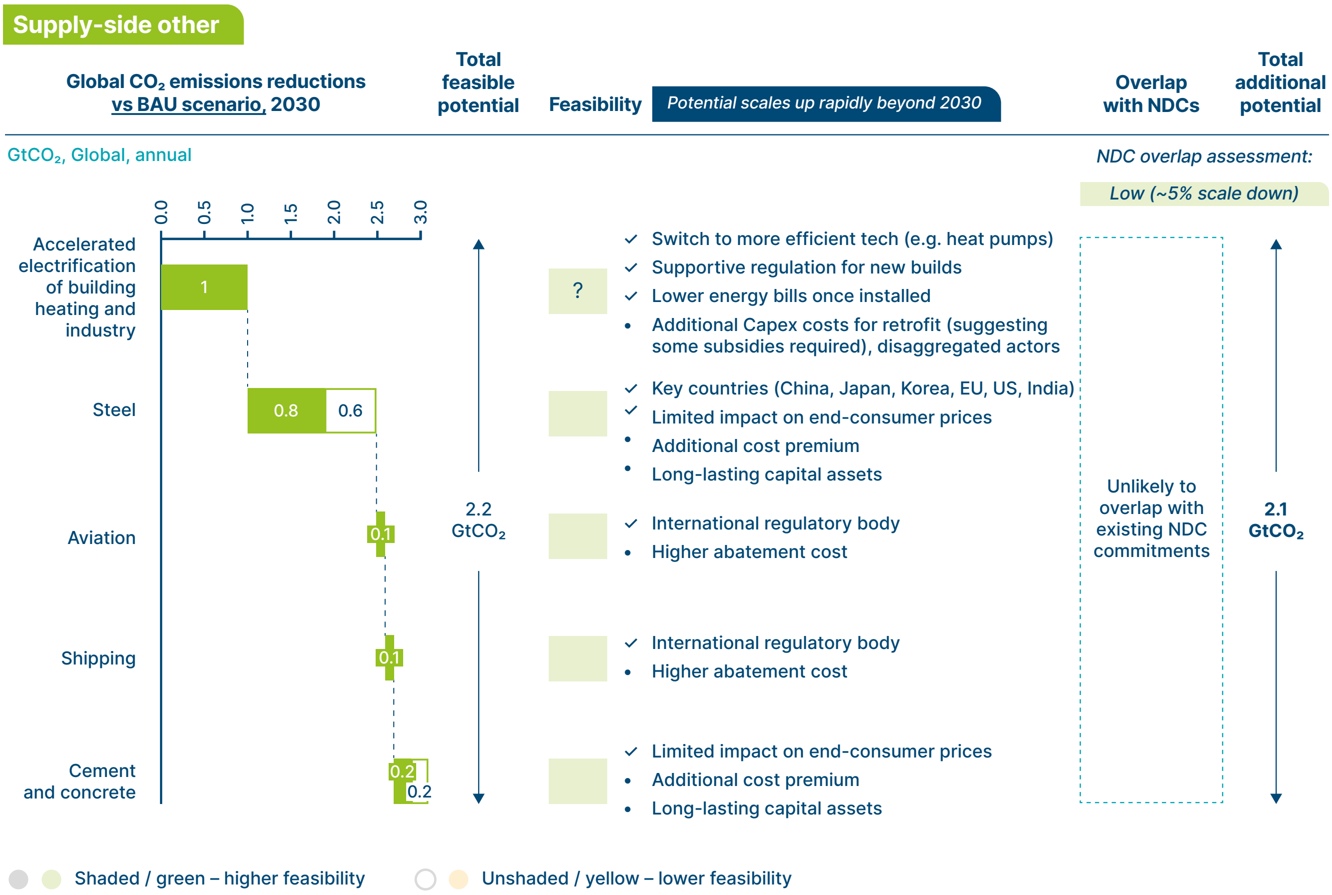
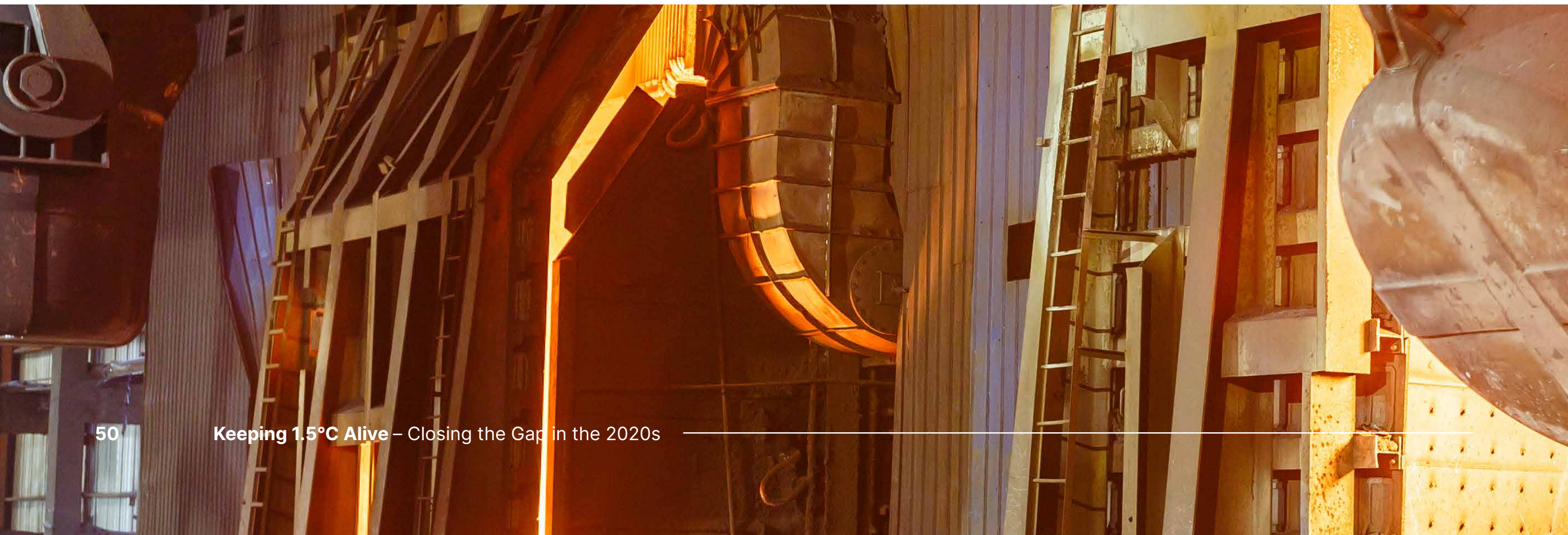


Exhibit 27

NOTE: [1] Represents impact from fuel switch for additional electrification in ETC scenarios vs BNEF BAU Power scenario, excluding impact on road transport.

SOURCE: Mission Possible Partnership Analysis, BloombergNEF, ETC (2021) *Bioresources within a Net-Zero Emissions Economy*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).



Supply-side decarbonisation in other sectors

Exhibit 28

Target outcomes from COP26

A strong agreement between leading coalitions of countries, companies and sectoral organisations to drive accelerated decarbonisation of the steel, cement, aviation and shipping sectors, building on existing sectoral initiatives such as the Net Zero Steel Initiative and the Getting to Zero Coalition for shipping.

Leading countries should also commit to accelerated electrification, and scaling up clean hydrogen.

Total feasible potential by 2030	2.2 $GtCO_2$
% NDCs scale down of sector	~ 5%
Additional feasible potential by 2030 beyond NDCs	2.1 $GtCO_2$

2030 objectives

- **1 Gt of CO_2 reductions from accelerated electrification** in buildings and industry
- **At least a 25% reduction in steel emissions** (implying a need for ~50 near zero-emissions steel plants)
- **10% sustainable aviation fuel (SAF) penetration**
- **5-7% zero-emission shipping fuel**

Supporting actions at international, national and company level in the 2020s	Primary actors
Introduce policy support to overcome "green cost premiums" via: • Carbon pricing, quantitative fuel mandates and contracts for difference • Public procurement (or voluntary/ encouraged private procurement) of decarbonised materials (e.g building on Clean Energy Ministerial Industrial Deep Decarbonisation Initiative • Regulated product standards – carbon emissions intensity of materials (e.g. steel or cement), or lifecycle emissions standards on end-products (e.g. auto, white goods) to create markets for decarbonised materials	• Developed and developing country governments Energy-intensive industries • Major customers of energy-intensive industries (automotive, construction, international freight)
• **Strengthening of IMO 2050 target** for 50% reduction to net zero with strong 2030 reduction target and supporting policy measures (e.g carbon price, zero carbon fuel mandate) • **Strengthening of ICAO 2050 target** for 50% reduction to net zero with strong 2030 reduction target and supporting policy measures (e.g carbon price, zero carbon fuel mandate)	• IMO and constituent members • ICAO and constituent members • Developed and developing country governments
• **National/ regional commitments from public and private stakeholders to develop green hydrogen capacity** (e.g EU commitment to 40 GW by 2030, Green Hydrogen Catapult objective of 25GW by 2026), and **regulations to switch existing hydrogen use to clean hydrogen**	• Developed and developing country governments • Energy producers, energy-intensive industries
• **Commitments to phasing out the use of gas boilers** in new builds by 2025, and to support heat pump deployment and technological advance	• Developed, developing country and city governments

4.6 Energy and resource efficiency improvements

In principle improvements in energy productivity (GDP per unit of energy consumed) should be a significant opportunity for low-cost reductions in the 2020s. Major opportunities exist along three dimensions:

- **Improvements in the energy efficiency of buildings, appliances, transport and industrial equipment.** For example, an initiative to double the efficiency of air conditioning, lighting and appliances in key countries, could lead to a reduction of at least 0.5 $GtCO_2$/year by 2030.[71]

- **Improvements in material efficiency and circularity**, for instance through better designed buildings which require less steel or cement input, and greatly increased recycling or reuse multiple products.

- **Wider improvements in energy productivity**, for instance through the development of shared transport systems or better designed cities which reduce transport emissions while still delivering high quality mobility services. These wider energy productivity improvements sometimes rely on consumer behaviour change, e.g. via shifts in modes of transport (e.g. towards ride-hailing, car-sharing, micromobility), as well as investments in upgrades to city design (e.g. cycling lanes).

Many past analyses have identified large opportunities along each of these dimensions, many of which are in principle available at low or negative cost, and most of which can be achieved with technology already available. In its *Net Zero by 2050* report, the IEA estimated that 25% of the CO_2 reductions attainable by 2030 – amounting to 5 $GtCO_2$/year – could come from either energy efficiency improvements or behaviour change, with a further 8 $GtCO_2$/year reduction possible in the subsequent 20 years (Exhibit 29). Additionally, the IRP (2018) report *The Weight of Cities* highlighted the emissions savings potential through redesigning infrastructure in cities, and that this could be achieved with limited investment, delivered by compact forms with higher densities, smaller scale urban blocks and dense street patterns, and retrofitting buildings to be more energy efficient.[72]

Energy and resource efficiency: 2030 emissions reduction scope and feasibility

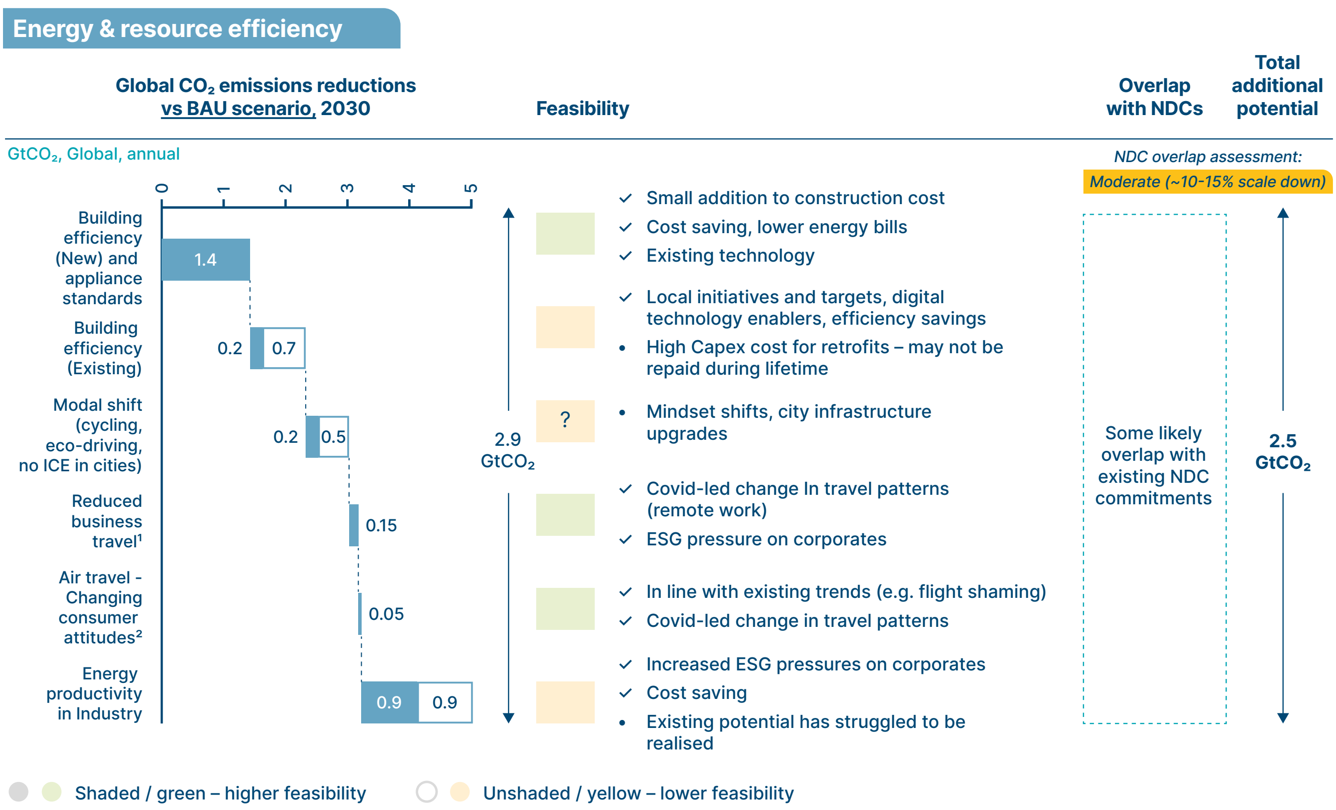


Exhibit 29

NOTE: [1] Reducing business class flights by 50% [2] 5% reduction of air travel.

SOURCE: Climate Action Tracker research, IEA (2021) *Net Zero by 2050: A Roadmap for the Global Energy Sector*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

71 See *COP26 Product Efficiency Call to Action*. Overall savings have been scaled down to reflect a reduction in coal in the power sector in the ETC's analysis.

72 IRP (2018) *The Weight of Cities: Resource Requirements of Future Urbanization*.

However, recent improvements in energy productivity have been disappointing, with annual improvement rates of only 1.5% in 2018 and 1.6% in 2019, falling to just 0.8% in 2020, as low energy prices, induced by the COVID-19 crisis, diluted incentives to reduce energy use.[73]

This disappointing performance reflects the inherent nature of many energy and resource efficiency opportunities. Some depend on actions with large lead times before full results, such as better city design. Many depend on action by a large number of diverse producers and consumers, making it more difficult to design specific policies and projects which can drive rapid progress in the way that is possible in the power system or road transport. And in some areas – for example the renovation of existing buildings - rapid action will only occur if governments set clear requirements and renovation standards. Finally, behaviour change often only occurs after slowly growing shifts in consumer perception, with political resistance to driving rapid and enforced change. Moreover, strong action on all aspects of energy productivity during the 2020s is essential to drive more rapid reductions in the 2030s and 2040s.

Giving this complexity, our scenario assumes that a lower proportion of the technically feasible opportunity for energy productivity improvement can be realised than in the other five categories (Exhibit 29). But out of 5 $GtCO_2$/year of technically feasible progress (broadly in line with the IEA's Net Zero pathway), an estimated 2.9 $GtCO_2$/year could be seized, if COP26 was the launching pad for multiple initiatives agreed by leading national, local and city governments and by leading companies who can play a major role in driving increased recycling (Exhibit 30).

The overlap between actions and current NDCs is assessed as "moderate". Although many countries identify improved energy efficiency for buildings as a key action, only 25% focus on opportunities in industry, with policies to improve material circularity often vague and unambitious.[74] Actions to induce changes in behaviour that could improve energy efficiency are less frequent, and lacking in specificity. Accounting for this "moderate" overlap, the additional potential would be 2.5 $GtCO_2$/year.

Exhibit 30

Energy and resource efficiency

Total feasible potential by 2030	2.9 $GtCO_2$
% NDCs scale down of sector	~ 10-15%
Additional feasible potential by 2030 beyond NDCs	2.5 $GtCO_2$

Target outcomes from COP26

A strong agreement to make energy and resource efficiency improvements key features of future NDCs, supported by adoption of best-in-class building standards and product efficiencies (e.g. via the Product Efficiency Call to Action).

2030 objectives

- **15%+ reduction in building emissions from non-heating efficiency** (implying a doubling of the efficiency of air conditioning, lighting and appliances in key countries and a commitment to zero-emissions in new builds from 2021 in OECD and from 2025 in non-OECD)
- **5%+ reduction in transport emissions from additional efficiency and reduced consumption** (including 20% reduction in total aviation emissions), driven by modal shift away from cars in urban centres, reduced business air travel and lower air travel demand growth
- **10%+ reduction in industry emissions from efficiency and reduced consumption**, driven by improvements across energy, material, and service efficiency

Supporting actions at international, national and company level in the 2020s	Primary actors
• **Global commitments to adopt best-in-class building & appliance efficiency** (e.g. via C40 Net-Zero Buildings Declaration, C40 Construction Declaration, Super Efficient Equipment & Appliance Deployment, PECA, Kigali Cooling Efficiency Programme) **and fiscal support for retrofits**	• Developed, developing country and city governments
• **Commitments from major cities to develop net zero mobility plans**, decreasing the need for individual road transport (e.g. via Cities Race to Zero, C40 Green and Healthy Streets Declaration)	• City governments
• **Commitments to increase taxation** of business class flights and short-haul flights and commitments to reducing flying	• Developed and developing country governments • Tech, finance, consulting
• **Separate collection of waste and recyclables and recycling/collection targets**, commitments to repair, light weighting targets, supply chain transparency	• Developed, developing country and city governments • Energy-intensive industry

73 IEA (2020) *Energy Efficiency 2020*.
74 UNFCCC (Feb 2021) *Nationally Determined Contributions under the Paris Agreement: Synthesis report by the Secretariat.*

Adding it up – Can we close the gap?

The six actions identified in this report could in principle close over 90% of the gap between the emissions pathway implied by the latest NDCs and what is required for the world to be on a path to limit global warming to 1.5°C by 2030. Exhibits 31 and 32 show our estimate of potential reductions with the figures adjusted to remove estimated overlap with NDCs.

- **Feasible methane emission cuts of 130 $MtCH_4$ per year beyond current NDCs** could deliver the carbon equivalent of between 3.5 $GtCO_2$ (100-year view) 11 $GtCO_2$ (20-year view) of emissions reductions by 2030.

- **Ending deforestation, beginning reforestation, improving forest management and agroforestry, and deploying BiCRS and DACCS** could achieve around 6.6 $GtCO_2$ per year by 2030.

- **Commitments to build no new coal power assets and to begin the phase out of existing coal generation** could deliver 3.5 $GtCO_2$ of additional reduction.

- **And a combination of actions in road transport, heavy industry, shipping and aviation, and through the acceleration of energy efficiency and productivity improvements**, could deliver an additional 7 $GtCO_2$ of reductions.

To different degrees, these actions could be the subject of focused, practical collaborations between groups of countries, and/or companies - which COP26 could launch, or where they exist, strengthen.

The biggest uncertainties among the six categories of action identified relate to nature-based solutions and the retirement of existing coal assets – since both will likely require financial commitments by rich developed countries (or companies) to support accelerated action in lower income developing nations.

By contrast, most of actions required to achieve methane reduction, road transport and energy productivity-based emission reductions are possible at very low or no additional cost, while accelerated action to decarbonise heavy industry, shipping and aviation will impose costs which can be easily absorbed since diffused across the global economy, very small relative to global GDP, and primarily eventually borne by rich country consumers.

But new commitments and agreements at COP26 would accelerate that progress yet further. Indeed recent technological and cost reduction progress, combined with company and sectoral commitments make it likely that in many sectors emissions reductions will progress faster than current NDCs even without new agreements. Moreover across all sectors of the economy, the stronger the reduction commitments made, and the more that countries work together, the faster technological progress, economy of scale and learning curve effects will drive down the cost of emission reductions, in some cases to costs below that of the high carbon equivalent.

Other actions to fill (and go beyond) the remaining emissions gap are also certainly technically feasible, and some of these have been identified in the individual sections of this report. However, these actions have been excluded from our summary total either because they are likely to entail higher cost, or because the multiplicity and diversity of the decision makers involved makes it more difficult for them to be progressed by agreements between coalitions of leading countries, companies and other actors.

Faster progress on these and other opportunities will need to be covered by further tightening of country NDCs in the future and encouraged by wide-ranging policy levers such as carbon pricing.

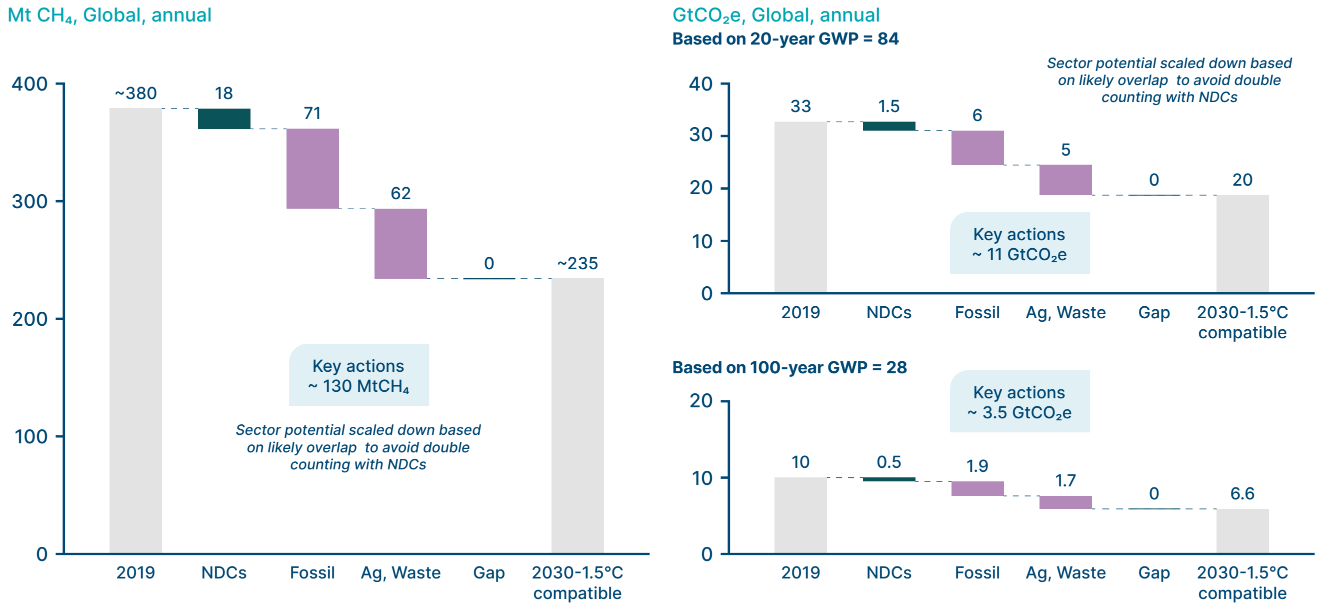
Overall, the conclusion of this report is that there are technically feasible and reasonably cost-effective actions which would give the world a 50% chance of limiting global warming to 1.5°C while delivering a 90% chance of limiting warming to 2°C.

A 1.5°C pathway is not yet out of reach: but we are running out of time to make it attainable. COP26 must catalyse the actions required to attain it.

Exhibit 31

Highly feasible actions to reduce methane can deliver an additional ~130 $MtCH_4$ (3.5-11 $GtCO_2e$) beyond current NDCs in 2030

Global CH_4 emissions



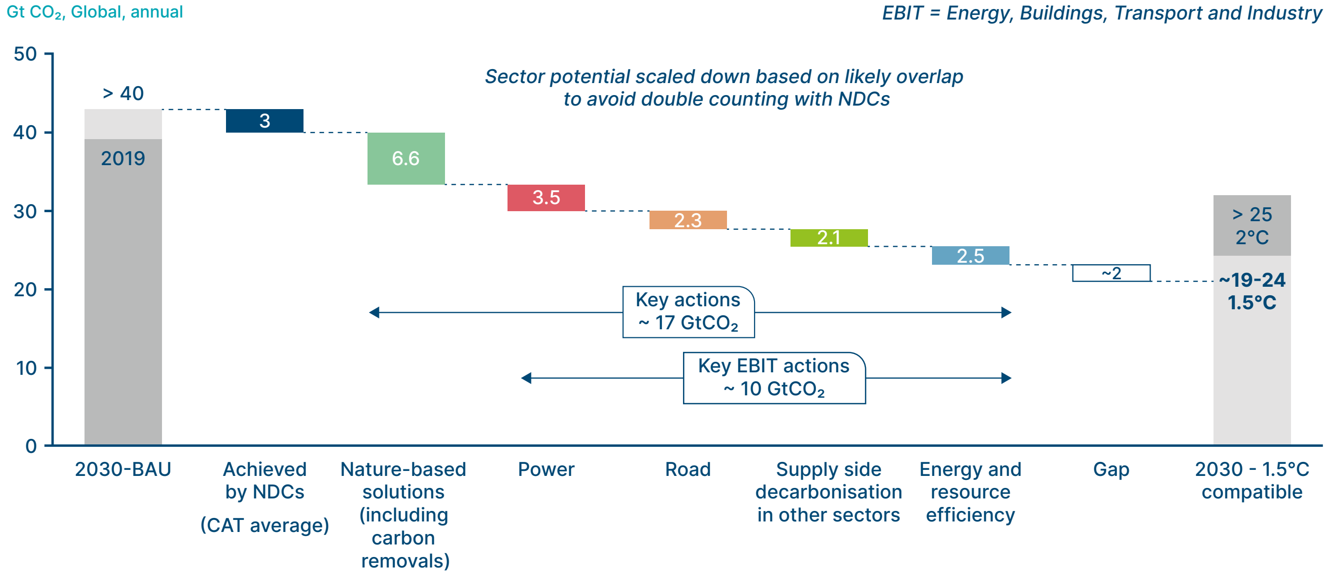
NOTE: NDC emissions reductions are based on average of CAT "pledges and targets" pathway adjusted for CH_4. 1.5C compatible levels in 2030 are based on IPCC 1.5C no/low overshoot scenario median.

SOURCE: IPCC (2018), *Global warming of 1.5°C. An IPCC Special Report*, Climate Action Tracker (CAT), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Exhibit 32

Highly feasible actions to reduce carbon dioxide can deliver an additional ~17 $GtCO_2$ reductions beyond current NDCs in 2030

Global CO_2 emissions



NOTE: 2030 BAU CO_2 emissions are estimated based on CAT CO_2e 2030 BAU average (53$GtCO_2e$) minus current methane levels in GWP=25 terms (9.3 $GtCO_2e$). NDC emissions reductions are estimated based on average of CAT "pledges and targets" pathway adjusted for CO_2. 1.5°C and 2°C compatible levels in 2030 are based on IPCC 1.5°C no/low overshoot scenario ranges.

SOURCE: IPCC (2018), *Global warming of 1.5°C. An IPCC Special Report*, Climate Action Tracker (CAT), SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Chapter 6

Actions at and after COP26

By COP26 the submitted NDCs are likely to fall well short of what is required to put the world on a 1.5°C compatible pathway. But this report has identified a suite of technically and economically feasible actions which could be implemented during the 2020s to deliver sufficient reductions by 2030 to make a 1.5°C limit still attainable. A comprehensive summary of these actions is presented in the tables at the end of this section.

The ideal outcome of COP26 would therefore be a set of collaboration efforts between leading countries, companies and other actors which – building on the NDCs – would accelerate action to deliver the six categories of additional reductions. For many of the actions identified in this report, initiatives are already underway, driven by the COP26 Presidency and the High-Level Champions (such as initiatives on phasing out coal in power generation, nature-based solutions and road transport)[75].

Implementing these initiatives is a challenging but plausible aim for COP26 and beyond. However even if implemented, the current initiatives will not be sufficient to close the entirety of the gap in the way which Exhibit 32 suggests is possible. But they could catalyse a process which could close the gap over the next few years. This process could entail:

- **Gaining widespread agreement that the six categories of action identified in this report are in principle feasible and economically affordable**, and that the world should seek to agree action programmes for each category as soon as possible;
- **Launching processes at COP26 which will drive further progress on the highest priority actions**, for instance by gaining international agreement to establish an independent monitoring and reporting process for methane emissions along with targets for methane emissions reduction;
- **Gaining agreement to a high level approach which could ensure tightening of future NDC commitments, reflecting progress on the actions and agreements identified in this report, which will be subject to the UNFCCC stock take in 2023.**

Key outcomes at COP26 are:

- **Country and company to cut global fossil methane emissions by 60% in the 2020s (building on the Global Methane Pledge).**
- **Country and company commitments to cut non fossil methane emissions by 30% in the 2020s, building on the Global Methane Pledge.**
- **Strong agreement on ending deforestation and driving ecosystem restoration, supported by clear commitments for international climate finance from developed nations.**
- **Strong agreement between major countries to move beyond coal in the 2020s, with clear commitments to no new coal, and developed country support for early exit.**
- **Strong agreement to commit to ending sales of light-duty ICE vehicles by 2035 at the latest, supported by clear targets from countries, cities and auto manufacturers.**
- **Strong agreement between countries, companies and sectoral organisations for accelerated decarbonisation of the steel, cement, aviation and shipping sectors.**
- **Strong agreement to make energy and resource efficiency key features of future NDCs, supported by adoption of best-in-class building standards, product efficiencies.**

75 For example, The Race to Zero campaign commits those companies that sign up, across all sectors, to halving emissions by 2030 and achieving net zero emissions as soon as possible - and by 2050 at the latest. The Powering Past Coal Alliance secures commitments to phase out existing coal power from national governments, and subnational actors. The actions identified here can be driven in part through initiatives like this.

Key actions at international, national and company level to keep Paris Agreement aims in reach

Additional feasible potential by 2030 beyond NDCs

71 $MtCH_4$ — Accelerating reductions from methane - *Fossil sector*

Commitments to standardised international satellite monitoring programmes for methane emissions measurement

Strong national regulations, starting in the top emitting countries, specifying maximum acceptable leak rates (well below 1%) and applying large fines for excess leaks

Demand-side pressure from large bloc-buyers setting maximum acceptable leak rates

Clear and ambitious commitments from companies (e.g. going beyond OGCI's goal of 20% reduction by 2025) to take actions and deploy technologies (e.g. replacement of pumps, electric motors, and other devices, installation of new emissions control devices such as vapour recovery units, deploying leak detection and repair)

Certification schemes which can enable customers to assess the full climate impact of oil or gas consumption (e.g. MIQ)

Clear commitments by the financial sector to cease funding oil and gas companies which fail to meet appropriate methane reduction standards

62 $MtCH_4$ — Accelerating reductions from methane - *Agriculture and Waste sector*

Individual action encouraged by government and industry public awareness campaigns to scale adoption of plant-rich diets

Commitment to develop labelling for low-methane meat, milk, and rice, and work with value chain to set low-methane standards,

Support for development of alternative proteins

Commitment to phase out policy support for intensive livestock farming and distorting subsidies

Industry commitments to reducing food waste arising on farms and in transit, e.g. via technology to improve supply chain effectiveness and procurement standards

Investment in wastewater treatment, particularly in developing countries **enabled by development finance**

Investment in waste collection, including separating organic and non-organic wastes, and recyclables

6.6 $GtCO_2$ — Nature-based solutions

Commitment to halt deforestation (esp. in Brazil, Indonesia, DRC), supported by financial support from developed countries (e.g. via Green Climate Fund, debt for nature swaps, grants)

Commitments to develop deforestation-free supply chains, building on existing initiatives (e.g. FACT Dialogue), and supported by due diligence standards, technology adoption for supply chain traceability, and individual action and public campaigns to scale deforestation-free consumption

Increase reforestation via leader-level pledges, building on initiatives (e.g. REDD+, Bonn Challenge), in line with high integrity standards (e.g. IUCN)

Expansion of carbon market mechanisms, including Voluntary, non-Voluntary (e.g. EU ETS, CORSIA) with full accounting of land-use emissions and for high-quality, additional offsets

Commitment to eliminating distorting agricultural subsidies (e.g. soy, palm) **and support for high-yield crops** improving agricultural productivity

Promote diet shift, "healthier calories", and reduced consumption particularly in developed countries

Commitments to accelerate standards and guidelines for CO_2 storage development and appraisal process, sustainability of biomass feedstock

3.5 $GtCO_2$ Decarbonising the power sector

Commitment to 2030 unabated coal phase out in OECD (e.g. via Powering Past Coal Alliance), alongside support for Just Transition strategies

Commitment to halt new coal projects (esp. in China and India)

Targeted financial support from developed countries for early coal retirement in developing countries (e.g. India), e.g. via commitments from Green Climate Fund and/or via philanthropic/private sector capital

Immediate commitments not to finance new coal power plants, new coal mines or coal mine extensions, and to cease financing companies in coal mining during the 2020s

Commitments to increased corporate procurement of renewables, via initiatives such as RE100, in addition to **government-set quantitative targets** for growth of zero-carbon generation and reduction of grid carbon intensity (gCO_2/kWh)

Immediate end to fossil fuel subsidies alongside redistributive measures

Introduction and extension of carbon pricing

2.5 $GtCO_2$ Energy and resource efficiency

Global commitments to adopt best-in-class building & appliance efficiency (e.g. via C40 Net-Zero Buildings Declaration, C40 Construction Declaration, Super Efficient Equipment & Appliance Deployment, PECA, Kigali Cooling Efficiency Programme) **and fiscal support for retrofits**

Commitments from major cities to develop net zero mobility plans, decreasing the need for individual road transport (e.g. via Cities Race to Zero, C40 Green and Healthy Streets Declaration)

Commitments from major cities to develop net zero mobility plans, decreasing the need for individual road transport (e.g. via Cities Race to Zero, C40 Green and Healthy Streets Declaration)

Commitments to increase taxation of business class flights and short-haul flights and commitments to reducing flying

Separate collection of waste and recyclables and recycling/collection targets, commitments to repair, light weighting targets, supply chain transparency

2.3 $GtCO_2$ Decarbonising road transport

Light-duty ICE sales bans by 2035, and commitments from major automakers for 100% zero-emission vehicles by 2035

Commitments to 100% new EV purchases in corporate and mobility fleets by 2030 at the latest (e.g. via EV100)

Commitment to stringent fleet-wide fuel efficiency standards for cars, vans and HGVs in gCO_2/km from the 2020s

Remove subsidies for petrol and diesel, maintain or increase taxation on petrol and diesel to create incentives for heavy-duty transition

Commitments to EV charging infrastructure rollout with clear international standards, alongside potential road tolls and fees for ICE vehicles, scrappage schemes for ICE vehicles

Bans and restrictions on use of ICE light duty vehicles in major cities aiming for comprehensive bans in most major cities (reinforcing and accelerating the Cities Race to Zero and the C40 Green and Healthy Streets Declaration)

2.1 $GtCO_2$ Supply-side decarbonisation in other sectors

- Carbon pricing, quantitative fuel mandates and contracts for difference
- Public procurement (or voluntary/ encouraged private procurement) of decarbonised materials (e.g building on Clean Energy Ministerial Industrial Deep Decarbonisation Initiative
- Regulated product standards – carbon emissions intensity of materials (e.g. steel or cement), or lifecycle emissions standards on end-products (e.g. auto, white goods) to create markets for decarbonised materials

Strengthening of IMO 2050 target for 50% reduction to net zero with strong 2030 reduction target and supporting policy measures (e.g carbon price, zero carbon fuel mandate)

Strengthening of ICAO 2050 target for 50% reduction to net zero with strong 2030 reduction target and supporting policy measures (e.g carbon price, zero carbon fuel mandate)

National/ regional commitments from public and private stakeholders to develop green hydrogen capacity (e.g EU commitment to 40 GW by 2030, Green Hydrogen Catapult objective of 25GW by 2026), and **regulations to switch existing hydrogen use to clean hydrogen**

Commitments to phasing out the use of gas boilers in new builds by 2025, and to support heat pump deployment and technological advance

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The team that developed this report comprised:

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